EPA Superfund
Proposed Record of Decision:
IRON MOUNTAIN MINE
EPA ID: CAD980498612
OU 06
REDDING, CA
06/02/2008

PART 1: DECLARATION

1.1 Site Name and Location

National Priorities List (NPL) Site Information (shown on Figure 1): Iron Mountain Mine (IMM), Shasta County, California (approximately 9 miles northwest of Redding, California) Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS) Identification Number CAD980498612 Operable Unit Information (shown on Figure 2): Iron Mountain Mining Operable Unit (OU) Number 6 The location map is shown on Figure 1, and site features are shown on Figure 2.

1.2 Statement of Basis and Purpose

This decision document presents the selected remedial action for control of releases of hazardous substances (i.e., acid mine drainage) from the Iron Mountain Mine (IMM), Shasta County, California, OU 6 of the Iron Mountain Mine Site. The selected 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 of 1986 (SARA), and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record file for this Record of Decision (ROD). The State of California concurs with the selected remedial action for acid mine drainage from Iron Mountain Mine.

1.3 Assessment of the Site

The mines at the IMM Site are discharging acidic waters, typically with a high concentration of heavy metals. The discharges are referred to as acid mine drainage, or AMD.

From the assessment of 1996, when the mine was discharging an average of 372 lbs. of copper per day, to the 2003 assessment, when it was determined that the mine was discharging 650 lbs. of copper per day, it may be seen that the pollution, and the source of the pollution, have substantially increased during that time.

It is reasonable to infer, and substantial documentation of the biology of the organisms inhabiting the mine that are the cause of the pollution now confirms, that this disintegration of the ore bodies by microorganism activity will continue to accelerate.

Therefore the mine owner, Iron Mountain Mines, Inc., through a joint venture agreement with Artesian Mineral Development & Consolidated Sludge, Inc. has submitted a proposal to implement the original CA10 alternative of ROD1. The CA10 alternative is modified to more fully conform to statutory guidance with a resource conservation and recovery initiative.

This proposal also modifies CA10 to include CA1 as a pilot plan, to determine if insitu solution mining can effectively remove the valuable metals and remove substantially all of the sulfur that causes the acid mine drainage..

Through the performance of the remedy review RI and remedy review FS, the U.S. Environmental Protection Agency (EPA) has determined that the response action selected in this Record of Decision (ROD) is necessary to protect the environment from actual or threatened releases of hazardous substances, is the most protective of Human Health and the Environment, and fulfills the objectives of CERCLA and the EPA.

1.4 Description of Prior Remedial Actions

Completed and ongoing remedial actions to control the sources of AMD have significantly reduced the acidity and metals content in surface water discharged from IMM to downstream water bodies. There are five prior RODs at this Site.

The first ROD for the IMM Site (ROD 1), signed in October 1986, provided for implementation of limited source control actions to begin lessening the IMM AMD discharges and also provided water management capability to manage the ongoing IMM AMD releases to surface waters. Specific activities authorized by ROD 1 include a diversion of Slickrock Creek around contaminant-bearing landslide debris, diversion of Upper Spring Creek to the Flat Creek drainage, and a partial cap of Brick Flat Pit and seven subsidence areas. All of these projects have been completed.

Pursuant to Records of Decision signed by EPA in 1992 (ROD 2) and 1993 (ROD 3), virtually all AMD releases from the three largest sources of IMM AMD (the Richmond portal, the Lawson portal, and the Old/No. 8 Mine Seep) are treated at the IMM treatment plant. In these RODs, EPA selected the high density sludge (HDS) treatment process to ensure the long-term reliability, effectiveness, and cost-effectiveness of IMM treatment and sludge disposal operations. The treatment residuals are disposed of onsite in the inactive open pit mine, Brick Flat Pit. The response actions implemented pursuant to these two RODs have significantly reduced the release of hazardous substances from the Site. During the five-year period of Water Years 1999 through 2003, collection and treatment of portal AMD discharges resulted in an average reduction in site-wide copper discharges of 88 percent and an average reduction in zinc discharges of 95 percent (CH2M HILL, 2003) from the uncontrolled site-wide metal discharges prior to EPA's remedial action.

The fourth ROD for the IMM Site (ROD 4), signed in September 1997, provided for collection and treatment of AMD discharges from the widespread area sources in the Slickrock Creek watershed at Iron Mountain Mine. ROD 4 provided for design and construction of a 220-acre-foot (ac-ft)-capacity retention reservoir to collect area sources of AMD discharges for treatment, clean surface water diversion facilities, erosion control for arsenic-laden tailings, an additional AMD conveyance pipeline, and a tunnel for gravity discharge of treated effluent to Spring Creek. The remedy will permit treatment of essentially all of the IMM AMD from the Slickrock Creek area sources, which comprise approximately 60 to 70 percent of the remaining uncontrolled copper and 40 to 50 percent of the remaining uncontrolled zinc and cadmium releases from the IMM Site.

Construction of the dam and associated facilities for the Slickrock Creek Retention Reservoir was completed in the spring of 2004. Startup and shakedown testing was completed in June 2004. Operation of the remedy under ROD 4, in combination with completed remedial actions to control the sources of AMD, will result in a total reduction of contaminants discharged from SCDD of 95 percent from the pre-1994 discharge.

The EPA has determined that further study is warranted with regard to continued development and evaluation of remedial alternatives for the Boulder Creek area source AMD discharges, which are not currently controlled or collected for treatment. The EPA anticipates that additional remedial investigation and feasibility study efforts will be conducted to evaluate control strategies for the area sources in Boulder Creek.

The fifth ROD for the IMM Site (ROD 5), signed in April 2004, The objectives of the selected remedy were to (1) prevent the migration and deposition of contaminated sediment from the Spring Creek Arm into the Sacramento River downstream of Keswick Dam and (2) reduce metal loads and suspended solids associated with contaminated sediment to meet protective water quality standards. The selected remedy will involve the partial dredging of sediment in the Spring Creek Arm that is most susceptible to erosion, and disposal of dredged sediment in an engineered disposal cell located adjacent to Spring Creek Reservoir. Dredging will remove about 50 to 60 percent of the volume of the existing contaminated sediment in the Arm. Sediment that is less susceptible to erosion will not be dredged at deeper depths in the most downstream pile, Pile C. The selected remedy included operational restrictions on Keswick Reservoir pool elevations during rare storm or flood events to prevent erosion of sediment remaining at deeper depths within the Arm.

AMD discharged from IMM is transported via Spring Creek through the Spring Creek Reservoir into the Spring Creek Arm. These features are shown on Figure 2. As a result of past mining activities and IMM AMD releases, the affected water bodies upstream of the Spring Creek Debris Dam (SCDD) are essentially devoid of aquatic life and amphibians that are dependent upon that aquatic life. Down gradient of the SCDD, as the metal-rich acidic water discharged from IMM mixes with the higher pH freshwater in Keswick Reservoir, hydrous metal oxides precipitate and is deposited within the Spring Creek Arm of Keswick Reservoir. As discussed in greater detail in Section 1.4, remedial actions that have been implemented to control the sources of AMD have reduced the acidity and reduced the metals content by 95 percent in surface water down gradient from IMM.

The Sediment Remedial Investigation (RI) Report (EPA, 2002a) characterizes the nature and extent of contaminated sediment at Iron Mountain Mine. Historical deposition, accumulation, and mixing of metals-enriched sediment and precipitates has formed three distinct deposits or piles of contaminated sediment within the Spring Creek Arm, identified in a downstream direction as Piles A, B, and C. The total volume of contaminated sediment within the Arm was approximately 280,000 cubic yards. The heavy metals contained in the contaminated sediment include, among others, arsenic, copper, cadmium, iron, nickel, and zinc. The concentrations of these metals are toxic to aquatic life.

The results of a benthic invertebrate study (EPA, 2002a) demonstrated areas of severely impoverished benthic community and no plant life in areas associated with the sediment piles within the Spring Creek Arm and lower Keswick Reservoir. Testing has shown that if the sediments move into the water column, the water can be toxic to aquatic life, even if diluted 44 times. The pollutants in the sediments are particularly toxic to organisms and habitat at the bottom of the creek and fish in early life stages.

The technical memorandum Updated Human Health and Ecological Risk Evaluations for the Spring Creek Arm of Keswick Reservoir, Appendix E of the Sediment Feasibility Study (FS) (CH2M HILL, 2004), evaluated the potential risk to human health and ecological receptors from contaminated sediment in the Arm. The risk evaluation concludes that contaminated sediment in the Spring Creek Arm does not pose a current or future unacceptable risk to human health and welfare; however, the contamination has resulted in great ecological impact to benthic and aquatic communities in the Arm.

The fishery resources and other sensitive aquatic species in the Sacramento River below Keswick Dam were the primary natural resources at risk from the mobilization of contaminated sediment from the Spring Creek Arm. These species, particularly at the early life stages present in the Sacramento River, are particularly sensitive to toxic metals such as copper and zinc.

Uncontrolled flows from SCDD into the Arm during major storm events, in conjunction with high flows from Spring Creek Power Plant (SCPP), could scour and move sediment located within the Spring Creek Arm, which would then enter Keswick Reservoir and carry this mass of metals into the Sacramento River ecosystem. The locations of SCDD and SCPP are shown on Figure 2. During such an event, Sacramento River water quality would be expected to be highly toxic to aquatic life. It is also expected that significant quantities of the toxic sediments would deposit into the gravels of the important Sacramento River spawning grounds. These sediments would threaten the early life stages of salmon and steelhead present at the time of the deposit. These deposited toxic sediments would be expected to continue to contaminate the spawning grounds until difficult cleanup operations could be performed. Since salmon return in cycles of three to four years, contamination in the spawning grounds over an extended period of time could have jeopardized the survival of the entire population of salmon.

If conditions were such that high flows coincide in both SCDD and SCPP, and the reservoir pool level is down, large quantities of the existing sediment would be expected to erode and be transported into the main stem of Keswick Reservoir and into the Sacramento River downstream of Keswick Dam. Increasing the reservoir elevation or decreasing the discharge from the SCPP could reduce this potential; however, these options significantly restrict reservoir and power plant operations and do not completely eliminate the erosion potential. Under conditions of high discharge from SCPP and SCDD and low Keswick Reservoir water elevations, it is likely that over time, much of the sediment in the Spring Creek Arm would have been transported into the Sacramento River.

Contaminated sediment has also been deposited in other areas of the IMM Site, in the Spring Creek Reservoir and the main body of Keswick Reservoir, that are not addressed by this remedy, but sediment in these areas is less susceptible to erosion or is contained by existing controls. The remedy for Spring Creek Arm sediment would be consistent with and would not affect potential future remedies for these other areas of contaminated sediment. The selected remedy for contaminated sediment in the Spring Creek Arm would be consistent with other potential response actions for the remaining area sources of IMM discharges (i.e., the Boulder Creek area sources of AMD). Completed, ongoing, and potential remedies to control AMD significantly reduce the source of contaminated sediment by reducing the metal loads discharged from SCDD and the subsequent formation of new precipitates in Keswick Reservoir.

The major components of the selected remedy included:

1 Removal of contaminated sediment in the Spring Creek Arm of Keswick Reservoir to an elevation that minimizes contaminated sediment loss during all operational scenarios of SCPP, SCDD, and Keswick Reservoir except for rare storm events when combined with operations of the Central Valley Project (CVP) facilities that would be very unlikely during such large storms

2 Operational controls to restrict Keswick Reservoir water levels under rare storm or flood conditions to prevent releases from SCPP and SCDD that could scour sediment remaining at greater depths in Pile C
3 Continued restrictions on the release schedule and criteria for the discharge of water from SCDD to the Spring Creek Arm
4 Limited residual management for sediment in Pile A, Pile B, or the main channel of the Spring Creek Arm that is technically infeasible to dredge and is susceptible to erosion
5 Short-term monitoring and resuspension management during implementation of the remedial action
6 Conveyance of dredge discharge from the Spring Creek Arm to the dewatering/disposal cell
7 Ex situ physical and chemical treatment of dredge discharge to separate solids and liquids for disposal and achieve compliance with applicable or relevant and appropriate requirements (ARARs) for discharge of filtrate and overflow
8 Disposal of dewatered solids in an engineered upland disposal cell located on the IMM CERCLA site, adjacent to Spring Creek Reservoir
9 Conveyance and discharge of return water from the disposal cell to Spring Creek Reservoir
10 Long-term monitoring, disposal cell maintenance and institutional controls

1.5 Description of the Selected Remedy

The selected remedial action is the sixth ROD for the IMM Superfund cleanup action.
During the RI/FS for ROD 1, assessments were carried out for 12 alternative remedies.
The only remedy found to be entirely consistent with CERCLA, NEPA, CWA, NCP, the Solid Waste Act, and other statutory regulations was proposal CA10, which required mining the remaining ore bodies, and disposal. This alternative was screened out for further consideration because it was estimated that the cost was too prohibitive.
The following is an excerpt from ROD 1:

VII. THE IRON MOUNTAIN MINE REMEDY

C. ALTERNATIVES EXCEEDING ALL APPLICABLE OR RELEVANT STANDARDS, GUIDANCE, AND ADVISORIES.
CA-10.
AMONG THE REMEDIAL ACTION ALTERNATIVES THAT COULD BE IMPLEMENTED BY EPA, THE TOTAL REMOVAL OF THE SOURCE AND SEDIMENTS IN RECEIVING WATERS (ALTERNATIVE CA-10) IS CONSIDERED THE ONLY REMEDY FOR THE IRON MOUNTAIN MINE SITE WHICH IS CAPABLE OF MEETING PROJECT CLEANUP OBJECTIVES AND THE FULL REQUIREMENTS OF THE CLEAN WATER ACT (CWA). THIS ALTERNATIVE WOULD EFFECTIVELY ELIMINATE DISCHARGES FROM IRON MOUNTAIN AND RESTORE ALL TRIBUTARIES TO PRISTINE CONDITION. THIS ALTERNATIVE WAS BASED ON TOTAL REMOVAL OF ALL THE SOURCES OF CONTAMINATION AND HAULING AND DISPOSING OF THEM IN A RCRA-APPROVED FACILITY. THIS INCLUDES MATERIAL FROM THE FOLLOWING FOUR AREAS:
A) REMOVE APPROXIMATELY 3.5 MILLION CUBIC YARDS OF ORE AND WASTE ROCK AND TAILINGS PILES ALONG BOULDER CREEK AND SLICKROCK CREEK.
B) REMOVE AN ESTIMATED 200,000 CUBIC YARDS OF CONTAMINATED BOTTOM SEDIMENTS IN SLICKROCK CREEK, BOULDER CREEK AND SPRING CREEK. IT WAS ASSUMED THAT SEDIMENT IN SLICKROCK CREEK NEAR THE BRICK FLAT PIT AREA WOULD BE REMOVED USING CONVENTIONAL CONSTRUCTION EQUIPMENT. FOR SEDIMENT REMOVAL IN THE OTHER RECEIVING WATERS, HYDRAULIC CLEARING WAS ASSUMED.
C) REMOVE APPROXIMATELY 620,000 CUBIC YARDS OF CONTAMINATED BOTTOM SEDIMENTS IN SPRING CREEK RESERVOIR.
D) REMOVE ABOUT 14,000 CUBIC YARDS OF TAILINGS MATERIAL IN THE MINNESOTA FLAT AREA.
THE TOTAL COST OF EXCAVATING AND REMOVING THE SOURCE MATERIAL AND HAULING IT TO A CLASS I LANDFILL WAS ESTIMATED TO BE $1.4 BILLION.

The proposal submitted by Iron Mountain Mines, Inc. at that time (CA1), was a proposal for insitu mining of the ore body, a relatively experimental technology at the time, particularly for copper mining in a mountain top. After an enforcement analysis, the EPA concluded that there was too little information to evaluate and declined to approve this technology.

The EPA selected alternative from ROD 1:

The selected remedies included capping the mine and plugging the mine, these two options and the capping of the open pit mine latter are the significant remedial actions considered as a “remedy” under CERCLA, all other actions have constituted removal actions.
Subsequently, it was determined that the principal proposed remedy, plugging the mine with Low Density Cellular Concrete (LDCC) was too risky and was abandoned.
After ROD5 was completed, the EPA announced that it has concluded any further investigation of remedial actions.

1.6 Statutory Determinations

The selected remedy is consistent with the requirements of Section 121 of CERCLA to:

1. Protect human health and the environment.
2. Comply with ARARs.
3. Be cost-effective.
4. Utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable.

Items 1 and 2 were substantively addressed in ROD1, and so there is no further need for a review here.
Item 3 is a significantly different issue than it was in 1986, particularly because of the Consent Decree of 2000, wherein the previous owners of the mine settled their liability for the pollution and environmental damages. Those proceeds pay for the current treatment and facilities.
The current owners have promised and agreed to undertake and accomplish the requirements of CA1 /CA10 with the funds available in trust for the remediation, and to pay for any additional costs with proceeds from mineral recovery sales.
Item 4 is significantly different because effective bioremediation technologies have developed since ROD1 that make recovery of minerals effective and environmentally friendly.

1.6.1 Protection of Human Health and the Environment

Risk evaluations conducted by EPA indicate that contaminated sediment and surface water in the Spring Creek Arm do not pose a current or future unacceptable risk to human health and welfare. Therefore, the selected remedy is focused on assuring the protection of the environment.
The fishery resources and other sensitive aquatic species in the Sacramento River below Keswick Dam are the primary natural resources at risk from the mobilization of contaminated sediment from the Spring Creek Arm. This fishery and ecosystem was the focus of the cleanup for OU5. These species, particularly at the early life stages present in the Sacramento River, are particularly sensitive to toxic metals such as copper and zinc.
The National Oceanic and Atmospheric Administration (NOAA) have identified this section of the Sacramento River as the most important salmon habitat in California.

This selected remedy is protective of the environment with respect to the releases of hazardous substances from the Spring Creek Arm of Keswick Reservoir that could harm the important Sacramento River ecosystem. Removal of contaminated sediment from the Spring Creek Arm that is most susceptible to erosion, and disposal of dredged sediment in an upland disposal cell, will mitigate the risk for release events of contaminated sediment.
The selected remedy will reduce the metal loads and suspended solids associated with contaminated sediment discharged from the Spring Creek Arm.
It is uncertain whether the selected remedy would ensure that a benthic community will be re-established in the Spring Creek Arm following implementation. Continued releases of dissolved copper from IMM sources via Spring Creek Reservoir would likely prevent the reestablishment of the benthic community. However, the selected remedy will improve conditions and a benthic community might become re-established to some extent. The selected remedy is also expected to indirectly improve aquatic habitat in Keswick Reservoir by limiting future mobilization of contaminated sediment and redeposition in Keswick Reservoir.
While the remedy is expected to essentially eliminate the risk posed by releases of hazardous substances from Iron Mountain Mine to the Sacramento River, the remedy does not respond to the remaining uncontrolled releases of hazardous substances from the IMM Site. The EPA therefore anticipates that the remedy will not fully protect human health and the environment and that additional remedial action will be required to respond to releases of hazardous substances from the IMM Site. The Owners have promised and agreed to undertake any remedies required to comply with the CWA, CERCLA, and California environmental laws.

1.6.2 Compliance with ARARs

Except for those ARARs that EPA is waiving for this interim remedy, the selected remedy will comply with all Federal and State ARARs. The ARARs selected in this ROD apply only to the remedial actions selected in this ROD. This ROD does not alter or amend the prior ARAR determinations by EPA for this site as selected in RODs 1-5.
The EPA is waiving compliance with certain ARARs on the basis that this remedial action is an interim action that will not respond to all releases of hazardous substances from the IMM Site until it is completed.
Since the actions selected in this ROD are interim actions that leave some releases of hazardous substances unabated, EPA is relying on the ARARs waiver for "interim measures" (CERCLA §121(d)(4)(A); 40 CFR §300.430(f)(l)(ii)(C)(l)) for this remedial action. In particular, the EPA anticipates that once the remedial actions selected in this ROD have been implemented, water quality in Keswick Reservoir and the Sacramento River will improve as the result of reducing metal loads and suspended solids associated with contaminated sediment. EPA does anticipate that this remedy, in conjunction with the other remedies implemented to date, will be sufficient to ensure compliance with (1) the numeric, chemical-specific water quality standards contained in the National Toxics Rule (NTR), California Toxics Rule (CTR) and the Basin Plan for copper, cadmium, or zinc, and (2) California Fish and Game Code §5650 (which prohibits discharge of contaminants "deleterious to fish, plant life, or bird life"). The EPA is therefore waiving compliance with those standards for the interim action selected in this ROD to the extent those standards cannot be achieved until the remedy selected in this ROD is completed. EPA is also employing the interim action waiver to waive the applicable requirements of SWRCB Resolution 92-49.

1.6.3 Cost-Effectiveness
The EPA has determined that the selected remedy is cost-effective pursuant to evaluations in accordance with §300.430(f)(l)(ii)(D) of the NCP.

1.6.4 Permanent Solutions and Treatment Technologies
The EPA has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized.

1.6.5 Five-Year Review Requirements
The selected remedy will result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure. Section 121(c) of CERCLA and the NCP at 40 C.F.R. 300.430(f)(5)(iii)(C) therefore require EPA to conduct a statutory review within 5 years after initiation of remedial action, and at least every 5 years thereafter, through the standard CERCLA review process. The reviews will be conducted to ensure that the selected remedy continues to be protective of human health and the environment.

1.7 ROD Certification Checklist
The following information is included in the Decision Summary (Part 2) of this ROD. Additional information can be found in the Administrative Record file for this ROD.

1 Baseline risk represented by the COCs - Section 2.7

2 Performance criteria for the sediment cleanup established for Remedial Action Objectives and the basis for these levels - Section 2.12.4

3 How source materials constituting principal threats are addressed - Section 2.11

4 Current and reasonably anticipated future land use assumptions used in the baseline risk assessment and ROD - Section 2.6

5 Potential land use that will be available at the Site as a result of the selected remedy - Section 2.6.1

6 Estimated capital, annual operation and maintenance and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected - Section 2.12.3 and Table 16

7 Key factor(s) that led to selecting the remedy - Sections 2.12.1

Cleanup levels are not established for the remedial action. Meeting the remedial action objectives (RAOs) will be the primary and fundamental indicator of performance, the ultimate aim of which is protection of the environment.

1.8 Authorizing Signature

________/s/________________________________ ____

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Site Cleanup Branch

U.S. Environmental Protection Agency

PART 2: THE DECISION SUMMARY

2.1 Site Name, Location, and Description

2.1.1 Site Name
The Iron Mountain Mine (IMM) Superfund site is located in Shasta County, California, approximately 9 miles northwest of the City of Redding (Figure 1). The collection of mines on Iron Mountain is known as Iron Mountain Mines. The Iron Mountain Mines are the southernmost mines in the West Shasta Mining District. The District encompasses more

than a dozen sulfide mines that have been worked for silver, gold, copper, zinc, and pyrite.

The CERCLIS Identification Number for the IMM Superfund site is CAD980498612.

The lead agency for the IMM Superfund site is the EPA. The support agencies are State and federal agencies that support the activities of the EPA in accordance with the NCP.

The State support agencies include the California Department of Toxic Substances Control (DTSC), Central Valley Regional Water Quality Control Board (RWQCB), Department of Fish and Game (CDFG), and the State Water Resources Control Board (SWRCB). DTSC is the lead agency for the State of California. Federal agencies involved in the IMM Superfund cleanup include the U.S. Bureau of Reclamation (Reclamation), U.S. Fish and Wildlife Service (USFWS), and the National Oceanic and Atmospheric Administration (NOAA).

2.1.2 Site Location

The IMM Site includes the inactive mines on Iron Mountain and areas where hazardous substances released from the mines have come to be located. The IMM Site contains approximately 4,400 acres of land that includes the inactive mining properties on Iron Mountain; the several inactive underground and open pit mines; numerous waste piles; abandoned mining facilities; mine drainage treatment facilities; the downstream reaches of Boulder, Slickrock, Flat, and Spring Creeks; Spring Creek Reservoir; Keswick Reservoir (which includes both the Spring Creek Arm and the main body of Keswick Reservoir); and the Sacramento River affected by drainage from IMM (see Figure 1).

This decision document presents the selected remedial action for control of releases of contaminated sediment from the Spring Creek Arm of Keswick Reservoir (the Spring Creek Arm or the Arm). The Spring Creek Arm is Operable Unit 5 (OU-5) for the IMM Site.

2.1.3 Site Description

Iron Mountain contains copper, zinc, silver, gold, and pyrite deposits that have been commercially mined since 1879. In the early twentieth century, the Site was one of the largest copper mines in the United States. Mineral extraction methods varied widely. Underground mining ceased in 1956, and surface mining ceased in 1963.

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. Within the IMM property, the two largest sources of AMD are the Richmond Mine and the Hornet Mine. Both of these sources drain into Boulder Creek. The third largest source, the Old/No. 8 Mine Seep, drains into Slickrock Creek.

Boulder and Slickrock Creeks are major tributaries to Spring Creek, and Spring Creek is a tributary to the Sacramento River. Spring Creek flows into Spring Creek Reservoir (the impoundment created by Spring Creek Debris Dam [SCDD]), and enters the Sacramento River at Keswick Reservoir (created by Keswick Dam). Keswick Dam is located approximately 8 miles below Shasta Dam. The Spring Creek Arm is the portion of Keswick Reservoir directly below SCDD and is located 1.4 miles upstream of Keswick Dam. The Arm is oriented due east of SCDD and is approximately two-thirds of a mile long. Figure 2 is an aerial photo showing these features.

AMD discharged from IMM is transported via Spring Creek through the Spring Creek Reservoir into the Spring Creek Arm. The Spring Creek Arm serves as a mixing basin for metal-rich acidic waters and sediments released from behind SCDD and freshwater from

Shasta Dam, Whiskeytown Reservoir, and Keswick Reservoir. Mixing metal-rich, low-pH water from SCDD with higher-pH water results in precipitation of hydrous metal oxides, which can be colloidal in nature. This phenomenon has resulted in deposition, accumulation, and mixing of metal-enriched sediment and precipitates in the Spring Creek Arm and lower Keswick Reservoir.

Completed and ongoing remedial actions to control the sources of AMD at IMM have significantly reduced the acidity and metals content in surface water from IMM. Starting in 1994, virtually all of the AMD discharged from the Richmond Mine, Hornet Mine, and Old/No. 8 Mine Seep has been treated at the IMM treatment plant constructed onsite at Minnesota Flats. From 1994 to 1996 the AMD was treated using the simple mix treatment method. Since January 1997, a high density sludge (HDS) treatment system has provided an improved means of treating these discharges. Further cleanup efforts under ROD 4 have recently been completed in the Slickrock Creek watershed at IMM. Among other items, ROD 4 provides for construction of a retention reservoir to collect AMD area source discharges in the Slickrock Creek Basin for treatment. Treatment of these IMM AMD flows by the completed remedial actions pursuant to ROD1 through ROD4 will result in a total reduction of copper, cadmium, and zinc discharged from IMM sources of approximately 95 percent of the pre-1994 discharge.

The fishery resources and other sensitive aquatic species in the Sacramento River below Keswick Dam are the primary natural resources at risk from the continuing uncontrolled IMM heavy metal discharges or mobilization of contaminated sediments from the Spring Creek Arm. As a result of past mining activities and current IMM AMD releases, the affected water bodies upstream of the SCDD are essentially devoid of aquatic life and amphibians that are dependent upon that aquatic life.

2.2 Site History and Enforcement Activities

2.2.1 History of Site Activities that Led to Current Problem

Iron Mountain was first secured for mining purposes in 1865 because of the presence of a large gossan cap, a surface mineral deposit that is the result of the oxidation of pyrite (iron sulfide) that weathered over geologic time to form a surface mineral deposit that is largely iron oxide containing small amounts of gold and silver. Various individuals held the property and conducted limited mining for the recovery of silver from the gossan areas 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 Mines, Ltd., began operation of the mine. In approximately 1896, Mountain Copper Company, LTD. (Mountain Copper) acquired ownership of the mine. Under Mountain Copper, IMM became the largest producer of copper in California and the sixth largest producer in the country during the first quarter of the twentieth century. High-grade copper ore and other minerals in the deposits were mined in Old Mine 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 1967, Stauffer Chemical Co. (SCC) acquired Mountain Copper. In 1968, SCC obtained legal title to the properties comprising IMM from its wholly owned subsidiary, Mountain Copper Company, Ltd. SCC originally took steps to reopen the mine, but the price of sulfur dropped to a point that caused the option to be uneconomical. SCC operated the copper cementation plant on Boulder Creek during its ownership of the Site and continued to investigate the commercial mining potential of the property. In November 1976, the Central Valley RWQCB issued an order to SCC requiring the abatement of the continuing water pollution from the mountain.

In December 1976, SCC transferred ownership of 31 parcels on Iron Mountain to Iron Mountain Mines, Inc. (IMMI), and in December 1980, SCC transferred five additional parcels to IMMI.

IMMI, a California corporation, is the current owner of the mining properties at Iron Mountain. But, certain property interests retained by SCC's successor at the Site are in the process of being transferred to BLM pursuant to a Consent Decree (signed in December 2000) between SCC, the State of California, and the federal government.

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.

2.2.2 Impacts of Mining Activity at Iron Mountain

Generation and Discharge of Acid Mine Drainage

Mining activities have fundamentally altered the geochemical and hydrologic conditions at Iron Mountain. In an undisturbed condition, a series of geologic and geochemical factors combined to permit the several large masses of sulfide mineralization to remain in place below the water table over geologic time. Now that mining has altered those conditions, however, the massive mineralization is no longer protected by the water table from oxidation, which in turn has exposed the mineralization to conditions that permit the rapid oxidation and release of acidity and metals from that deposit. These mininginduced changes are the source of the severe pollution problem at MM.

Metals such as copper, zinc, iron, cadmium, gold, and silver are commonly found as part of massive sulfide mineral deposits. When iron sulfide (pyrite) is exposed to moisture and an oxidant (such as free oxygen or aqueous ferric iron), the pyrite oxidizes and releases acidity. Copper, zinc, aluminum, cadmium, and manganese are released into the AMD in parallel chemical reactions. Pyrite oxidation is aided by certain bacteria which form ferrous iron, hydrogen ions, and sulfate ions. The ferrous iron is subsequently oxidized to ferric iron, which acts as an oxidant, attacking additional pyrite and other metal sulfides, which produces additional hydrogen ions. The resulting low-pH water containing the dissolved metals then discharges from the mine, and mixes with and contaminates surface water. This is the general process for the formation of AMD at IMM, and the movement of AMD down Spring Creek and into Spring Creek Reservoir.

The rate of oxidation of the mineralized zone is accelerated when the surface area of the pyrite deposit exposed to oxidizing conditions is increased by mining. At IMM, the historical operations at the Site included both open-pit and underground mining. The mining operations fractured massive sulfide deposits that had been contiguous and relatively unfractured, rubblized great quantities of the pyritic orebody through collapse of the underground openings, and lowered the water table through construction of haulage drifts and tunnels. The end result is exposure of a vast surface area to the oxidizing process and production of great quantities of AMD in a relatively short time period.

Mine wastes such as waste rock and tailings that were disposed of adjacent to the mines also contain residual sulfide materials that oxidize when exposed to water and air. Mine wastes with greater pyritic surface area available under oxidizing conditions produce stronger acidic discharges at greater rates of AMD production. The mine workings draining Iron Mountain still contain more than 12 million tons of unmined, disturbed massive sulfide deposits. IMM is unusual in the strength and rate of acid production and the subsequent release of large quantities of heavy metals into the environment.

Precipitation of Metal Hydroxides and Formation of Sediments

Over time, surface flows from the IMM Site have carried various mine wastes, native sediment that might contain metals, and AMD downstream via the Spring Creek drainage into the Sacramento River system. As the AMD mixes with rain and other surface waters at a higher pH, hydrous metal oxides, primarily iron oxyhydroxides, precipitate. The topography and varying flow velocities within the Spring Creek Arm channel (influenced by the discharges from Shasta Dam, Spring Creek Power Plant [SCPP], and SCDD) acted upon the metal-enriched sediments and precipitates and influenced how these materials settled out within the Spring Creek Arm of Keswick Reservoir. As a result, three major contaminated sediment piles (Piles A, B, and C, with Pile A being closest to SCDD and Pile C being closest to Keswick Reservoir) were deposited in the Spring Creek Arm primarily between the completion of SCDD in 1963 and 1994, when the IMM treatment plant became operational. Deposition likely continued after 1994, although at a substantially reduced rate. The presence of metal-enriched material on the bottom of the Spring Creek Arm has been shown to severely impact aquatic life in those areas.

2.2.3 History of Federal and State Site Investigations

The following summarizes the history of federal and State site investigations of (1) AMD sources and discharge and (2) contaminated sediment in Spring Creek Reservoir and Keswick Reservoir.

Acid Mine Drainage Sources and Discharge

Remedial investigation (RI) activities at Iron Mountain began in September 1983, when Iron Mountain was placed on the CERCLA National Priorities List of the nation's most contaminated sites.

EPA issued a remedial investigation/feasibility study (RI/FS) report in 1985 and an FS Addendum in 1986. The 1985 RI report characterized the entire IMM Site with respect to the nature and extent of contamination.

The EPA signed the first Record of Decision for the IMM Site in October 1986. ROD 1 selected an interim remedy for the Sitewide OU, 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 clean surface water diversion in Slickrock Creek to avoid AMD-generating waste rock; 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 SCDD, the exact size of which would be selected after a determination of the effectiveness of the other remedies. EPA selected a 9,000-acre-foot reservoir as the preliminary size in ROD 1. Underlying studies indicated that a 15,000-acre-foot reservoir would be required for a protective remedy. In its selection of a smaller reservoir size, EPA relied on a "fund-balancing" waiver, which permits EPA to waive compliance with protective standards for cleanups that are being paid for by the

Superfund.
The EPA's Public Health Risk Assessment was updated in 1991. Site characterization studies continued for the Boulder Creek watershed, and EPA prepared a second Rl/FS report for that area in 1992. An Endangerment Assessment (EA) was prepared in 1992 to characterize and evaluate the current and potential threats to the environment that may be posed by IMM contaminants migrating to the groundwater, surface water, and air.
The Boulder Creek OU ROD (ROD 2), signed in September 1992, addressed remedial actions for (1) AMD from the Richmond portal (Richmond Mine) and Lawson portal (Hornet Mine), 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.
Site characterization studies continued for the Slickrock Creek watershed, and EPA prepared an RI/FS report for that area in 1993. The Old/No. 8 Mine Seep OU ROD (ROD 3), signed in September 1993, addressed the third largest source of contaminant discharges at MM.
On the basis of the results of its ongoing monitoring program, EPA concluded that the area source discharges of heavy metals, especially copper, zinc, and cadmium, were closely associated with the intense storm-related high runoff events that characterize the hydrology of the Spring Creek watershed at IMM.
Through a formal action in 1991 known as an explanation of significant differences (BSD), EPA revoked the fund-balancing waiver upon which EPA relied for ROD 1. This formal action removed the legal basis for EPA's tentative selection of a 9,000-acre-foot reservoir in ROD 1 in lieu of a larger, more protective dam. Consistent with the SCDD enlargement component of ROD 1 and the ESD, EPA conducted engineering and other studies regarding enlarging the SCDD. These studies indicated that a reservoir of at least 15,000 acre-feet would be required.
Because of the projected increased costs of the SCDD enlargement and the availability of other new information, EPA decided to expand its studies, re-evaluate other remedial technologies, and publish for public review and comment a new feasibility study and proposed plan.
In June 1994, EPA published a Water Management FS, which examined potential remedial alternatives that could control, treat, or manage the safe release of continued uncontrolled contaminant discharges from the numerous and widely dispersed area sources in the Boulder Creek and Slickrock Creek watersheds at MM. In the 1994 Water Management FS, EPA developed five alternatives for detailed evaluation. These alternatives included a range of approaches that relied on source control, collection and treatment, and water management technologies. Although some area sources could be readily identified and remediated (such as waste piles), a large proportion of the area source discharge was associated with buried and collapsed mine workings and was, in general, difficult to identify and characterize.
The approaches used in the remedial alternatives developed and evaluated in the Water Management FS relied more heavily on collection and treatment and water management technologies rather than on source control. In June 1994, EPA issued a Proposed Plan with a set of remedial actions for the MM area source AMD discharges.
During the public comment period for the 1994 Proposed Plan, a potentially responsible party (PRP), Rhone-Poulenc, Inc. (Rhone-Poulenc, a successor to SCC) (through its

representative, Stauffer Management Company [SMC]), submitted a Focused Feasibility Study (FFS). The FFS identified a range of general collect and treat alternatives for the area source releases from the Slickrock Creek watershed. Rhone-Poulenc urged EPA to delay selecting a remedy so that an additional season of data could be collected. The EPA determined that delay in remedy selection was justified because the information submitted by Rhone-Poulenc suggested that it was technically feasible (and also more costeffective) to control the MM pollution on the mountain rather than simply diluting the pollution by enlarging the SCDD and controlling the discharge rate into Keswick Reservoir.

This delay permitted Rhone-Poulenc and EPA an opportunity to collect additional data to characterize the MM area source AMD discharges in the Boulder Creek watershed and characterize and define key hydrologic and engineering factors for the development and evaluation of the Slickrock Creek "dam and treat" approach. Rhone-Poulenc and EPA developed remedial design concepts for proposed Slickrock Creek and Boulder Creek remedies. In August 1995, EPA and Rhone-Poulenc presented their respective analyses and conclusions with regard to the ongoing Boulder Creek studies to a panel of senior technical specialists for review and technical comment. Consistent with the panel comments, EPA concluded that adequate control of the Boulder Creek area sources was feasible, but deferred action on developing and evaluating proposed remedial approaches for these sources to allow time for additional study. EPA issued the Boulder Creek Remedial Alternatives Study in 1995.

The EPA incorporated these and other investigations into a Water Management Feasibility Study Addendum (FSA) in May 1996. The FSA evaluated an additional remedial alternative as a supplement to the June 1994 Water Management Feasibility Study. EPA's May 1996 Public Comment Water Management FSA updated the public record to include an evaluation of an alternative that addressed only the remediation of Slickrock Creek, Alternative SRI.

In May 1996, EPA formally announced that it proposed to select Alternative SRI as its "Preferred Alternative" for the contaminated Slickrock Creek flows. The EPA proposed to perform additional studies regarding the Boulder Creek area source AMD discharges to support further development and evaluation of alternatives for decision making.

The EPA signed the fourth Record of Decision (ROD4) for the Slickrock Creek OU at the MM Site in September 1997. The selected remedy includes the construction of the Slickrock Creek Retention Reservoir to assure the collection and treatment of the contaminated storm water flows to address the principal threat posed by contaminant releases from area sources within the Slickrock Creek watershed at the MM Site.

Contaminated Sediment

This section discusses investigations of contaminated sediment formed from the precipitation of heavy metals in AMD discharged from IMM to the Spring Creek watershed. Contaminated sediments in the Spring Creek Arm of Keswick Reservoir are considered to be the fifth operable unit (OU-5) for the MM Site.

Historical investigations began in 1960 with Reclamation's investigation of the geology of the foundation rock for design of SCDD. Following construction of SCDD, Reclamation conducted a series of investigations and reports related to siltation, pollution problems, and chemical and grain-size analysis of sediment in Spring Creek, Spring Creek Reservoir, and the Spring Creek Arm of Keswick Reservoir. Additional investigations were also performed by other agencies, including analysis of acid volatile sulfide and simultaneously extractable metals in Keswick Reservoir sediments by USFWS in 1993, collection of high-resolution seismic reflection data by the U.S. Geological Survey (USGS) in 1993 and 1994, and a chemical and lexicological characterization of Keswick Reservoir sediments by CDFG in 1995. These investigations are summarized in the Final Iron Mountain Mine Sediment Remedial Investigation Report (EPA, 2002a).

EPA conducted site characterization activities in 1997 and 1998 to support the RI of contaminated sediment. These activities were a collaborative effort among EPA, USGS, and Reclamation. The Sediment RI identified four study areas: Spring Creek Reservoir, the Spring Creek Arm, upper Keswick Reservoir, and lower Keswick Reservoir. A comparison of RI data with historical data was performed as part of the site characterization for the Sediment RI. EPA issued the Final Iron Mountain Mine Sediment Remedial Investigation Report (Sediment RI) in 2002. The RI included surface water, sediment, and pore water sampling results for physical, geochemical, and biological characterization.

Additional investigations of the contaminated sediment were performed in 1998 through 2003. A treatability study was conducted in 1998 in conjunction with the Sediment RI. Results are discussed in the Technical Memorandum - Iron Mountain Mine Sediments Treatability Study (CH2M HILL, 2000). A bathymetric and geophysical survey was conducted in 2001 to provide three-dimensional data on the distribution and volume of fine-grained sediment in Keswick Reservoir. Results are summarized in the Keswick Reservoir Bathymetric and Geophysical Survey Report (David Evans and Associates, Inc., 2002). Treatability testing was conducted in 2003 on Spring Creek Arm sediment to support the development and evaluation of remedial alternatives. Results are summarized in the Iron Mountain Mine Sediments Treatability Study Report (CH2M HELL, 2004a).

Modeling and engineering analyses that were performed as part of the Feasibility Study for OU-5 indicate that the uncontrolled flows from SCDD during major storm events, in conjunction with high flows from SCPP, have the potential to erode sediment in the Spring Creek Arm. When combined with conditions of low reservoir elevations, sediment would be transported into the main stem of Keswick Reservoir and into the Sacramento River downstream of Keswick Reservoir. Investigations, including laboratory toxicity testing and field benthic surveys that were performed as part of the RI for OU-5, indicate that the mobilization of contaminated sediments into the Sacramento River could cause significant adverse impacts to important fishery resources. Downstream of Keswick Reservoir and MM, the Sacramento River provides high-quality habitat for spawning and rearing fish, including anadromous fish populations such as chinook salmon and steelhead.

In June 2004, EPA issued for public comment the Iron Mountain Mine Sediment Feasibility Study Report (Sediment FS) (EPA, 2004). The Sediment FS developed and evaluated remedial alternatives to minimize or eliminate the potential for mobilization of contaminated sediment from the Spring Creek Arm into the Sacramento River ecosystem. In August 2004, EPA issued a Proposed Plan presenting its preferred alternative for remediation of the contaminated sediment located in the Spring Creek Arm.

2.2.4 History of CERCLA Enforcement Activities and Remedial Actions

The EPA has identified the following persons as PRPs: the former owner and operator, Aventis CropScience USA, Inc. (the successor to Rhone-Poulenc, who in turn is the successor to Stauffer Chemical Company and Mountain Copper, Ltd.) and the current owner and operator, Iron Mountain Mines, Inc., and its president and sole shareholder, Mr. T.W. Arman.

In December 2000, the United States and the State of California successfully settled cost recovery litigation with Aventis CropScience USA. The settlement provides funding that ensures proper operation and maintenance of the remedies implemented pursuant to RODs 1 though 4. The settlement also provided funds to the Natural Resource Trustees to conduct restoration activities at MM, and to EPA and the State to fund limited additional site remediation activities. The settlement does not provide sufficient funds to address the remedial actions selected in this ROD.

EPA's cost recovery litigation is continuing with respect to the liability of MMI and Mr. T.W. Arman.

A history of remedial actions at the MM Site is summarized in Table 1. Following Table 1 is a discussion of significant CERCLA enforcement activities and remedial actions related to (1) AMD sources and discharge, and (2) contaminated sediment in Spring Creek Reservoir and Keswick Reservoir.

TABLE 1

History of Remedial Actions at Iron Mountain Mine Superfund Site

Iron Mountain Mine Record of Decision 5, Shasta County, California

Date	Event
1958	The Boulder Creek Copper Precipitation Plant was constructed to reduce the toxicity of water flowing from Spring Creek.
1963	All mining operations were closed down, except operation of the copper cementation plant.
1960 through 1963	Reclamation built the SCDD to regulate the contaminant discharges from IMM and to prevent sediment buildup at the SCPP.
1964	Operation of the SCPP began.
1977	A copper cementation plant was constructed on Slickrock Creek to remove copper from the water discharge at the Old/No. 8 Mine Seep.
1980	SWRCB, U.S. Water and Power Resources Service, and CDFG signed the Memorandum of Understanding (MOU) to Implement Actions to Protect the Sacramento River System from Heavy Metal Pollution from Spring Creek and Adjacent Watersheds. The MOU presented release schedule and criteria for discharge of water from SCDD to the Spring Creek Arm.
1983	IMM was placed on the National Priorities List.
1986	EPA issued the first ROD (ROD 1) for interim remedial action.
1988	Brick Flat Pit and various caved ground areas on Iron Mountain were capped.

TABLE 1

History of Remedial Actions at Iron Mountain Mine Superfund Site

Iron Mountain Mine Record of Decision 5, Shasta County, California

Date	Event
through 1989	Tailings from Minnesota Flats were removed, deposited in Brick Flat Pit, and capped. The Richmond adit was rehabilitated to access and evaluate the condition of the mine workings. Slickrock Creek was diverted around Big Seep

and an overburden dump.
1989
A temporary emergency treatment plant began operation to handle the most concentrated discharges emanating from the Richmond and Lawson portals pursuant to UAO 89-18 and was later expanded pursuant to UAO-92-26.
1990
Clean water from Upper Spring Creek was diverted to Flat Creek to decrease the volume of flow into Spring Creek Reservoir pursuant to UAO 90-08.
The United States filed its cost recovery litigation against Rhone-Poulenc, IMMI and Mr. T.W. Arman
1992 EPA issued the second ROD (ROD 2), selecting construction of a treatment plant to treat discharges from the Richmond and Lawson portals.
1993
EPA issued the third ROD (ROD 3), selecting capture and treatment of discharges from the Old/No. 8 Mine Seep.
The NMFS issued its *Biological Opinion for the Operation of the Federal Central Valley Project (CVP) and the California State Water Project* to address effects of the long-term operation of the CVP by Reclamation on Sacramento River winter-run Chinook salmon.
1994
A lime neutralization treatment process, consisting of an aerated simple mix (ASM), was completed at Minnesota Flats Treatment Plant (MFTP) by PRPs pursuant to UAO 93-01 and UAO 94-12. The plant treated mine water and released it to Spring Creek at higher pH levels. Sludge was produced from the treated ASM discharges, discharged to drying beds, and hauled to Brick Flat Pit. This operation effectively removed more than 99 percent of all contaminants from the water. PRPs operated and maintained the IMM treatment plant pursuant to UAO 94-12.
1996
A high density sludge (HDS) treatment plant was completed at the MFTP site. The HDS process produced a denser sludge than the ASM process was capable of producing, thus prolonging the useful life of Brick Flat Pit as a final sludge disposal site, and reducing operating expenses.
1997
EPA issued the fourth ROD (ROD 4), providing for design and construction of a dam and reservoir in the Slickrock Creek Basin to collect and treat IMM AMD from Slickrock Creek area sources. PRPs designed the ROD4 remedy and constructed several components of the remedy pursuant to UAO 97-16.
2000
A settlement was concluded between the United States and State of California, and Aventis CropScience USA, Inc. to fund future cleanup costs at IMM Site.
A statement of work was issued for Site operations and maintenance.
2001
Pursuant to the settlement, EPA began construction on the Slickrock Creek Retention Reservoir (SCRR) component of ROD 4. CH2M HILL was selected to perform the construction for EPA, and CH2M HILL procured Stimpel-Wiebelhaus &

Associates as the construction subcontractor.
2003 The Brick Flat Pit Dam was raised to increase the available volume for disposal of high density sludge produced at MFTP treatment plant.
2003 The Richmond Mine Adits and Drifts Rehabilitation was completed.
2004
Construction of the dam and associated facilities for SCRR was completed. Startup and shakedown period began in March. In conjunction with previous remedial actions at IMM, SCRR is expected to reduce contaminant discharge from SCDD to 5 percent of the discharge prior to 1994.

Acid Mine Drainage Sources and Discharge

The EPA's Superfund program began to assess 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 SCC and MMI for the past and continuing releases of hazardous substances from Iron Mountain and the resulting damage to, and destruction of, natural resources.

The MM Site was listed on the National Priorities List in 1983. EPA signed the first ROD (ROD 1) in October 1986. The remedial actions specified in ROD 1 included the construction of a partial cap over the Richmond mineralized zone and capping Brick Flat Pit; a diversion of clean surface water in Slickrock Creek to by-pass AMD-generating waste rock; a diversion of the Upper Spring Creek to avoid polluting its cleaner water and filling Spring Creek Reservoir; a diversion of the South Fork of Spring Creek for a similar purpose; and an enlargement of SCDD, the exact size of which would be selected after a determination of the effectiveness of the other remedies.

During 1987 and 1988, EPA sought a court order to ensure 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 remediated tailings materials from the Minnesota Flats area and other selected areas, by placing the materials into Brick Flat Pit below an impermeable membrane or "cap." The EPA completed construction of the partial cap in July 1989. Through Reclamation, EPA began construction of the Slickrock Creek diversion in July 1989 and completed construction in January 1990. Under EPA Administrative Order 90-08, ICIA, on behalf of Rhone-Poulenc, began construction of the Upper Spring Creek (USC) diversion in July 1990. The USC diversion became operational in January 1991.

In addition to the activities implemented pursuant to ROD 1, EPA recognized the need for further actions. During the 1988-89 rainy season, EPA operated an emergency treatment plant at the Site to reduce the toxicity of the AMD releases.

In August 1989, EPA issued Administrative Order 89-18, which required the PRPs to operate an emergency treatment plant at the Site to reduce the toxicity of the AMD discharges for the upcoming 1989-90 rainy season and to provide for metals removal for future years until 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, ICIA, on behalf of Rhone-Poulenc, constructed the treatment plant and operated this treatment plant during the 1989-90, 1990-91, and 1991-92 rainy seasons. The EPA also issued Administrative Order 91-07, requiring the PRPs to operate and maintain EPA-constructed remedial actions and the remedial projects undertaken by the PRPs under other orders.

Because of the continuing drought in California and the critical fishery conditions, EPA issued Administrative Order 92-26 on September 2,1992, for the 1992-93 rainy season, requiring that additional emergency measures be implemented, including increasing the capacity of the treatment plant.

As part of its ongoing efforts to control the AMD from MM, EPA conducted an operable unit feasibility study to develop and evaluate remedial alternatives for the AMD discharges in the Boulder Creek watershed. The EPA's 1992 RI report summarizes the data which show the concentration, volume, and historic patterns of releases of AMD from the Boulder Creek watershed at MM. On September 30, 1992, EPA signed ROD 2, a Record of Decision that selected treatment of the AMD discharges from the Richmond and Lawson portals, the two largest AMD discharges at MM, on an interim basis in a lime neutralization HDS treatment plant. That Record of Decision also selected the consolidation and capping of seven waste piles onsite. Under ROD 2, treatment plant sludges are to be disposed of onsite in the inactive open pit mine, Brick Flat Pit, which was modified to comply with applicable disposal standards.

On November 3,1992, EPA issued Administrative Order 93-01, requiring the PRPs to design and construct all necessary facilities to collect, convey, and treat the discharges of AMD from the Richmond and Lawson portals (including facilities for disposal of treatment sludges). Administrative Order 93-01 also required the PRPs to excavate, consolidate, and cap seven waste piles. Pursuant to that order, ICIA, on behalf of Rhone-Poulenc, agreed to design and construct the treatment plant and to excavate, consolidate, and cap the seven waste piles. However, ICIA opposed EPA's selection of the HDS process technology and refused to implement that portion of Order 93-01. EPA decided to use Superfund funds to build the HDS components of the treatment plant selected in ROD 2, reserving its rights to recover the costs of doing so.

The EPA continued to conduct studies to control the AMD discharges from MM and performed an operable unit feasibility study to develop and evaluate remedial alternatives for the AMD discharges in the Slickrock Creek watershed. In February 1993, EPA published an RI/FS report summarizing data regarding AMD discharges in the Slickrock Creek watershed. The February 1993 RI/FS developed and evaluated remedial alternatives for the Old/No. 8 Mine Seep AMD discharges. On September 24, 1993, EPA signed ROD 3 selecting treatment of the AMD discharges from the Old/No. 8 Mine Seep on an interim basis at the MM lime neutralization HDS treatment plant, as appropriately modified.

On April 19,1994, EPA issued Administrative Order 94-12, requiring the PRPs to design and construct all necessary facilities to collect, convey, and treat the discharges of AMD from the Old/No. 8 Mine Seep. Administrative Order 94-12 also required the PRPs to operate the MM treatment plant. SMC (a subsidiary of ICIA and subsequently Zeneca), on behalf of Rhone-Poulenc, agreed to design and construct the collection and conveyance facilities and the necessary modifications to the MM treatment plant to ensure treatment of the Old/No. 8 Mine Seep AMD discharges. Rhone-Poulenc also agreed to operate the aerated simple mix components of the MM treatment plant.

The aerated simple mix treatment plant became fully operational in October 1994. Since 1994, the MM treatment plant has treated essentially all of the AMD discharges from the Richmond and Lawson portals and the Old/No. 8 Mine Seep. EPA constructed the HDS components of the treatment plant, which became operational in January 1997. The EPA amended Administrative Order 94-12 to clarify requirements pertaining to HDS plant operations.

In 1995, EPA issued the Water Management Feasibility Study and a Proposed Plan that proposed to enlarge the Spring Creek Debris Dam to increase the capacity of Spring Creek Reservoir to hold contaminated MM runoff to 15,000 acre-feet. In commenting on the Proposed Plan, SMC proposed an alternative that would collect and treat contaminated runoff from the Slickrock Creek watershed. EPA performed a detailed evaluation of SMC's proposed alternative and in May 1996 issued the Water Management FS Amendment and a revised Proposed Plan proposing to collect and treat the contaminated runoff from the Slickrock Creek watershed.

The EPA signed the fourth Record of Decision for the MM Site on September 30, 1997, selecting the collection and treatment of the Slickrock Creek area source AMD discharges. Among other items, ROD 4 provided for design and construction of a 220-acrefoot (ac-ft)-capacity retention reservoir to collect area sources of AMD discharges in the Slickrock Creek Basin for treatment, clean surface-water diversion facilities, a hematite erosion control structure, an additional AMD conveyance pipeline, and a tunnel for gravity discharge of treated effluent to Spring Creek. The remedy will permit treatment of essentially all of the MM AMD from the Slickrock Creek area sources, which comprise approximately 60 to 70 percent of the remaining uncontrolled copper and 40 to 50 percent of the remaining uncontrolled zinc and cadmium releases from the MM Site.

On September 30, 1997, EPA issued Administrative Order 97-16 for the PRPs to comply with ROD 4. SMC, on behalf of Rhone-Poulenc, agreed to design and construct the ROD 4 remedial action.

In 1999, Rhone-Poulenc merged with Hoechst to create Aventis S.A., the parent company to Aventis CropScience USA.

In December 2000, the United States and the State of California successfully settled cost recovery litigation with one of the MM PRPs (Aventis CropScience USA). The settlement provides funding that ensures proper operation and maintenance of the remedies implemented pursuant to RODs 1 though 4. The settlement also provides additional funding to provide for natural resource restoration activities at MM, and some limited additional cleanup activities at MM. Cost recovery litigation continues with Iron Mountain Mines, Inc., and its president and primary owner, Mr. T.W. Arman.

EPA completed construction of the dam and associated facilities for SCRR in the spring of 2004. Startup and shakedown testing began in March 2004. Operation of SCRR and associated facilities under ROD 4, in combination with completed remedial actions to control the sources of AMD, will result in a total reduction of contaminants discharged from SCDD by 95 percent from the pre-1994 discharge.

Other remedial actions that have been completed during the construction period for SCRR include raising the Brick Flat Dam to increase the available volume for disposal of high density sludge produced at the Minnesota Flats Treatment Plant (MFTP) and rehabilitation of the Richmond Mine adits and drifts.

Contaminated Sediment

No Superfund remedial actions or enforcement activities have yet been conducted under CERCLA to address contaminated sediments deposited in the Spring Creek Reservoir, Spring Creek Arm of Keswick Reservoir, or the main body of Keswick Reservoir. However,

Reclamation and other support agencies have performed actions to manage the discharge of pollutants from the Spring Creek watershed into the Sacramento River ecosystem to minimize impacts of the MM metal discharges on human health and the environment.
In 1963, Reclamation constructed the SCDD to help control the toxic releases from Spring Creek and to prevent sediment from forming a delta in the vicinity of the SCPP tailrace. The SCDD allowed for the formation of Spring Creek Reservoir and the storage and the controlled release of contaminated water from the Spring Creek Basin.
IMM contaminated water contained in the Spring Creek Reservoir is currently released in a controlled manner by Reclamation in accordance with the requirements of the 1980 Memorandum of Understanding (MOU)(SWRCB et al., 1980). The MOU is an agreement among the SWRCB, U.S. Water and Power Resources Service (a predecessor to Reclamation), and CDFG that presents the short- and long-term actions and responsibilities of the signatory agencies in minimizing toxicity problems in the vicinity of Spring Creek. The MOU presents the release schedule and criteria for the discharge of water from SCDD to the Spring Creek Arm and establishes a monitoring program. Now that the SCRR is operational, data will be acquired to support renegotiation of the 1980 MOU.
Reclamation also operates SCDD and Keswick Reservoir to comply with requirements of the 1993 National Marine Fisheries Service (NMFS) Biological Opinion (NMFS, 1993). The 1993 Biological Opinion addresses the effects of the long-term operation of the Central Valley Project (CVP) by Reclamation, in conjunction with the Department of Water Resources' (DWR) State Water Project, on Sacramento River winter-run Chinook salmon. The Biological Opinion was prepared by NMFS in response to a request from Reclamation for formal consultation pursuant to Section 7 of the Endangered Species Act. The Biological Opinion requires that Reclamation maintain Keswick Reservoir at or above the normal operating level during all operation of SCPP, to prevent scouring of metals-laden sediment from the Spring Creek Arm. Currently, Reclamation restricts the operating level of Keswick to between 578 and 587 feet msl. The Biological Opinion also includes additional monitoring requirements for SCDD outflow and the Sacramento River below Keswick Dam, and requires Reclamation to operate SCDD to target metals concentration levels specified by the RWQCB's Water Quality Control Plan for the Sacramento River and San Joaquin River Basins (Basin Plan), except during extremely critical water years (NMFS, 1993).
In June 2004, EPA issued the Sediment FS for public comment. The Sediment FS develops and evaluates remedial alternatives to minimize or eliminate the potential for mobilization of contaminated sediment from the Spring Creek Arm into the Sacramento River ecosystem. In August 2004, EPA issued a Proposed Plan presenting its preferred alternative for sediment in the Spring Creek Arm.
The selected sediment remedial action is expected to be a Fund Lead action. The 2000 settlement with Rhone-Poulenc does not provide funds to implement the sediment remedy. It is uncertain whether EPA's cost recovery litigation with MMI and Mr. T.W. Arman would provide adequate funds.

2.3 Highlights of Community Participation

The EPA has regularly provided information to the public regarding the Superfund cleanup activities at Iron Mountain. The community has maintained interest in the progress of cleanup at the Site. Prior to the winter rainy seasons of 1991 and 1992, community involvement was moderate. Community interest and involvement increased in 1992 as a result of the special release of 92,000 acre-feet of valuable water resources from Shasta

Lake to dilute pollution from the MM Site (during serious drought conditions). Since that time, interest in the progress of the EPA Superfund cleanup of the MM AMD discharges has remained significant from the community and other state and federal agencies. Throughout the cleanup activities, 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 media coverage. The EPA has provided regular updates on the progress of cleanup actions through the release and distribution of fact sheets and through presentations to local community groups. With the assistance of the Shasta County Library, EPA has also made copies of critical documents related to the Site available for public review. This local information repository also includes copies of the Administrative Record for this ROD as well as RODs 1 through 4.

2.3.1 Public Participation for Previous RODs

The EPA issued its first Record of Decision for the MM Site in October 1986. The EPA has issued fact sheets 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). The EPA also updated its Community Relations Plan, which was finalized in May 1990.

In May 1992, EPA issued a Proposed Plan for the Boulder Creek OU at MM. The Proposed Plan provided an update on the status of remedial and emergency response activities at the Site. The May 1992 Proposed Plan summarized EPA's development and evaluation of remedial alternatives for the AMD discharges from the Richmond and Lawson portals and invited public comment on EPA's proposed cleanup approach. The EPA held a public meeting in June 1992 to present its Proposed Plan, to answer questions, and to receive public comments. In September 1992, EPA issued its second Record of Decision for the Site. The second Record of Decision selected the interim treatment remedy described above.

In February 1993, EPA issued a Proposed Plan for the Old/No. 8 Mine Seep OU to address the AMD discharges from this source at MM. The Proposed Plan provided an update on the status of remedial and emergency response activities at the Site. The February 1993 Proposed Plan summarized EPA's development and evaluation of remedial alternatives for the AMD discharges from the Old/No. 8 Mine Seep and invited public comment on EPA's proposed cleanup approach. The EPA held a public meeting in February 1993 to present its Proposed Plan, to answer questions, and to receive public comments. The EPA issued its third Record of Decision for the Site in September 1993, selecting the interim treatment remedy described above for these AMD discharges.

In October 1993, EPA issued a Technical Assistance Grant (TAG) to the Shasta Natural Science Association. The grant provided funding to support the development and dissemination of information to the community regarding EPA's MM cleanup activities. The TAG was annually extended through March 1997 and has now expired.

In 1995, EPA issued the Water Management Feasibility Study and a Proposed Plan that proposed to enlarge the Spring Creek Debris Dam to increase the capacity of Spring Creek Reservoir to hold contaminated MM runoff to 15,000 acre-feet. In commenting on the Proposed Plan, SMC proposed an alternative that would collect and treat contaminated runoff from the Slickrock Creek watershed. EPA performed a detailed evaluation of SMC's proposed alternative.

In May 1996, EPA issued the Water Management Feasibility Study Addendum and a revised

Proposed Plan to implement a "dam and treat" remedy for the Slickrock Creek watershed largely derived from the most effective alternative identified by a PRP (Rhone-Poulenc) in its Focused FS. The remedy involved diverting upper Slickrock Creek flows (and flows from the unmined side of Slickrock Creek Valley) around the most heavily mining-impacted reach of Slickrock Creek and collecting and treating the most heavily impacted reach of Slickrock Creek. The EPA proposed to perform further study of the Boulder Creek area source AMD discharges to support the additional development and evaluation of remedial alternatives for these sources.

The public comment period was held for 60 days (EPA extended the public comment period in response to a request from Rhone-Poulenc). In May 1996, EPA held a public meeting in Redding, California, to present EPA's Proposed Plan, to answer questions, and to receive public comments. The EPA also participated in a June 1996 community workshop that was organized by the Shasta Natural Science Association (the MM TAG grantee) to present the Proposed Plan, answer questions, and invite community participation in the decision making process. In September 1997, EPA issued its fourth Record of Decision for the Site. The fourth Record of Decision selected the interim treatment remedy described above.

On May 6, 2004, EPA hosted a dedication ceremony for the Slickrock Creek Retention Reservoir, completed under ROD 4. Representatives from interested State and Federal agencies attended the ceremony as well as members of the local television news and press. A fact sheet was prepared summarizing completed remedial actions to control AMD and potential future remedial actions at the MM Site.

2.3.2 Public Participation for Sediment Proposed Plan

In August 2004, EPA issued a Proposed Plan to address environmental threats posed by contaminated sediment in the Spring Creek Arm of Keswick Reservoir. The Proposed Plan presented EPA's preferred cleanup alternative, Partial Dredge with Disposal. The preferred alternative provides for partial removal of contaminated sediment that is most susceptible to erosion and disposal of the sediment in an engineered disposal cell adjacent to Spring Creek Reservoir. The alternative would be designed to fully remove contaminated sediment in areas that have high erosion potential (Piles A and B and sediment in the main channel of the Arm) and partially remove sediment located in a deep water area of the Spring Creek Arm (Pile C) so that the remaining sediment would not be susceptible to erosion except under rare and very unlikely circumstances.

The EPA provided a public comment period from August 11, 2004, to September 13, 2004, for the proposed remedial action described in the Proposed Plan. The Proposed Plan, Sediment FS, Sediment RI, and other supporting documents were available to the public in the Administrative Record File maintained at the EPA Records Center in San Francisco, California, and information repositories maintained at the Shasta County Library in Redding, California, and Meriam Library, California State University-Chico, in Chico, California.

An announcement for a public meeting, the comment period, and the availability of the Proposed Plan and supporting documentation was published in the Record Searchlight, a newspaper of general circulation in Redding, California, on August 11, 2004. On August 25, 2004, EPA held a public meeting in Redding, California, to present EPA's Proposed Plan, to answer questions, and to receive public comments. The public meeting was attended by approximately 40 people. Fifteen community members asked questions during the meeting, and eight community members submitted oral comments during the official comment period of the public meeting. EPA also received written comments from four community members and two local government agencies: the Redding Municipal Utilities District and the Shasta County Air Quality Management District. EPA also received letters of concurrence from two state support agencies: DTSC and CDFG. The EPA carefully reviewed, analyzed, and considered the comments that were received. The comments are summarized under the State and Community Acceptance subsections of Section 2.10. The EPA has provided detailed responses to the comments on the 2004 Proposed Plan in the Responsiveness Summary, Part 3 of this Record of Decision. The Administrative Record includes a transcript of the public meeting held in connection with the 2004 Proposed Plan.

2.4 Scope and Role of Response Action

2.4.1 Role of IMM Remedial Action

The overall objective of EPA's IMM Superfund cleanup program is to eliminate IMM AMD discharges that are harmful to human health and the environment. Due to the complexity and magnitude of the pollution problem, EPA divided the IMM response action into separate operable units. This approach enabled EPA to address the most serious problems quickly and to achieve a rapid reduction in hazardous substance releases. The previous RODs and areas that were addressed include:

1 ROD 1 - the open pit at Brick Flat Pit, caved ground areas above the Richmond Mine, Minnesota Flats tailings pile, Slickrock Creek and Upper Spring Creek surface water diversions, rehabilitation of the underground mine workings in the Richmond Mine

2 ROD 2 - Boulder Creek watershed, including Richmond and Lawson portal AMD discharges, seven pyritic mine waste piles

3 ROD 3 - Old/No. 8 Mine seep flow

4 ROD 4 - Slickrock Creek watershed area sources of AMD discharge

5 ROD 5 – Matheson reservoir cleanup

The construction of the remedial actions selected in RODs 1 through 5 has been completed. The dam and associated facilities for SCRR under ROD 4 were completed in the spring of 2004, and the effectiveness of the remedy will be evaluated as the SCRR becomes operational. Completed and ongoing remedial actions at MM will significantly improve surface water quality below SCDD, decrease the frequency, duration, and toxicity of SCDD spills of MM AMD, make significant progress in improving water quality in and below Keswick Reservoir, and provide improved water quality above the SCDD. With the completion of the ROD 4 remedial action, heavy metals discharged through SCDD are expected to be reduced by 95 percent from the pre-1994 discharge.

Despite the effectiveness of the completed and ongoing remedies, in the absence of further remediation, uncontrolled releases of MM contaminants over SCDD spillway are estimated to continue to occur every 4 to 8 years. Water quality criteria may still be exceeded under some circumstances in the Sacramento River downstream of Keswick Dam, and regular exceedances of water quality are likely to continue in areas of Keswick Reservoir and in the Spring Creek watershed due to the few remaining sources of contamination. The most significant remaining areas of contamination include (1) heavy metal sediment associated with past and current release of MM AMD (in Spring Creek Reservoir, the Spring Creek Arm and main body of Keswick Reservoir, and other areas) and (2) the area sources of AMD in the Boulder Creek Basin. The remedial action selected in this ROD addresses the contaminated sediment that is located in the Spring Creek Arm of Keswick Reservoir. Studies of the remaining site issues are currently underway. These studies will assess the feasibility of further source control, the appropriateness and feasibility of relying on water management options as a component of a final Site remedy, and the need for other response actions. Proceeding in this phased manner enhances the ability of EPA to evaluate the feasibility of restoring portions of the receiving waters in the Spring Creek watershed and other affected water bodies.

2.4.2 Scope of Problem Addressed by Selected Remedial Action

This Record of Decision represents the final remedy for the Site.

2.5 Site Characteristics

All mining waste on the IMM properties and associated sites.

2.5.1 Site Features and Surface Water Pathways

Site features for the area of interest are identified in the aerial photograph presented as Figure 2. Spring Creek is a tributary to the Sacramento River, approximately 14.5 miles long, with a 17-square-mile drainage area. The major tributaries to Spring Creek include the South Fork of Spring Creek, Slickrock, and Boulder Creeks. Historically, the Spring Creek drainage transported sediment and low-pH, high metals-content surface water from MM to the lower reaches of the drainage, which terminates in Spring Creek Reservoir, the impoundment created by SCDD. Spring Creek flows from Spring Creek Reservoir, through the Spring Creek Arm, and enters the Sacramento River at Keswick Reservoir, created by Keswick Dam. Keswick Dam is located approximately 8 miles below Shasta Dam. The Spring Creek Arm is 1.4 miles upstream of Keswick Dam.

The Spring Creek Arm is the portion of Keswick Reservoir directly below SCDD. The Arm is oriented due east of SCDD and is approximately two-thirds of a mile long. Discharges from SCDD flow into the Spring Creek Arm and enter the Sacramento River at Keswick Reservoir. The area upstream of the confluence of Spring Creek is referred to as upper Keswick Reservoir and is not impacted by discharges from the MM Site via Spring Creek. The area downstream of the confluence with Spring Creek is referred to as lower Keswick Reservoir.

Downstream of Keswick Dam, the Sacramento River provides high-quality habitat for spawning and rearing fish, including anadromous fish populations. This segment of the Sacramento River supports diverse fishery resources including migratory populations of Chinook salmon (Oncorhynchus tshawytscha), steelhead trout (Oncorhynchus mykiss), and resident populations of rainbow trout (Oncorhynchus mykiss). The Sacramento River winter-run Chinook salmon is listed as endangered by the State of California, and the Sacramento River spring-run Chinook salmon is listed as threatened.

2.5.2 Dams and Power Plants

Flow through Keswick Reservoir is currently constrained by three dams. Construction of Shasta Dam, located upstream of the MM Site, and Keswick and Spring Creek Debris dams, located downstream of the MM Site, have influenced water quality in the Sacramento River and its tributaries. Shasta Dam and Shasta Power Plant, Keswick Dam and Keswick Power Plant, and SCDD and the nearby SCPP are part of the CVP operated by Reclamation. At Shasta and Keswick power plants, electricity is generated using water from their respective dams. SCPP generates power from water piped from Whiskeytown Reservoir, not from Spring Creek water. In addition to the three dams discussed in this section, the dam and associated facilities for SCRR were completed in the spring of 2004 and are collecting area sources of AMD discharges in the Slickrock Creek Basin for treatment.

Shasta Dam

Shasta Dam was completed in 1945. Data collected prior to the dam's completion demonstrate that the Sacramento River upstream of Spring Creek contained elevated concentrations of copper. Elevated Sacramento River copper concentrations upstream of Spring Creek resulted from the uncontrolled discharges from other mines in the West Shasta Mining District, adjacent to the area now submerged beneath Shasta Lake.

Since the construction of Shasta Dam, discharges from these mines enter Shasta Lake and are diluted by the much greater volume of the relatively clean Shasta Lake water. A significant portion of the copper and other metals precipitate and are deposited within Shasta Lake. A consequence of the construction of Shasta Dam has been improvement in the year-round water quality of the Sacramento River downstream of Shasta Dam. Concentrations of dissolved copper in releases from Shasta Dam averaged 2.0 micrograms per liter (ug/L) and total copper averaged 2.7 ug/L during the period from October 1998 through July 2003, as presented in the 2003 Five-year Review for MM (CH2M HELL, 2003).

Shasta Power Plant

Shasta Dam has five 15-foot-diameter penstocks leading to Shasta Power Plant's five main generating units and two station service units. Shasta Power Plant's generators had an original capacity of 379,000 kilowatts (kW) in 1945. By 2003, their capacity had been increased to 646,000 kW through various upgrades.

Keswick Dam

Reclamation completed construction of Keswick Dam, located approximately 4.5 miles northwest of Redding, in 1950. The dam and reservoir are used to equalize flow discharged from Shasta Dam and SCPP and to generate power. The flow equalization capacity of Keswick Reservoir enables relatively constant flow in the Sacramento River downstream of Keswick Dam while power is generated each day at Shasta Dam and SCPP during periods of peak demand.

Keswick Power Plant

Keswick Reservoir operates both as an afterbay for Shasta Power Plant and forebay for Keswick Power Plant. The hydroelectric generators in Keswick Power Plant are designed to operate within a normal reservoir water elevation range of 574 to 587 feet msl. The minimum pool elevation of Keswick Reservoir, that is, the minimum elevation to provide water to the hydroelectric generator penstocks, is 568 feet msl. The maximum reservoir operating level is 587 feet, which is the elevation of the spillway. Keswick Power Plant has an installed capacity of 105 megawatts, consisting of three 35-megawatt vertical shaft generators. The range of operating levels in Keswick Reservoir has been reduced because of concerns that sediment with high metals concentrations in the Spring Creek Arm would mobilize. The lower end of the elevation range has been raised by 4 feet, to a current operating range of 578 to 587 feet msl.

Spring Creek Debris Dam

SCDD was constructed in 1963 to regulate the discharge flow rate of metal-rich contaminated Spring Creek into the Sacramento River and to reduce or prevent sediment in the Spring Creek Basin from entering the Spring Creek Arm. The reservoir is operated to provide maximum storage capacity and flow regulation for the rainy season. The initial capacity of the reservoir, following construction, was approximately 5,870 ac-ft. The storage capacity has been reduced by sediment accumulation.

A reconnaissance-feasibility investigation of the Spring Creek Basin was performed in the fall of 1957 in preparation for the construction of SCDD. A preconstruction investigation was performed in 1960. At that time, no biological activity (fish or algae) was noted in the polluted section of Spring Creek. According to Reclamation records, all sediment was excavated from the existing Spring Creek Arm prior to construction of SCDD. Additional excavations were completed on the left and right abutments, at the locations of the spillway and the outlet works. Areas occupied by smelter wastes required excavation, generally at depths up to 5 feet.

SCDD was completed in the summer of 1963. Reclamation operated SCDD with the intent of meeting water quality standards in the Sacramento River downstream of Keswick Dam. However, the small size of Spring Creek Reservoir, relative to the contaminant load and volume of flow discharged from MM, resulted in numerous uncontrolled releases from SCDD prior to implementation of EPA remedial actions. Reclamation has attempted to alleviate the effects of uncontrolled releases of water over SCDD through releases of water from Shasta Dam.

Spring Creek Power Plant Immediately downstream of the debris dam is SCPP, a hydropower facility that receives high-quality water from the Trinity River System via a pipeline from Whiskeytown Reservoir. The power plant does not operate with water from Spring Creek. The SCPP is operated by Reclamation and serves as a source of peaking power to the Western Area Power Administration (WAPA) electrical grid. During power generation, the SCPP discharges up to a maximum of 4,900 cfs to the Spring Creek Arm.

During winter releases from SCDD, an acceptable level of dilution for the metal-rich, acidic water is targeted through releases from Whiskeytown Reservoir (via SCPP) and Shasta Dam. The required minimum flow from SCPP during SCDD releases is 250 cubic feet per second (cfs). These low-flow releases are required to flush Spring Creek Reservoir water through the Spring Creek Arm.

Impacts of Spring Creek Arm Sediment on Power Plant Operations

The range of operating levels of Keswick Reservoir has been reduced because of concerns that sediment with high metals concentrations in the Spring Creek Arm would become mobilized. The lower end of the elevation range has been raised by 4 feet, to a current operating range of 578 to 587 feet msl. This restriction limits the ability of the CVP facilities to produce power during peak demand periods, and reduces the value of the power produced by the CVP facilities.

An analysis of the consequences of the Keswick Reservoir operational restrictions on the ability of Shasta, Spring Creek, and Keswick Power Plants to meet peak power demands demonstrates that approximately 200 million kWh of power are annually generated off-peak instead of during peak demand. The restricted Keswick Reservoir operations cause the CVP to lose $3 to $6 million annually (Mortimeyer, 2003).

2.5.3 Sediment Investigations

Numerous publications and other literature describe the MM Site, background information, and historical investigations. Summaries of literature dating back to 1960 are included in the Sediment RI, and a comparison of current data with historical data was performed as part of the site characterization for the RI. The recent investigations on MM sediment are discussed in this section.

Sediment Remedial Investigation (1997 and 1998)

EPA conducted initial site characterization activities for the Sediment RI in 1997 and 1998. Investigations were performed by EPA's contractor (CH2M HILL), U.S. Geological Survey (USGS), and Reclamation. The Sediment RI (EPA, 2002a) identified four study areas: Spring Creek Reservoir, the Spring Creek Arm, upper Keswick Reservoir, and lower Keswick Reservoir. Site characterization activities conducted as part of the Sediment RI included:

? Sampling - Sampling activities included onshore drilling, test pit excavations in Spring Creek Reservoir, barge-mounted offshore drilling, and a subaqueous investigation from boats and a barge. Samples were collected of surface water, ghost-layer water, ghost-layer sludge, sediment, and pore water. The ghost layer is a metals-enriched colloidal material found in suspension over the sediment and ranges from 6 inches to 2 feet in thickness.

? Physical characterization - Analyses were conducted to assess the physical attributes of collected samples, including percent moisture, particle size analysis, and bulk density.

? Geochemical characterization - Laboratory chemical analyses were conducted on the ghost layer, sediment, and pore water samples from each study area.

? Biological characterization - Biological characterization consisted of bioaccumulation sampling and analysis in Spring Creek Reservoir; a benthic survey in the Spring Creek Arm, upper Keswick Reservoir, and lower Keswick Reservoir; and toxicity testing conducted on Spring Creek Arm and lower Keswick Reservoir sediment pore water.

Treatability Study (1998)

A treatability study was conducted in 1998 on sediment from the Spring Creek Arm. Results are discussed in the *Technical Memorandum - Iron Mountain Mine Sediments Treatability Study* (CH2M HELL, 2000). The treatability testing was conducted in conjunction with the Sediment RI. The focus of the 1998 Treatability Study was treatment requirements for materials that might be dredged from the Arm. Some testing was conducted on sediment samples from Keswick Reservoir and Spring Creek Reservoir for comparison. The 1998 Treatability Study was conducted in three phases:

? Phase I - General characterization of the physical and chemical properties of sediment samples from the Spring Creek Arm, Keswick Reservoir, and Spring Creek Reservoir

? Phase II - More detailed chemical characterization, flocculation, and settlement jar testing on samples from the Spring Creek Arm

? Phase III - Capillary suction time testing and specific filtration index testing on sediment from the Spring Creek Arm

Bathymetric and Geophysical Survey (2001)

Because of the degree of uncertainty in volume estimates of contaminated sediment in the Spring Creek Arm, EPA conducted a bathymetric and geophysical survey in 2001 to provide three-dimensional data on the distribution and volume of fine-grained sediment. The survey was completed for EPA by CH2M HELL and David Evans and Associates, Inc. Results are summarized in the *Keswick Reservoir Bathymetric and Geophysical Survey Report* (David Evans and Associates, Inc., 2002). The survey was conducted within the Spring Creek Arm and over approximately 1.4 miles within Keswick Reservoir, from just north of the Arm to Keswick Dam. Precision bathymetry, subbottom profiling, and Acoustic Doppler Current profiling were used to obtain detailed data on the reservoir bottom, shallow stratigraphy, and current speed and direction.

Treatability "Study and Sediment Sampling (2003)

Additional treatability testing was conducted in 2003 on Spring Creek Arm sediment to support the development and evaluation of sediment removal and capping alternatives. For sediment removal alternatives, the Treatability Study assessed the treatment requirements, settling rates, and dewatering characteristics of dredged sediment from the Spring Creek Arm. Solid-liquid separation testing was conducted in two phases: (1) 2-liter jar tests (small-scale settling tests), and (2) 7-foot-high, 6-3/8-inch-diameter column tests (large-scale dewatering tests). For development and evaluation of an in situ sediment capping alternative, the 2003 Treatability Study assessed the compressibility of in situ sediment. In addition, discrete sediment samples were also collected for metals analysis to support updates to the human health risk evaluation. The results of the treatability testing are summarized in the *Iron Mountain Mine Sediments Treatability Study Report* (CH2MHELL, 2004a).

2.5.4 Conceptual Model

The conceptual site model is displayed on Figure 3 and shows the surface water pathways and metal sources. The conceptual site model reflects conditions of Spring Creek as of 1994, prior to remedial actions in the area, to provide an understanding of how contamination in Spring Creek Reservoir and the Spring Creek Arm was transported and deposited. Elements of the MM sediment conceptual site model include the flow regime, site chemical characteristics, and routes of exposure. A conceptual model highlighting potential exposure pathways for human and ecological receptors is presented in Section 2.7, Summary of Site Risks.

Flow Regime

An understanding of the uncontrolled and controlled flow conditions within the MM system is fundamental to understanding the conceptual site model. At present, uncontrolled flow conditions exist above Spring Creek Reservoir, except for surface water retained by SCRR and minor volumes of flow retained temporarily at the MM treatment plant. In addition, the Spring Creek Diversion, constructed by EPA in 1991, diverts approximately 6 square miles (40 percent) of the Spring Creek watershed into the Flat Creek drainage.

Flows within the Spring Creek Arm originate primarily from SCDD and SCPP, with minor inflow from Shasta Dam releases. The estimated dissolved copper and zinc concentrations in Spring Creek Reservoir and the release rate from Shasta Dam and SCPP are the controlling factors determining the allowable discharge from SCDD.

Typically, Reclamation controls the release rate from SCDD in a manner that matches the discharges from Shasta Dam and SCPP, so that water quality criteria are met downstream of Keswick Dam. These procedures are based on the agreements in the 1980 MOU (SWRCB et al., 1980). During the infrequent periods in which Spring Creek Reservoir is full and the discharge from SCDD is uncontrolled (via overtopping of the spillway), Reclamation may increase discharges from Shasta Dam or SCPP to meet water quality standards downstream of Keswick Dam. Spring Creek Reservoir water quality is expected to improve with the completion of SCRR and associated facilities. EPA expects that the 1980 MOU will be renegotiated once data are acquired to characterize the effectiveness of EPA's remedial action to construct the SCRR. The renegotiation of the 1980 MOU, however, is not required by this ROD. Reduction in metals concentrations will allow additional releases from SCDD and lower dilution requirements from Shasta Dam and SCPP.

Releases from Keswick Reservoir are used to regulate the flow of the Sacramento River and to maintain water quality standards in the river. The key characteristics of inflows to Keswick Reservoir and releases from Keswick Dam are shown in Table 2.

The hydrodynamics of the Spring Creek Arm and the quantity of metals released from SCDD influence the deposition and resuspension of sediment. The highest flows in the Arm result from SCPP rather than SCDD releases. The historical maximum daily flow released from SCPP is 4,860 cfs; the historical maximum flow released from SCDD is 1,700 cfs. Average flows are also considerably higher from SCPP.

Peak flows from SCDD occur during winter and early spring in response to the filling of Spring Creek Reservoir. A typical release from SCDD is approximately 40 to 100 cfs, and a high release flow is approximately 400 cfs (Fujitani, 1998). Concurrent flows from SCPP are highly variable, ranging from a minimum of 250 cfs required during SCDD releases to a maximum of 4,900 cfs (Reclamation, 2000, 2001). Power plant releases are generally higher during the day in response to increased power demand requirements.

TABLE 2

Keswick Reservoir Inflow and Release Characteristics

Iron Mountain Mine Record of Decision 6, Shasta County, California

Inflows and

Releases Key Characteristics

SCDD Outlet Low to moderate flow volume (approximately 90 percent of flows are 100 cfs or lower). However, flow has been as high as 1,700 cfs.

Very high copper concentrations (200 to 1,000 parts per billion [ppb]).

SCPP Low to moderate flow volume (50 to 4,900 cfs).

Very low copper concentrations (near 1 ppb).

Releases generally support peak power production. Keswick Dam is operated to store or release these flows for regulation of the Sacramento River.

Shasta Dam Moderate to very high flow volume (generally 3,000 to as high as 80,000 cfs).

Low to moderate copper concentrations (1 to 5 ppb).

Releases support peak power production except under very high flow releases.

Keswick Dam is operated to store or release these flows for regulation of the Sacramento River.

Keswick Reservoir

Accretion Flows

Low to moderate flow volume (500 to 7,000 cfs).

Low to moderate copper concentration (generally 3 to 6 ppb).

Peak flow characteristics - Keswick Dam is operated to store or release these flows for regulation of the Sacramento River.

Keswick Dam Moderate to very high flow volume (generally 3,000 to as high as 80,000 cfs).

Low to moderate copper concentrations (2 to 6 ppb), except during AMD spills (generally 6 to 14 ppb).

Releases regulate Sacramento River flow and provide baseload power production.

Source: *Response to Comments, Water Management Feasibility Study and Addendum* (EPA, 1997b)

Site Chemical Characteristics and Formation of Sediment

Over time, surface flows from the MM Site have carried various mine wastes, native sediment that might contain metals, and AMD downstream via the Spring Creek drainage into the Sacramento River system. The Spring Creek Arm serves as a mixing basin for metalrich acidic waters and sediment released from SCDD, and freshwater from Shasta Dam, Whiskeytown Reservoir, and Keswick Reservoir. Mixing metal-rich, low-pH water from SCDD with higher pH water results in precipitation of hydrous metal oxides (HMOs). A pH of approximately 4 will result in the formation of hydrous metal oxides, primarily iron and aluminum. If the pH rises above 5, other metals, such as copper, co-precipitate and adsorb onto the hydrous metal oxides. The newly formed precipitates have a very small particle size (colloidal) and tend to remain in suspension. They might agglomerate and settle, and as more precipitation occurs in the higher pH water, precipitates from upstream and native sediment might become coated. As these precipitates form and begin to settle, the waters within the Spring Creek Arm become correspondingly lower in dissolved iron, copper, and aluminum.

The topography and varying flow velocities within the Spring Creek Arm channel (influenced by the discharges from Shasta Dam, SCPP, and Spring Creek Reservoir) acted upon the metal-enriched sediments and precipitates and influenced how these materials settled out within the Arm. Figure 4 shows three bends in the Arm that influence the flow velocity and backwater effects. Each bend causes an eddy that permits the mixing and settling of sediments and precipitates into the three major deposits or piles (Piles A, B, and C). The three sediment piles were deposited primarily between 1963 when SCDD was completed and 1994 when the IMM treatment plant became operational. Deposition likely continued after 1994, although at a reduced rate. Sediment has also been deposited in lower Keswick Reservoir downstream from the Spring Creek Arm.

Current and Potential Routes of Exposure

The Spring Creek Arm and main body of Keswick Reservoir are used for recreational activities, including fishing and boating. The potential routes of human exposure to site contaminants include incidental ingestion and dermal contact with Spring Creek Arm surface water and sediment by future recreational users. As discussed in Section 2.7, the human health risk evaluation indicates that surface water and sediment in the Spring Creek Arm do not pose a current or future unacceptable risk to human health and welfare.

The potential routes of ecological exposure include exposure of aquatic resources to site contaminants in surface water and sediment in the Spring Creek Arm. These resources include several sport fish species that may periodically range into the Arm and benthic communities. In addition, exposure of aquatic resources to site-related chemicals in the Sacramento River downstream of Keswick Reservoir has been historically documented. The important Sacramento River salmon and steelhead spawning grounds are also threatened by the potential mobilization of toxic sediments from the Spring Creek Arm into the Sacramento River. Contamination of the spawning gravels with these toxic sediments would threaten the early life stages of salmon and steelhead. Contamination of the spawning grounds over an extended period could jeopardize the survival of the entire populations.

2.5.5 Chemicals of Concern

Chemicals of concern (COCs) at the Site are limited to heavy metals associated with AMD and HMO precipitates. Results of sediment benchmark screening conducted as part of the ecological risk assessment identified the following chemicals of ecological concern (COECs): arsenic, cadmium, copper, nickel, and zinc. Of these metals, arsenic and copper had the highest factors of exceedances above benchmark screening levels and likely pose the greatest risk to aquatic resources. In addition, iron was determined to be primarily responsible for acute toxicity of pore water to the water flea (Ceriodaphnia dubia) during porewater bioassays. Therefore, iron is also considered a COEC. Results from the risk evaluation will be discussed in greater detail in Section 2.7.

2.5.6 Extent of Contamination

Table 3 provides a summary of metals concentrations for sediment samples collected during the Sediment RI. Investigations conducted under the Sediment RI targeted four study areas: Spring Creek Reservoir, the Spring Creek Arm, upper Keswick Reservoir, and lower Keswick Reservoir. Upper Keswick Reservoir has not been impacted by discharges from the IMM Site via Spring Creek. Table 3 allows comparison of Spring Creek Reservoir, Spring Creek Arm, and lower Keswick Reservoir sediment with conditions in upper Keswick Reservoir.

TABLE 3
Sediment Metals Concentration Summary
Iron Mountain Mine Record of Decision 5, Shasta County, California

Statistics	Copper (ppm)	Iron (%)	Zinc (ppm)
Average Values			
Spring Creek Reservoir	468	9.8	164
Spring Creek Arm, Pile A	767	14	584
Spring Creek Arm, Pile B	1,050	15	775
Spring Creek Arm, Pile C	1,598	17	1,144
Upper Keswick Reservoir	225	4.8	208
Lower Keswick Reservoir	857	8.6	730
Minimum Values			
Spring Creek Reservoir	253	4.4	99
Spring Creek Arm, Pile A	245	5.4	262
Spring Creek Arm, Pile B	406	6	180
Spring Creek Arm, Pile C	199	4	85
Upper Keswick Reservoir	217	4	162
Lower Keswick Reservoir	212	5.0	101
Maximum Values			
Spring Creek Reservoir	958	21.3	340
Spring Creek Arm, Pile A	1,747	36	3,693
Spring Creek Arm, Pile B	1,943	38	2,388
Spring Creek Arm, Pile C	4,765	47	6,578
Upper Keswick Reservoir	243	5	235
Lower Keswick Reservoir	1,738	19.5	1,391
Standard Deviation			
Spring Creek Reservoir	140	3.6	55
Spring Creek Arm, Pile A	389	7.7	621
Spring Creek Arm, Pile B	442	6.9	458

Spring Creek Arm, Pile C 844 8.1 1,182
Upper Keswick Reservoir 12.4 0.5 33.9
Lower Keswick Reservoir 441 4.33 385
Notes: Table taken from Sediment RI (Table 3-18). Table includes 63 samples from Spring Creek Reservoir; 43 from Spring Creek Arm Pile A; 43 from Pile B; 72 from Pile C; 4 from upper Keswick Reservoir; and 9 from lower Keswick Reservoir,
ppm = parts per million

Although elevated concentrations of copper, iron, and zinc have been detected in sediment samples from Spring Creek Reservoir and lower Keswick Reservoir, these areas of sediment contamination are not addressed by the selected remedy. As discussed in greater detail under Section 2.5.7, Contaminant Migration Potential, sediment in these areas is less susceptible to erosion or is contained by existing controls. This section describes the extent of contamination in the Spring Creek Arm.

The Spring Creek Arm is approximately two-thirds of a mile long and flows approximately due east. Deposition, accumulation, and mixing of metals-enriched sediment and precipitates has formed three distinct deposits or piles within the Arm: Piles A, B, and C, as shown on Figure 4. The photograph used for Figure 4 was taken at a time when the reservoir was drawn down, and portions of the normally submerged piles were exposed. Estimates of the volume and thickness of the piles in the Spring Creek Arm were determined using a bathymetric and geophysical survey conducted in 2001 (David Evans and Associates, Inc., 2002). The survey provided three-dimensional data on the distribution and volume of fine-grained sediment. Sediment thickness contours developed using results from the bathymetric survey and geophysical survey are illustrated on Figure 5. Volume estimates derived from the 2001 survey are presented in Table 4. The piles increase both in volume and thickness in the downstream direction. For the conceptual model, sediment piles (Piles A, B, and C) are defined as areas where the thickness of fine-grained sediment is greater than or equal to 4 feet. Approximately 90 percent of the volume of contaminated sediment, or 250,000 cubic yards (cy), is located in the three piles. The remaining 10 percent of the volume of contaminated sediment in the Arm is located outside of the pile boundaries at a thickness less than 4 feet.

TABLE 4
Estimates for In situ Sediment Piles - Spring Creek Arm of Keswick Reservoir
Iron Mountain Mine Sediment Feasibility Study

Location	Volume[a] (cy)	Pile Area[b] (acres)	Pile Thickness (feet) Average[c]	Pile Thickness (feet) Maximum
Spring Creek Arm (Total)	284,000			
Pile A	28,000	2.7	7	10
Pile B	47,000	3.8	8	14
Pile C	177,000	7.2	22	37
Spring Creek Arm Channel[d]	32,000			

[a]Source: David Evans and Associates, Inc., 2002, and CH2M HILL, 2004a
[b]Pile boundaries defined as sediment thickness of 4 feet
[c]Estimated from sediment thickness isopach map

dSediment located outside of sediment pile boundaries

An approximate description of the stratigraphy of the piles was developed from soil borings drilled during the RI and sediment sampling conducted by the USGS in 1993. A layer of variable thickness (generally 6 inches to 2 feet) forms the cloudy surface of each pile. This layer, referred to as the ghost layer, consists primarily of metalsenriched colloidal material in suspension over the pile. Sediment below the ghost layer consists primarily of gelatinous material that is sludge-like in nature and of variable density, intermixed with sand and clay. The sludge layers consist primarily of metalsenriched precipitates and are variable in thickness. Compared to typical saturated sediment, these sludge layers have a high water content. Bottom material of the Spring Creek Arm, located beneath the fine-grained sediment and metal precipitates of the piles, has been characterized as fine to medium sand, brown to black in color, with cobbles and gravel in some locations.

Physical characterization from the 1998 and 2003 treatability studies demonstrated differences in densities and moisture contents of sediment from the top and bottom halves of the piles. In the 2003 Treatability Study, the average bulk density and percent solids (by mass) of sediment composite samples from the top halves of Piles A, B, and C

equaled 1.10 kilograms per liter (kg/L) and 16 percent, respectively. In contrast, the average bulk density and percent solids of sediment composite samples from the bottom halves of the piles equaled 1.43 kg/L and 46.6 percent, respectively. For comparison, the percent solids of typical sediment (particulate material derived through erosion processes, rather than chemical precipitation processes) ranges from 70 to 85 percent.

The summary of metals concentrations in Spring Creek Arm sediment shows a relatively uniform increase of copper and zinc concentrations moving downstream through the system from Spring Creek Reservoir to Piles A, B, and C (Table 3). Iron increases somewhat from Spring Creek Reservoir to Pile A and then remains relatively constant within the Arm. As part of sediment sample collection for the 2003 Treatability Study (CH2M HILL, 2004a), nine samples were collected of fine-grained sediment and HMO sludge at discrete depths from cores in Piles A, B, and C. These samples were analyzed for metals to update the risk evaluation. Sediment samples were analyzed for a wider range of metals than examined in the Sediment RI. A summary of these data is presented in Table 5.

TABLE 5

Spring Creek Arm Sediment Metals Concentration Summary from 2003 Sediment Sampling

Iron Mountain Mine Record of Decision 5, Shasta County, California

Analyte Minimum
Concentrationa
Average
Concentrationa
Maximum
Concentrationa
Standard
Deviationa
Bottom Material
Concentrationb

Antimony	0.9	4.1	7.7	2.8	0.5
Arsenic	86	168	392	98	5
Cadmium	2.4	5.3	9.4	2.2	0.5
Chromium	20	66	194	59	27
Copper	456	1,822	3,890	1,053	75
Iron (%)	8.1	18.7	38.5	10.7	4.6
Lead	32	49	72	13	2
Nickel	2	57	290	99	15
Silver	1.3	3.5	7.4	2.1	0.2
Zinc	321	768	1,050	254	63

a Summary statistics are provided for nine samples collected within Piles A, B, and C. Results are in mg/kg for all analytes other than iron.

b Bottom material was identified as clayey gravel. Data presented are for Sample No. SCAKR-C-100, collected from 13 to 13.5 feet below the top of Pile C.

In addition, one sample was collected of the bottom material (clayey gravel) beneath Pile C. Concentrations of arsenic, cadmium, copper, iron, lead, and zinc were up to two orders of magnitude lower in the sample of clayey gravel from the bottom of Pile C than the samples of fine-grained sediment and HMO sludge collected from the sediment piles.

2.5.7 Contaminant Migration Potential

Spring Creek Arm of Keswick Reservoir

Uncontrolled flows from SCDD during major storm events, in conjunction with high flows from SCPP, have the potential to transport sediment within the Spring Creek Arm. If conditions are such that high flows coincide in both SCDD and SCPP, and the reservoirpool level is down, existing sediment is expected to erode and be transported farther in the Arm and eventually into the main stem of Keswick Reservoir and into the Sacramento River downstream of Keswick Dam. Increasing the reservoir elevation or decreasing the discharge can reduce this potential; however, these options do not completely eliminate the erosion potential.

The Hydrologic Engineering Center-River Analysis System (HEC-RAS), a computer modeling system developed by the U.S. Army Corps of Engineers, was used to hydraulically model the Spring Creek Arm and adjacent portions of Keswick Reservoir as part of the Sediment FS. Velocity results from the model were compared against a permissible velocity to determine possible sediment movement at various depths of reservoir pools, and various SCDD and SCPP operational conditions. Conclusions from the model indicated that Piles A, B, and C within the Spring Creek Arm are presently vulnerable to erosion.

Erosion potential is greatest under high discharge from SCPP and SCDD and low Keswick Reservoir water elevations (578 feet msl or less). Under these conditions, the HEC-RAS model velocities in most locations within the three sediment piles were one to six times greater than the permissible velocity and up to eight times greater than the permissible velocity in the channel outside the pile boundaries. Under conditions of high discharge from SCPP and SCDD and low Keswick Reservoir water elevations, it is likely that over time, much of the sediment in the Spring Creek Arm would be transported to the main stem of Keswick Reservoir.

As discussed previously, Reclamation currently maintains Keswick Reservoir above 578 feet msl during releases from SCPP to limit erosion. Under conditions that are more typical of current operation scenarios, when the combined discharge from SCPP and SCDD is as high as 4,900 cfs and Keswick Reservoir elevation is as low as 578 feet msl, sediment within and surrounding Piles A and B would be subject to erosion. In general, model velocities within and surrounding Piles A and B marginally exceed the permissible velocity.

Even without dewatering the Spring Creek Arm, some fraction of HMO moves through the Arm into lower Keswick Reservoir and beyond. This movement is primarily a function of size and agglomeration of the colloidal HMOs and water velocity through the Spring Creek Arm. The hydraulic velocity is increased by an increase in flow or a decrease in water elevation in the Spring Creek Arm.

The metals concentrations for the Spring Creek Arm were used to estimate the percentage of iron and copper retained within the Arm relative to the total mass of metals passing through SCDD. Data from Reclamation, RWQCB, USGS, the Final Remedial Investigation (EPA, 1985), and the Sediment RI were used to develop an estimate of the mass of iron and copper remaining in the Arm. Calculations suggest that, of the total mass passed through SCDD since 1964, 12 percent of the total iron released and 5 percent of the total copper released is retained within the Spring Creek Arm. These results indicate the majority of the copper and iron released from Spring Creek Reservoir has been transported out of the Spring Creek Arm into Keswick Reservoir and into the Sacramento River downstream of Keswick Dam.

Spring Creek Reservoir

Discharge of metals through SCDD has decreased considerably because of remedial actions upstream. Discharge of contaminants from SCDD is expected to be reduced to 5 percent of the pre-1994 discharge with the completion of SCRR and associated facilities. Literature references (Propokovich, 1991) have indicated that there is a potential to transport sediment from the Spring Creek Reservoir through SCDD into the Spring Creek Arm. However, review of 9 years of water quality monitoring data of the discharge from SCDD for total and dissolved metals demonstrated that little contaminated sediment has been detected in SCDD discharge. Total metals concentrations detected in SCDD discharge are nearly identical to the dissolved values (see Sediment FS). If significant contaminated sediment were present in SCDD discharge, higher total metals concentrations (as compared to dissolved concentrations) would be expected. On the basis of source control upstream of the SCDD and ongoing controlled operations of SCDD by Reclamation, Spring Creek Reservoir is not considered a significant source of ongoing metals release. The feasibility of restoring this area, the appropriateness and feasibility of relying on water management options as a component of a final Site remedy, and the need for other response actions will be further evaluated in future studies and RODs.

Keswick Reservoir

A large accumulation of sediment is present in Keswick Reservoir and extends from the mouth of the Spring Creek Arm to the base of Keswick Dam. The estimated volume of sediment in Keswick Reservoir derived from the 2001 bathymetric and geophysical survey was 1.1 million cy. This is an estimate of all fine-grained sediment in lower Keswick Reservoir and includes uncontaminated sediment deposited from sources upstream of the Spring Creek Arm.

Using high-resolution seismic reflection data collected in 1993 and 1994, the USGS estimates the volume of contaminated sediment in Keswick Reservoir as 144,000 cy (USGS, 1998). Sediment in the main body of Keswick Reservoir has a lower potential for release and migration downstream of Keswick Dam than sediment in the Spring Creek Arm because of the greater depth of water in Keswick Reservoir and the location of the sediment at greater depths in the reservoir (approximately 60 to 80 feet below the water surface). As discussed for sediments in Spring Creek Reservoir, the feasibility of restoring this area and the need for other response actions will be further evaluated in future studies and RODs.

2.6 Current and Potential Future Land and Water Uses

2.6.1 Adjacent Land Uses

The City of Redding has a population of approximately 87,000 people and is located approximately 9 miles from the Site. The closest community is Keswick, located just east of the Site, and less than one mile south of the Spring Creek Arm.

The land surrounding the Spring Creek Arm is owned by the federal government (i.e., public lands) or Southern Pacific Railroad. The Shasta County General Plan Map for the South Central Region designates the following land uses within one mile of the Spring Creek Arm: Natural Resource Protection-Open Space (N-O), Rural Residential (RA or RB), and Suburban Residential (SR). However, no private residential land directly adjoins the Spring Creek Arm or the Spring Creek Reservoir.

Keswick Reservoir is used for recreational activities (e.g., fishing and boating). Land access to the Spring Creek Arm is limited because of steep shores and limited locations where roads or trails extend down to the Arm. Primary access to the Spring Creek Arm is by water from the boat ramp located on the main body of Keswick Reservoir, just to the north of the Spring Creek Arm. Additional access is provided to limited sections of the Arm by the extension of the Sacramento River Trail, constructed by the Bureau of Land Management (BLM) on the old Southern Pacific railroad bed. The section of the Sacramento River downstream from Keswick Reservoir (i.e., below Keswick Dam) currently serves as the water source for the City of Redding, and is used for recreational activities, including fishing and boating.

There is no expectation for the future use of the land adjacent to the Spring Creek Arm to change. The Shasta County General Plan Map indicates the majority of the land surrounding the Arm is public lands and will not be developed for residential, commercial, or industrial use. The General Plan is the official land use policy document for Shasta County. Zoning classifications as well as other development policies must be consistent with the General Plan. A proposed change to the County's adopted land use policies or maps contained in the General Plan would require advertised public hearings because of potential environmental and/or land use impacts.

2.6.2 Natural Resource Uses

Keswick Reservoir and the Sacramento River downstream of Keswick Reservoir are major components of Reclamation's water distribution system in California. In addition to providing valuable water resources, these surface waters provide recreational opportunities and high-quality habitat for spawning and rearing fish, including anadromous fish populations.

The Central Valley Project (CVP) is one of the nation's major water conservation developments and is a central component of the California water distribution system. Purposes of the CVP include:

? Providing irrigation water

? Supply of domestic and industrial water

? Flood control

? Generation of electric power
? Conservation of fish and wildlife
? Improving Sacramento River navigation
? Providing recreational opportunities
? Enhancing water quality

Specifically, Keswick Dam and Reservoir are used to equalize flow discharged from Shasta Dam and SCPP to enable a relatively constant flow in the Sacramento River downstream of Keswick Dam. Shasta Power Plant, Keswick Power Plant, and SCPP provide power first to meet the project facilities requirements, and then remaining energy is marketed to various customers in northern California. Shasta Power Plant and SCPP are classified as peaking plants, while Keswick Power Plant is a run-of-the-river plant.

As discussed in Section 2.5.2, the past and current IMM AMD discharges continue to impact the beneficial uses of the CVP water resources. Although the current IMM metal discharges have been reduced by 95 percent from the uncontrolled levels, it remains necessary to make low-flow releases from SCPP during releases from SCDD to flush the contaminated water through the Spring Creek Arm to prevent the buildup of metal concentrations in the Arm. The sediment deposits in the Spring Creek Arm that have resulted from past IMM metal releases restrict the range of operating levels of Keswick Reservoir because of concerns that sediment with high metals concentrations in the Spring Creek Arm would become mobilized.

The portion of Keswick Reservoir affected by IMM AMD has reduced recreational value. The resident trout fishery in Keswick Reservoir and the main body of the Sacramento River is impacted by both the heavy metal contaminants in the water column of the mixing zones and the heavy sediment loading caused by the precipitation of iron and other heavy metals discharged from the IMM Site over the past century.

The Sacramento River salmon fishery (downstream of Keswick Dam) is the most important fishery in the State of California. The salmon fishery has experienced large population declines because of a number of factors, including the IMM AMD impacts. The Sacramento River Winter-run Chinook salmon is listed as endangered by the United States and the State of California, and the Sacramento River Spring-run Chinook salmon is listed as threatened. The Sacramento River also supports a major steelhead trout and resident rainbow trout fishery.

Spring Creek Reservoir was constructed in part as a mitigation measure for the AMD discharges and does not support aquatic life, nor is it currently used for any recreational purpose. The Spring Creek Reservoir meters the Spring Creek watershed surface waters, contaminated by the continuing uncontrolled IMM AMD area source discharges, into the Sacramento River at Keswick Reservoir. The portions of Spring Creek impacted by IMM AMD are essentially lifeless.

2.7 Summary of Site Risks

2.7.1 Conceptual Site Model

The conceptual site model (CSM) identifies the means by which human or ecological receptors at or near the Spring Creek Arm may contact chemicals in environmental media. The CSM provides a current understanding of the sources of contamination, physical setting, beneficial uses of water, current and future land use, and identifies potentially complete human and ecological exposure pathways for the Spring Creek Arm. The CSM was used to identify potentially complete exposure pathways that warrant human

health and ecological evaluations.
The conceptual exposure model was formulated according to guidance, with the use of professional judgment and information on contaminant sources, release mechanisms, routes of migration, potential exposure points, potential routes of exposure, and potential receptor groups associated with the site. Figure 6 presents the conceptual exposure model schematic for the site.
Based on current understanding of present and future land and water uses at or near the site, the following potentially complete human exposure pathways were considered for the site:
? Incidental ingestion and dermal contact with Spring Creek Arm surface water by future recreational users (This pathway was evaluated as part of the baseline risk assessment [PRC, 1991].)
? Incidental ingestion and dermal contact with Spring Creek Arm sediment by future recreational users (Evaluation of this pathway was revised as part of the 2004 updated human health risk evaluation [CH2M HELL, 2004b].)
Based on the current understanding of available habitat types and wildlife potentially using the Spring Creek Arm, and the beneficial use of surface water, the most plausible potentially complete ecological exposure pathways exist for the following scenarios:
? Potential exposure of aquatic resources to site-related chemicals in surface water in the Spring Creek Arm (This pathway was evaluated as part of the Environmental Endangerment Assessment [EPA, 1992a].)
? Potential exposure of aquatic resources to site-related chemicals in sediment in the Spring Creek Arm (Evaluation of this pathway was revised as part of the 2004 updated ecological risk evaluation [CH2M HILL, 2004b].)
Additionally, exposure of aquatic resources to site-related chemicals in the Sacramento River downstream of Keswick Reservoir has been historically documented. The potential for toxicity to aquatic resources downstream of the Spring Creek Arm was also discussed in the Ecological Risk Evaluation.

2.7.2 Human Health Risk Evaluation

The baseline risk evaluation estimated current and future risks posed by the Site in the absence of any remedial action. This section summarizes human health risk methodology and conclusions made in the technical memorandum Updated Human Health and Ecological Risk Evaluations for the Spring Creek Arm of Keswick Reservoir, Appendix E of the Sediment FS (CH2M HELL, 2004b; EPA, 2004). The memorandum was an update to previous human health and ecological risk evaluations at the IMM Site related to sediments in the Spring Creek Arm of Keswick Reservoir (PRC, 1991; EPA, 1992a).
Exposure Assessment An assessment of chemical intake was conducted in accordance with applicable EPA guidance documents for risk assessment. The procedures used for this risk evaluation are consistent with those described in the following guidance documents:
? Risk Assessment Guidance for Superfund (RAGS) - Volume I: Human Health Evaluation Manual, Part A (Interim Final) (EPA, 1989)
? Risk Assessment Guidance for Superfund- Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment Interim) (EPA, 2001)
Chemical intakes were calculated for the exposure scenarios developed in the CSM and based on available media at the site and current and future land use.

The surface water exposure pathway, incidental ingestion and dermal contact with Spring Creek Arm surface water by future recreational users, was previously evaluated as part of the human health risk assessment conducted in 1991 by PRC Environmental Management, Inc. (PRC, 1991). The 1991 risk assessment concluded that individuals who come into direct contact with or ingest water from Keswick Reservoir are not currently at risk. Therefore, the surface water exposure pathway is not considered to pose significant risk to human health and was not further evaluated in the updated human health risk evaluation.

In the 1991 risk assessment, noncancer toxicity risks were also quantified for the consumption of fish from the Sacramento River for four contaminants of concern (cadmium, copper, iron, and zinc). The risk evaluation was conducted using exposure point concentrations derived using two approaches:

(1) Metals concentrations directly measured in the liver of resident rainbow trout collected in the Sacramento River below Keswick Dam

(2) Modeled metals concentrations in edible fish tissues based on bioconcentration factors for the specific metals

Hazard indices calculated by PRC using fish liver data were above regulatory thresholds; hazard indices were calculated as 2.2 for average concentrations and 5.9 for reasonable maximum exposure (RME) concentrations. Copper and cadmium were the primary contributors of risk. However, PRC concluded that risk calculations based on fish liver data very likely exaggerate the risk of consumption of fish. Humans usually eat only fish muscle and not soft tissues (i.e., liver), and concentrations of metals in the muscle are expected to be much less than the concentrations found in the liver. Hazard indices were also calculated using metal concentrations in the Sacramento River and modeled metals concentrations in edible fish tissues based on bioconcentration factors for the specific metals. Hazard indices calculated using bioconcentration estimates were 0.16 using average concentrations and 0.76 using RME concentrations, below the regulatory threshold value of 1.0. Based on calculations using bioconcentration estimates, consumption offish is not considered to pose a significant risk to human health. This pathway was not further evaluated in the updated human health risk evaluation.

Since the 1991 risk assessment, EPA obtained and reviewed sediment data from a 1997 USGS investigation and a 2003 sediment sampling event that indicated additional chemical constituents other than those previously evaluated were detected at elevated concentrations. Risks related to the Spring Creek Arm sediment exposure pathway were further evaluated using these additional data. This exposure pathway includes incidental ingestion and direct contact with contaminated sediment by a hypothetical current and future recreational user (modeled as a youth). Major assumptions regarding exposure frequency, duration, and other exposure factors included in the exposure assessment are detailed in Appendix E of the Sediment FS (CH2M HILL, 2004b).

Chemicals of Potential Concern and Exposure Point Concentrations

Considering the historical activities in the watershed, COCs are limited to heavy metals associated with AMD and HMO precipitates. Ten metals were identified in the human health and ecological risk evaluations as chemicals of potential concern (COPCs): antimony, arsenic, cadmium, chromium, copper, iron, lead, nickel, silver, and zinc.

Table 6 presents the COPCs and exposure point concentration (EPC) determined from Spring Creek Arm sediment samples. The EPC is the concentration that was used to estimate the exposure and risk from each metal. As will be discussed in greater detail in this section, results from the human health and ecological risk evaluations were used to identify COCs from this list of COPCs.

The EPCs for the Spring Creek Arm were calculated in accordance with EPA guidance for statistical analysis of monitoring data (EPA, 2002b). Table 6 includes the range of concentrations detected for each metal, as well as the frequency of detection, the EPC, and the statistical measure used to derive the EPC.

Toxicity Assessment

Toxicity values for the COPCs were compiled from the Integrated Risk Information System (IRIS) (EPA, 2003) and Health Effects Assessment Summary Tables (HEAST) (EPA, 1997c).

Carcinogens. Table 7 provides carcinogenic risk information which is relevant to chemicals of concern in Spring Creek Arm sediment. Of the COPCs evaluated, oral carcinogenic slope factors are only available for arsenic.

TABLE 6

Spring Creek Arm Sediment Exposure Point Concentrations

Iron Mountain Mine Record of Decision 5, Shasta County, California

Chemical	**Concentration Detected**			**No. of Samples**	**No. of Detects**	**Percent Detects**	**95% Normal UCL**	**95% Lognormal UCL**	**EPC**	**Statistical Measure**
	Min.	**Max.**	**Mean**							
Antimony	0.48	7.7	3.9	9	8	89	5.8	18	5.8	Normal (Student's-t)
Arsenic	4.6	933	285	31	31	100	350	510	362	Bootstrap-t
Cadmium	0.49	37	6.1	31	31	100	8.1	8.3	8.3	Lognormal
Chromium	3.4	194	24	31	30	97	47	48	48	Lognormal
Copper	75	4,765	1,262	181	181	100	1,353	1,422	1,361	Bootstrap-t
Iron	39,672	469,895	160,986	181	181	100	170,393	172,812	170,863	Bootstrap-t
Lead	2.4	393	73	31	31	100	94	110	112	Bootstrap-t
Nickel	2.1	290	35	31	31	100	53	52	71	Bootstrap-t
Silver	0.21	19	7.0	31	21	68	8.8	12	9.1	Bootstrap-t
Zinc	63.4	6578	892.5	181	181	100	999	973.6	974	Lognormal

Notes:

All units are in mg/kg, milligrams per kilogram.

EPC = exposure point concentration, UCL = upper confidence level

TABLE 7

Summary of Cancer Toxicity Values Used in the Human Health Risk Evaluation

Iron Mountain Mine Record of Decision 5, Shasta County, California

Chemical Name	**Oral Cancer Slope Factor**	**Dermal Cancer Slope Factor**	**Slope Factor Units**	**Weight of Evidence/Cancer Guideline Description**	**Source**
Antimony	--	--	--	D	--
Arsenic	1.5	1.5	(mg/kg-day)-1	A	IRIS,2003
Cadmium	--	--	--	B1	--
Chromium	--	--	--	A	--
Copper	--	--	--	D	--
Iron	--	--	--	--	--
Lead	--	--	--	B2	--
Nickel	--	--	--	D	--
Silver	--	--	--	D	--
Zinc	--	--	--	D	--

Notes:
= not applicable
IRIS = Integrated Risk Information System, U.S. EPA
A - human carcinogen;
B1 - probable human carcinogen, indicates that limited human data are available;
B2 - probable human carcinogen, indicates sufficient evidence in animals and inadequate or no evidence in humans; and
D - Not classifiable as a human carcinogen

Because carcinogenic slope factors and noncarcinogenic reference doses (see next section) are not available for the dermal route of exposure, dermal slope factors and reference doses used in the risk evaluation were extrapolated from oral values. An adjustment factor is sometimes applied, and is dependent upon how well the chemical is absorbed via the oral route. Adjustments are particularly important for chemicals with less than 50 percent adsorption via the ingestion route. Adjustment was not necessary for arsenic. Therefore, the same value presented for the oral cancer slope factor was used as the dermal cancer slope factor for arsenic.

Noncarcinogens. Table 8 provides non-carcinogenic toxicity factors which are relevant to the COPCs in Spring Creek Arm sediment. Toxicity data available for oral exposures have been used to develop oral reference doses (RfDs).

TABLE 8
Summary of Non-cancer Toxicity Values Used in the Human Health Risk Evaluation
Iron Mountain Mine Record of Decision 5, Shasta County, California

Chemical Name	Oral RfD Value	Oral RfD Units	Dermal RfD Value	Dermal RrD Units	Source	Data
Antimony	4.00E-04	mg/kg-day	6.00E-06	mg/kg-day	IRIS	2003
Arsenic	3.00E-04	mg/kg-day	3.00E-04	mq/kq-day	IRIS	2003
Cadmium	5.00E-04	mg/kg-day	1.25E-05	mg/kg-day	IRIS	2003
Chromium	3.00E-03	mg/kg-day	7.50E-05	mg/kg-day	IRIS	2003
Copper	4.00E-02	mg/kg-day	4.00E-02	mg/kg-day	HEAST	1997
Iron	3.00E-01	mg/kg-day	3.00E-01	mg/kg-day	PRG	1997

TABLE 8
Summary of Non-cancer Toxicity Values Used in the Human Health Risk Evaluation
Iron Mountain Mine Record of Decision 5, Shasta County, California

Chemical Name	Oral RfD Value	Oral RfD Units	Dermal RfD Value	Dermal RrD Units	Source	Data
Lead	--	--	--	--	--	--
Nickel	2.00E-02	mg/kg-day	8.00E-04	mg/kq-day	IRIS	2003
Silver	5.00E-03	mg/kg-day	5.00E-03	mq/kq-day	IRIS	2003
Zinc	3.00E-01	mg/kg-day	3.00E-01	mg/kq-day	IRIS	2003

Notes:
= not applicable
IRIS = Integrated Risk Information System, U.S. EPA
HEAST = Health Effects Assessment Summary Tables (HEAST) FY 1997 Update. EPA-540-R-97-036. July 1997.
PRG = EPA Region IX PRG Tables, October 2002

As discussed for carcinogens, reference doses are not available for the dermal route of exposure. Thus, the dermal slope factors and reference doses used in the assessment have been extrapolated from oral values. An adjustment factor is sometimes applied, and is dependent upon how well the chemical is absorbed via the oral route. Adjustments are particularly important for chemicals with less than 50 percent adsorption via the ingestion route. Dermal toxicity factors were derived in accordance with guidance in Appendix A of RAGS (EPA, 1989).

Lead. Potential risks from lead concentrations were evaluated using different methods than those conventionally used for other carcinogens and noncarcinogens. For direct contact pathways, the EPCs for lead in sediment were compared to the EPA Region IX residential soil preliminary remediation goal (PRG) of 400 mg/kg. The residential soil PRG is based on EPA's Integrated Exposure Uptake Biokinetic (IEUBK) model. The IEUBK model is designed to predict probable blood-lead concentrations for children between 6 months and 7 years of age who have been exposed to lead through various sources (air, water, soil, dust, and in utero contributions from the mother).

Risk Characterization

For carcinogens, risks are generally expressed as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to the carcinogen. The excess lifetime cancer risks are determined by multiplying the intake level with the cancer slope factor.

These risks are probabilities that usually are expressed in scientific notation (e.g., 1xlO-6). An excess lifetime cancer risk of 1xlO-6 indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an "excess lifetime cancer risk" because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual developing cancer from all other causes has been estimated to be as high as one in three. EPA's generally acceptable risk range for site-related exposures is 10-4 4 to 10-6. The chronic daily intake was calculated for each exposure pathway (i.e., incidental ingestion and dermal contact) using exposure factors such as exposure frequency, exposure duration, body weight, etc. The exposure assumptions for calculating the chronic daily intake are provided in Appendix E of the Sediment FS (CH2M HLLL, 2004b, EPA 2004).

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period with a reference dose (RfD) derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of estimate intake (i.e., exposure) to toxicity value (i.e., RfD) is called a hazard quotient (HQ). An HQ<1 indicates that a receptor's dose of a single contaminant is less than the RfD, and that adverse noncarcinogenic effects from that chemical are unlikely. Additionally, a hazard index (HI) is generated by adding the HQs for all chemical(s) of concern that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. An HI<l indicates that, based on the sum of all HQs from different contaminants and exposure routes, adverse noncarcinogenic effects from all contaminants are unlikely. An HI>1 indicates that site-related exposures may present a risk to human health.

The potential exposure to Spring Creek Arm sediment was evaluated under a recreational user scenario. Potential routes of exposure to sediment include incidental ingestion and dermal contact. The following assumptions were used to estimate reasonable maximum exposure (RME) for hypothetical current and future recreational users:

A 45.8-kilogram youth was assumed to be exposed to sediment for 12 days per year, over a 9-year duration.

The excess lifetime cancer risk (ELCR) estimates for the recreational user scenario are summarized in Table 9.

The cumulative ELCR from all carcinogenic COPCs is 1 x 10-5. This risk level indicates that if no cleanup action is taken, an individual would have an increased probability of 1 in 100,000 of developing cancer as a result of site-related exposure to the COPCs. This risk level is within the EPA Superfund regulatory target risk threshold range of 1 x 10-6 to 1 x 10-6. The primary contributor to risk is arsenic (100 percent contribution).

TABLE 9

Recreational User Scenario - Potential Excess Lifetime Cancer Risk, Spring Creek Arm Sediment ***Iron Mountain Mine Record of Decision 5, Shasta County, California***

Chemical	**Ingestion**			**Dermal**			**Total ELCR**	**Percent Contribution**
	CDI	**CDI Units**	**ELCR**	**CDI**	**CDI Units**	**ELCR**		
Arsenic	6.68E-06	mg/kg-day	1.0E-05	2.13E-06	mg/kg-day	3.2E-06	1.3E-05	100.00
Total Risk			1.0E-05			3.2E-06	1.3E-05	

Notes:

CDI = chronic daily intake

ELCR = excess lifetime cancer risk

Table 10 provides hazard quotients (HQs) for each route of exposure (i.e., incidental ingestion or dermal contact) and the hazard index (HE, sum of hazard quotients) for all routes of exposure. The Risk Assessment Guidance (RAGS) for Superfund states that, generally, an HE greater than one indicates the potential for adverse noncancer effects. The HE for exposure to Spring Creek Arm sediment is 0.3, which is below the regulatory threshold value.

TABLE 10

Recreational User Scenario - Potential Noncarcinogenic Risk, Spring Creek Arm Sediment ***Iron Mountain Mine Record of Decision 5, Shasta County, California***

Chemical	**Ingestion**		**Dermal**		**Total HI**	**Percent Contribution**
	CDI (mg/kg-day)	**HQ**	**CDI (mg/kg-day)**	**HQ**		
Antimony	8.31E-07	<0.01	--	--	<0.01	0.6
Arsenic	5.19E-05	0.2	1.66E-05	0.06	0.2	70
Cadmium	1.19E-06	<0.01	1.26E-08	<0.01	<0.01	1.0
Chromium	7E-06	<0.01	--	--	<0.01	0.7

Copper 2E-04 <0.01 -- -- <0.01 1.5

TABLE 10

Recreational User Scenario - Potential Noncarcinogenic Risk, Spring Creek Arm Sediment *Iron Mountain Mine Record of Decision 5, Shasta County, California*

	Ingestion		Dermal			
Chemical	**CDI (mg/kg-day)**	**HQ**	**CDI (mg/kg-day)**	**HQ**	**Total HI**	**Percent Contribution**
Iron	2E-02	0.08	--	--	0.08	25
Lead	2E-05	--	--	--	--	--
Nickel	1E-05	<0.01	--	--	<0.01	0.2
Silver	1E-06	<0.01	--	--	<0.01	0.1
Zinc	1E-04	<0.01	--	--	<0.01	0.1
Total Risk		0.3		0.06	0.3	

Notes:
CDI = chronic daily intake
HQ = hazard quotient
HI = hazard index
- = Toxicity criteria are not available to quantitatively address this route of exposure.

As discussed previously, potential risks from lead concentrations were evaluated using different methods than those conventionally used for other carcinogens and noncarcinogens. All detected concentrations of lead were below the Region IX residential PRG of 400 mg/kg.

In summary, the human health risk evaluation indicates that contaminated sediment in the Spring Creek Arm does not pose a current or future unacceptable risk to human health or welfare.

2.7.3 Ecological Risk Evaluation

This section summarizes ecological risk methodology and conclusions made in the technical memorandum Updated Human Health and Ecological Risk Evaluations for the Spring Creek Arm of Keswick Reservoir, Appendix E of the Sediment FS (CH2M HELL, 2004b, EPA 2004). The risk evaluation used the sediment data presented in the human health risk summary (Section 2.7.2) and previous studies (e.g., bioassays, benthic bioassessments, etc.) to assess the potential current and future risk to benthic and aquatic communities in the absence of any remedial actions.

The procedures used for the ecological risk evaluation were consistent with those described in the following guidance documents:

? Guidelines for Ecological Risk Assessment (EPA, 1998)

? Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (EPA, 1997d)

Ecological Risk Methodology

Potential effects to benthic and aquatic communities were assessed using an approach which considers multiple lines of evidence collectively (EPA, 1998). The results from the historical and current environmental evaluations were collectively considered. The following lines of evidence were evaluated to identify the potential for risk to aquatic resources:

? Identification of chemical concentrations in sediment that exceed effects-based screening benchmarks (e.g., threshold effect concentrations [TEC], probable effect concentrations [PEC], and upper effects threshold [UET] screening levels)

? Direct measurement of infaunal toxicity using sediment and porewater bioassays

? Rapid bioassessment of benthic community

The results of each of these lines of evidence are briefly discussed below.

Additionally, the ecological risk evaluation discussed the potential for adverse effects to fishery resources downstream of Keswick Reservoir using data from California Department of Fish and Game (CDFG) investigations.

Benthic Exposure and Effects Estimation. Benthic receptors are directly exposed to constituents in the media in which they live, and because toxicity values for these taxa are expressed in terms of media concentrations, site media concentrations (i.e., Spring Creek Arm sediment data) were directly compared with benthic macroinvertebrate screening benchmarks. This ecological evaluation used the TEC and PEC provided in the "Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems" (MacDonald et al., 2000) and the UET from the National Oceanic and Atmospheric Administration's (NOAA) *Screening Quick Reference Tables* (Buchman, 1999) for screening benchmarks.

TEC and PEC screening levels represent estimates of the level below which adverse effects to benthic macroinvertebrates are not expected to occur and above which adverse effects are expected to occur, respectively (MacDonald et al., 2000). Constituent concentrations in sediment falling between their respective TEC and PEC screening levels represent the range where adverse effects would occasionally occur. Because no threatened or endangered invertebrate species were identified in the Spring Creek Arm, it is most appropriate to base management decisions regarding the toxicity of the sediments on population-level effects rather than each individual. Considering this, the PEC is the most appropriate screening level for supporting management decisions regarding the potential toxicity of the sediments for benthic macroinvertebrates.

EPCs for COPECs in sediment were calculated as the lesser of either the maximum value or the ninety-fifth percentile UCL of sediment chemistry data. EPCs for all results and chemical concentrations from individual samples were used for the benchmark comparisons. Table 11 provides a comparison of the estimated sediment EPCs with freshwater sediment benchmarks. The EPC basis and summary statistics for the COPECs were presented in Table 6.

TABLE 11

Comparison of Exposure Point Concentrations with Sediment Benchmarks

Iron Mountain Mine Record of Decision 5, Shasta County, California

Chemical	EPC	TEC	Factor of Exceedance	PEC	Factor of Exceedance	UET	Factor of Exceedance
Antimony	5.8	--	--	--	--	3	1.9

Arsenic 362 9.79 36.9 33 11.0 17 21.3
Cadmium 8.3 0.99 8.3 4.98 1.7 3 2.8
Chromium 48 43.4 1.1 111 0.4 95 0.5
Copper 1,361 31.6 43.1 128 10.6 86 15.8
Iron 170,863 -- -- -- -- -- --
Lead 112 35.8 3.1 128 0.9 127 0.9
Nickel 71 22.7 3.1 48.6 1.5 43 1.6
Silver 9.1 -- -- -- -- 4.5 2.0
Zinc 974 121 8.0 459 2.1 520 1.9
Notes:
-- = not available
All units are in mg/kg, milligrams per kilogram
EPC = exposure point concentration;
TEC = threshold effects concentration
PEC = probable effects concentration;
UET = upper effects threshold Factor of exceedance is calculated as the EPC divided by the sediment benchmark concentration (i.e., TEC, PEC, or UET).

EPCs exceeding applicable screening benchmarks (i.e., a factor of exceedance greater than 1.0) indicate that there is a potential for adverse risk to benthic species; however, the results of the benchmark screening are considered collectively with the other lines of evidence discussed in the following subsections.

Sediment Bioassays. The results of bioassay tests conducted on sediment samples from Spring Creek Reservoir during the RI were reported in *Bioassay Report: Acute and Chronic Definitive Bioassays Conducted September 24 through November 27, 1997* (provided as Appendix F of the RI Report [EPA, 2002a]). The following bioassays were conducted to determine the toxicity of sediment and soil at the site:

? Chronic exposure of earthworms (*Eiseniafoetida*) (14-day survival and growth) to dry sediment or soil
? Chronic exposure of lettuce seeds (*Lactuca sativa*) (28-day germination and growth) to dry sediment or soil
? Acute (LC50) and chronic (no observed/lowest observed) exposure of amphipods (*Hyalella azteca*) to wet sediment
? Forty-five day growth and survival bioassays with wet sediments using yellow nutsedge (*Cyperus esculentus*)
? Acute 96-hour frog embryo toxicity ass&y-*Xenopus* (FETAX) tests with wet sediment samples, measuring survival and malformation rate

All five of these bioassays indicated that sediment and soil were toxic at 100 percent or lower concentrations. Results of the earthworm tests indicated that toxicity (statistically significant mortality) was generally observed in soil samples of less than 25 percent whole soil. Lettuce seed bioassays indicated that toxicity of soils to this species was at soils concentrations of less than 25 percent whole soil for all samples tested.

Wet sediment tests with amphipods had adverse effects at sediment concentrations ranging from 1 to 15 percent whole sediment for all samples tested. Lethal effects (LC50) concentrations ranged from 2.5 to 13.1 percent whole sediment. Nutsedge tests indicated that for all sediments tested, adverse effects were seen at the 100 percent sediment concentration.

The FETAX assays indicated that all sediments tested had malformation rates (EC50) at sediment concentrations of less than 25 percent whole sediment. Lethal effects (LC50) for frogs were seen at whole sediment concentrations ranging from 12.1 percent to less than 25 percent.

Rapid Bioassessment - Benthic Invertebrate Study. A one-time sampling and analysis of benthic invertebrates was conducted at locations associated with sediment piles within the Spring Creek Arm, lower Keswick Reservoir, and background areas within upper Keswick Reservoir. Results of that investigation are presented in Appendix G of the RI Report, *Keswick Reservoir Fall 1997 Benthic Invertebrate Study* (Slotton, et al., 1998; EPA, 2002a). This investigation found dramatically reduced benthic diversity and biomass within Sediment Piles A, B, and C and in lower Keswick Reservoir in comparison to similar depth ranges in upper Keswick Reservoir. The numerical abundance of benthic invertebrates in and downstream of the Arm ranged from 0.55 to 9.2 percent of the numerical abundance of upper Keswick Reservoir. Similarly, the benthic biomass ranged from 0.05 to less than 20 percent of the benthic biomass in upper Keswick Reservoir areas. This represents reductions of greater than 90 percent in numerical abundance and greater than 80 percent in benthic biomass in comparison to control areas. The results of this investigation demonstrated areas of severely impoverished benthic community associated with the sediment piles within the Spring Creek Arm and lower Keswick Reservoir.

Porewater Bioasssays with Ceriodaphnia dubia. Acute 48- and 96-hour toxicity tests with sediment porewaters prepared from samples collected from Piles A, B, and C within the Spring Creek Arm were conducted to determine the lethality of these solutions to *Ceriodaphnia dubia (C. dubia)*. Results of these toxicity tests are presented in Appendix H of the RI Report, *An Evaluation of the Toxicity of Sediment Porewater from the Iron Mountain Superfund Site to Ceriodaphnia dubia* (Pacific Eco-Risk Labs, 1998; and EPA, 2002a).

Acute toxicity tests with porewater from Pile A and Pile B sediments indicated that 48-hour and 96-hour LC50s were in the range of 0.8 to 1.8 percent porewater (dilution of 125: 1 to 55: 1) in the samples tested. In acute toxicity tests with Pile C porewaters, 48- and 96-hour LC50s ranged from 0.6 percent to 2.2 percent porewater for samples collected from 0 to 10 feet in depth. Background samples from Shasta, Whiskeytown, and the laboratory demonstrated no significant mortality in 100 percent porewater.

As a result of the findings of these acute and chronic tests, a Phase I toxicity identification evaluation (TIE) was conducted with sediment porewater from Pile C. Results of this evaluation indicated that iron was primarily responsible for the acute toxicity of this porewater to *C. dubia*.

The results of these bioassays with sediment elutriates and porewater are consistent with the bioassays of bulk sediment and soil samples. All of these bioassays demonstrated that constituents in these media contribute to significant toxicity to invertebrates, plants, and amphibians.

Aquatic Resources Downstream of Keswick Reservoir. The Sacramento River between Keswick and Squaw Hill Bridge, near Vina, includes areas designated as prime salmon and steelhead spawning areas (CDFG Code Section 1505). These areas are used by salmon species listed as threatened and endangered, including two state-listed species: Sacramento River winter-run and spring-run Chinook salmon (*Oncorhynchus tshawytscha*). When low reservoir elevations are combined with high power plant discharges, sediment could be mobilized to expose listed species of salmon in Sacramento River spawning areas to contaminants during sensitive life stages. At least one such event has occurred during the past 20 years, on May 25, 1988. Six weeks after the release of contaminated sediment, sediment "sludge" samples were collected in redd areas (e.g., salmonid spawning areas) downstream of Keswick Dam. Copper, zinc, and cadmium were detected at elevated concentrations of 364, 864, and 5 mg/kg in the downstream area (Turtle Bay West, CDFG data). This discharge was believed to affect the Sacramento River as far downstream as Hamilton City.

The CDFG evaluated the potential toxicity of resuspended Keswick Reservoir sediment to fish and invertebrates residing in the Sacramento River (Finlayson et al., 2000). Bulk sediment and elutriate water bioassay tests were conducted using rainbow trout (*O. mykiss*), amphipods (*H. azteca*), and cladocerans (*C. dubia*). The tests were conducted to simulate conditions that could occur during an actual discharge of sediments to the Sacramento River. Both bulk sediment and elutriate bioassay tests resulted in significant toxicity, and the authors indicated a good correlation with zinc concentrations was observed, although they believe low pH and alkalinity conditions could have influenced survival rates. These results indicate that if significant downstream releases of sediment from the Spring Creek Arm occur, bulk sediment and sediment elutriate waters represent a significant potential hazard to aquatic life (including state-listed salmonid species) in the Sacramento River downstream of Keswick Dam, particularly the early life stages of salmon and steelhead. Because cleanup of toxic sediments in the spawning grounds would be expected to be a difficult operation, toxic conditions could extend over a several year period and jeopardize the survival of the entire populations.

Ecological Risk Characterization

To provide confidence in decision making for the Spring Creek Arm, potential effects to benthic communities were assessed using an approach which considers multiple lines of evidence collectively (EPA, 1998). The results of each of these lines of evidence are summarized in Table 12.

TABLE 12
Summary of Risk Characterization Lines of Evidence
Iron Mountain Mine Record of Decision 5, Shasta County, California

Evidence	**Result**	**Explanation**
Benthic Benchmark Screening	+	2003 - Several COPEC concentrations (using historical and current sediment data) exceed each of the sediment benchmarks (copper and arsenic showed the highest risk).
Sediment Bioassays	+	1997 - Amphipod bioassays showed adverse effects at sediment concentrations from 1 to 15 percent whole sediment. Nutsedge tests indicated toxic effects in 100 percent samples in all sediments tested. FETAX assays indicated significant malformations (EC50 of <25 percent whole sediment) and mortality (LC50s of 12.1 to 25 percent whole sediment) in all sediments tested.

Rapid
Bioassessment -
Benthic
Invertebrate Study
+ 1997 - Results indicate dramatic reductions in benthic diversity and biomass in Spring Creek Arm Piles A, B, and C when compared with reference areas.
Porewater
Bioassays
+ 1998 - Significant mortality (LC50s all <2.2 percent) to *Ceriodaphnia dubia* occurred when exposed to sediment porewater from Piles A, B, and C in the Spring Creek Arm.
+ = indicates that the evidence is consistent with the occurrence of the endpoint effect.

When considering the collective weight of evidence using sediment benchmark comparisons, rapid bioassessment, and bioassay results for potential risk to aquatic/benthic communities, sufficient evidence exists to conclude that the identified COPCs are resulting in ecologically significant impacts to these communities in the Spring Creek Arm. Essentially all the lines of evidence support this conclusion.

Additionally, data collected following historical releases of sediment from the Spring Creek Arm and bulk sediment and elutriate water bioassay tests on aquatic species indicate that a significant release of sediment from the Spring Creek Arm could adversely impact downstream fisheries within the Sacramento River. A release would pose a serious potential risk to United States and California-listed spring-run Chinook salmon (threatened species), winter-run Chinook salmon (endangered species), and other aquatic resources.

Chemicals of Concern Considering the results of the sediment benchmark screening, sediment constituents exceeding PECs have been identified as chemicals of ecological concern (COECs). The COECs include: arsenic, cadmium, copper, nickel, and zinc. Of these metals, arsenic and copper had the highest factors of exceedances above PECs and likely pose the greatest risk to aquatic resources. A PEC was not available for iron; however, porewater studies indicated that iron could have been responsible for *C. dubia* toxicity; therefore, iron is also considered a COEC.

2.7.4 Basis for Remedial Action

The risk evaluations indicate that contaminated sediment in the Spring Creek Arm does not pose a current or future unacceptable risk to human health and welfare. However, the contamination has resulted in ecologically significant impacts to benthic and aquatic communities in the Arm. Additionally, a potential future release of contaminated sediment could adversely impact important downstream fisheries through the deposition of sediments containing toxic levels of metals in spawning beds of the Sacramento River.

The site risk evaluation indicates that remedial action is warranted and identified the contaminants and exposure pathways that need to be addressed by remedial action. EPA has determined that the response action selected in this ROD is necessary to protect the environment from actual or threatened releases of hazardous substances into the environment.

2.8 Remedial Action Objectives

Remedial action objectives (RAOs) provide a general description of what the cleanup is expected to accomplish and provide a design basis for remedial alternatives. RAOs define the extent of site cleanup required to protect human health and the environment. Where applicable, RAOs take into consideration COCs, routes of exposure and receptors, and acceptable contaminant concentrations for each impacted medium at the Site. RAOs developed for the remedial action selected in this ROD are:

? Protect the Sacramento River ecosystem from releases of heavy metals originating from the Spring Creek Arm, by preventing the mobilization and redeposition of contaminated sediment into important fishery spawning habitats located in the Sacramento River downstream of Keswick Dam.

? Prevent adverse impacts on water quality and the beneficial uses of the Sacramento River below Keswick Dam, by reducing the metal loads and suspended solids associated with contaminated sediment discharged from the Spring Creek Arm to the Sacramento River.

Achievement of the above RAOs is expected to have the following ancillary benefits:

? Increase the possibility that a benthic community could become re-established in the Spring Creek Arm.

? Improve aquatic habitat in Keswick Reservoir through remedial actions in the Spring Creek Arm.

? In addition, it is expected that operation of the SCDD and power plant may be subject to reduced restrictions regarding Keswick Reservoir operating levels. However, renegotiation of current restrictions on Keswick Reservoir operations is not required under this ROD.

The selected remedy will not address upgradient sources of contaminant discharges from the IMM Superfund Site. These discharges are being addressed through other remedial actions currently underway (e.g., SCRR) and potential future remedial action decisions for the MM Site.

2.9 Description of Alternatives

2.9.1 General

This section provides a brief description of remedial alternatives developed to address contaminated sediment in the Spring Creek Arm of Keswick Reservoir. Alternatives were developed to provide a range of waste management options that vary in the extent of active remediation and the extent to which they rely on long-term management of residuals and untreated wastes. In accordance with CERCLA guidance, remedial alternatives were developed by assembling technology types (e.g., dredging) and process options chosen to represent the various technology types (e.g., hydraulic dredging). The "no action" alternative was also evaluated.

The Sediment FS evaluated the three major cleanup methods for sediment in accordance with the *Contaminated Sediment Guidance for Hazardous Waste Sites*, OSWER 9355.0-85 (EPA, 2002c). These cleanup methods include natural recovery, in situ capping, and dredging (or excavation) with treatment or disposal. During the identification and screening of technologies, EPA determined that monitored or enhanced natural recovery would not satisfy RAOs. Natural recovery uses ongoing, naturally occurring processes to contain, destroy, or otherwise reduce the bioavailability or toxicity of contaminants in sediment. Biological or chemical transformation would be too slow in the Spring Creek Arm to provide remediation to acceptable levels in a reasonable timeframe for the metals of concern. The potential for migration of contaminated sediment in the Spring Creek Arm would remain during implementation of natural recovery. Therefore, an alternative was not developed that included natural recovery as the sole component of the remedy.

Six alternatives were developed and screened in the Sediment FS. Table 13 presents a summary of the components of each alternative. These alternatives include no further action, institutional controls, capping, dredging, and a combination of capping and dredging. The most promising alternatives identified during the screening were selected for further development.

The sixth alternative summarized in Table 13 was dropped during screening. That alternative was designed to limit the mobilization of contaminated sediment in the Spring Creek Arm using controls that limit SCDD releases and power plant operations. No engineering controls or active remediation were included in Alternative 6. Such operational controls would not significantly improve long-term protection compared to existing conditions. More details regarding this alternative and the screening process are provided in the Sediment FS (EPA, 2004).

The alternatives described in this section are those that were retained for further analysis following screening in the Sediment FS. The cost and design details provided for the five alternatives passing initial screening are based on preliminary engineering estimates. More detailed cost estimates and designs will be completed in the Remedial Design phase of the cleanup.

2.9.2 Alternative 1 - No Action

The No-action Alternative is evaluated to determine the risks that would be posed to public health and the environment if no further actions were taken to reduce the potential for mobilization of contaminated sediment into the Sacramento River. This alternative also serves as a basis for comparison with the other remedial alternatives under consideration. The No-action Alternative for the Sediment FS should be considered as "No Further Action." Under the No-action Alternative, contaminated sediment would be left in place in the Spring Creek Arm and no engineering controls would be used to contain the sediment. This alternative assumes continued operation of SCDD and Keswick Reservoir in accordance with the 1980 MOU (SWRCB et al., 1980) and the 1993 Biological Opinion (NMFS, 1993). The MOU is an agreement among the SWRCB, United States Water and Power Resources Service (the predecessor to Reclamation), and the CDFG that presents the short- and long-term actions and responsibilities of the signatory agencies to minimize toxicity problems in the vicinity of Spring Creek. The 1993 Biological Opinion addresses the effects of Reclamation's long-term operation of the CVP, in conjunction with the Department of Water Resource's State Water Project, on Sacramento River Winter-run Chinook salmon (NMFS, 1993). Reclamation would continue to control the release rate from SCDD in a manner that matches the discharges from Shasta Dam and the SCPP so that water quality criteria are met downstream of Keswick Dam. Reclamation would continue low-flow releases from SCPP during SCDD releases to flush Spring Creek Reservoir water through the Spring Creek Arm. Keswick Reservoir operating levels would continue to be restricted within an operating range of 578 feet msl to 587 feet msl during all operation of SCPP to limit scouring of contaminated sediment from the Spring Creek Arm.

TABLE 13
Alternative Components Summary
Iron Mountain Mine Record of Decision 5, Shasta County, California
Alternatives

General Response Action
or Technology Description 1 2A 2B 3A 3B 4A 4B 5A 5B 6
No Action X
Operational Controls Restrictions on SCDD and power plant operations, access, and/or recreational use
X X X X X X X X X
Containment - In situ
Subaqueous Cap
Covering piles with coarse sand and/or armoring stone (gravel and riprap)
X X X X
Sediment Removal -
Dredging
Removal of contaminated sediment to the extent technically feasible
X X
Partial removal of contaminated sediment (to 560 feet msl)
X X X X
Limited Residual
Management
Evaluating and minimizing mobilization potential for small volumes of residual sediment remaining in dredged areas
X X X X X X
Resuspension Management Controls to limit suspension and migration of contaminated sediment during remedial action, such as Best Management Practices (BMPs), engineering design, and sediment curtain barriers
X X X X X X X X
Materials
Transport/Conveyance
Pumping dredge discharge to treatment area disposal cell X X X X X X
Ex-situ Physical and
Chemical Treatment of
Dredge Discharge
Treatment of dredge discharge, including polymer addition, pH adjustment, and gravity settling in dewatering/disposal cell
X X X X X X
Disposal in Upland
Disposal Cell
Disposal cell adjacent to Spring Creek Reservoir X X X
Disposal cell adjacent to Iron Mountain Road X X X
Return-water Conveyance
and Discharge

Piping return water to Spring Creek Reservoir X X X X X X
Monitoring Short-term monitoring during implementation of remedial action
X X X X X X X X
Long-term monitoring following implementation of remedial action
X X X X X X X X

2.9.3 Alternative 2 - Capping the Sediment in Place (in situ Subaqueous Sediment Cap)

Alternative 2 provides for placement of a subaqueous cap over contaminated sediment in the Spring Creek Arm. As part of the technology screening and conceptual design, a cap consisting of granular and rock material was selected as a less expensive and more technically feasible option compared to other capping options. The cap would be designed to contain sediment and limit mobilization of sediment into the Sacramento River. The sediment would remain in place (*in situ*); no sediment would be removed under Alternative 2. Alternative 2 includes two subalternatives: capping the full extent of the Spring Creek Arm (Alternative 2A) and capping sediment in Piles A, B, and C (Alternative 2B). Alternative 2B would contain about 90 percent of the volume of contaminated sediment in the Arm, but the cap would extend over only 60 percent of the area of the Arm.
Placement of capping materials would be limited to times when SCPP is not operating and no flow is being released from SCDD. This would facilitate construction and limit migration of suspended sediment. Other methods to limit suspension and migration of contaminated sediment might include best management practices, engineering design, and sediment curtain barriers. Alternative 2A is estimated to require 3 years to construct, and Alternative 2B would require 2 years.
The engineered cap would be designed to contain sediment during the greatest anticipated discharges to the Spring Creek Arm under low and high reservoir water elevations. No restrictions would be required on Keswick Reservoir operating elevations or maximum SCPP release rates. Both Alternatives 2A and 2B include use controls to prevent dredging or construction activities within the Spring Creek Arm that could damage the cap.
Alternatives 2A and 2B include long-term maintenance of the cap and long-term monitoring of the effectiveness of the remedial action, including surface water quality monitoring and monitoring of cap integrity.

2.9.4 Alternative 3 - Full Dredge with Disposal in Upland Dewatering/Disposal Cell

Alternative 3 provides for removal of contaminated sediment in the Spring Creek Arm to the full extent technically feasible. The target volume of contaminated sediment to be removed is 284,000 cy. As part of the technology screening and conceptual design, hydraulic dredging was selected as a more flexible and lower cost option with higher production rates in comparison to other dredging methods. Discharge from a hydraulic dredge would be pumped to a treatment and disposal area, where solids would be separated from liquid during dewatering. Treatment would include the addition of polymer, to flocculate and aid in the settling of solids, and lime, to improve water quality by raising the pH and precipitating metals.
Solids would be disposed in the upland, engineered disposal cell, and water would be discharged to the Spring Creek Reservoir. As part of the technology screening and

conceptual design, an engineered, upland disposal cell was selected as a more protective disposal option than in-water disposal and more administratively feasible than disposal in Brick Flat Pit. Alternative 3 includes two subalternatives that evaluate different locations for the engineered disposal cell: Alternative 3A (behind SCDD, adjacent to Spring Creek Reservoir) and Alternative 3B (adjacent to Iron Mountain Road, about 1 mile north of the Spring Creek Arm). Both locations are the IMM CERCLA site. The disposal cell at either location would include a low permeability cover and liner and a filtrate collection and removal system.

Dredging would primarily be limited to times when SCPP is not operating and no flow is being released from SCDD. This would allow easier anchoring and movement of dredging equipment and limit migration of suspended sediment. Other methods to limit suspension and migration of contaminated sediment might include best management practices, engineering design, and sediment curtain barriers. Alternatives 3A and 3B are estimated to require 3 to 4 years to complete.

A small percentage of sediment would likely remain in the Spring Creek Arm after dredging is complete because the sediment is technically infeasible to remove for reasons such as underwater obstructions or digging depths. The residual sediment would be managed as necessary to provide long-term erosion protection during future power plant operations. Management of the residual contaminated sediment could range from monitored natural recovery to placing a small cap of clean material (e.g., sand and gravel) over contaminated sediment. The extent of residual management would be dependent on the amount of sediment remaining in the Arm after dredging and the potential for erosion. Following sediment removal and residual management, no restrictions would be required on Keswick Reservoir operating elevations or maximum SCPP release rates. The disposal cell would require long-term maintenance and management in the form of cover maintenance, collection and disposal of filtrate, monitoring, inspections and institutional controls.

2.9.5 Alternative 4 - Partial Dredge with Disposal in Upland Dewatering/Disposal Ceil

Alternative 4 provides for partial removal of sediment in the Spring Creek Arm that is most susceptible to erosion. For the conceptual design, it was assumed contaminated sediment would be removed to an elevation of 560 feet msl, which would allow removal of approximately 55 percent of the volume of contaminated sediment (158,000 cy). Dredging to an elevation of 560 feet msl would remove all of Pile A, all of Pile B, and approximately one-third of Pile C. Approximately 126,000 cy of fine-grained sediment would remain in Pile C below an elevation of 560 feet msl following dredging. The removal elevation would be further evaluated during the remedial design.

As described for Alternative 3, discharge from the dredge would be pumped to a treatment and disposal area, where solids would be separated from liquid during dewatering. Solids would be disposed in an upland, engineered disposal cell, and water would be discharged to the Spring Creek Reservoir. Similar to Alternative 3, Alternative 4 includes two subalternatives that evaluate different locations for the engineered disposal cell: Alternative 4A (adjacent to Spring Creek Reservoir) and Alternative 4B (adjacent to Iron Mountain Road).

Alternative 4 would include methods to limit suspension and migration of contaminated sediment during in-water work as described for Alternative 3. Following dredging, a small percentage of sediment might remain in Pile A, Pile B, or the main channel of the

Spring Creek Arm because it is infeasible to remove for reasons such as underwater obstructions. Alternative 4 would also include management of limited volumes of residual sediment in Pile A, Pile B, or the main channel that is infeasible to remove and could be potentially eroded under restricted operational scenarios described below. Alternatives 4A and 4B are estimated to require 2 to 3 years to complete.

Limited restrictions would be required on Keswick Reservoir operating levels to prevent erosion of sediment remaining in Pile C. During rare flood events, operational restrictions would be needed to maintain Keswick Reservoir above 578 feet msl (the lower end of current operations). EPA's analysis indicates that restrictions would be required when discharges from SCPP and SCDD approach 6,600 cfs. The flow of 6,600 cfs is equivalent to the upper end of SCPP capacity and the historical maximum flow from SCDD. Alternative 4 includes long-term monitoring and disposal cell maintenance as discussed for Alternative 3. These operating restrictions may be incorporated into a future revision of the 1980 MOU. Alternatively, such restrictions may be included in a standalone agreement between EPA, the State of California, Reclamation and others.

2.9.6 Alternative 5 - Partial Dredge with In situ Subaqueous Sediment Cap for Pile C

Alternative 5 is similar to Alternative 4 in that it provides for partial removal of sediment in the Spring Creek Arm that is most susceptible to erosion. However, Alternative 5 also provides for placement of a cap to contain sediment that remains after dredging. As discussed for Alternative 4, for the conceptual design, it was assumed contaminated sediment would be removed to an elevation of 560 feet msl, which would allow removal of approximately 55 percent of the contaminated sediment (158,000 cy). Approximately 126,000 cy of fine-grained sediment would remain in Pile C below an elevation of 560 feet msl. A subaqueous cap would be placed over sediment remaining in Pile C. Alternative 5 would also include management of residual sediment surrounding Piles A and B as necessary to provide long-term erosion protection during future power plant operations.

As described for Alternative 3, discharge from the dredge would be pumped to a treatment and disposal area, where solids would be separated from liquid during dewatering. Solids would be disposed in an upland, engineered disposal cell, and water would be discharged to the Spring Creek Reservoir. Similar to Alternatives 3 and 4, Alternative 5 includes two subalternatives that evaluate different locations for the engineered disposal cell: Alternative 5A (adjacent to Spring Creek Reservoir) and Alternative 5B (adjacent to Iron Mountain Road). Alternatives 5A and 5B are estimated to require 3 years to complete.

No restrictions would be required on Keswick Reservoir operating elevations or maximum SCPP release rates. The cap would require periodic inspections, long-term maintenance, and land use restrictions. Alternative 5 also includes long-term monitoring and disposal cell maintenance as discussed for Alternative 3.

2.10 Comparative Analysis of Alternatives

The detailed analysis of alternatives consists of an assessment of individual alternatives against nine evaluation criteria identified in the NCP and a comparative analysis that focuses on the relative performance of each alternative against those criteria. The resulting strengths and weaknesses of the alternatives are weighed to identify the alternative providing the best balance among the nine criteria. The nine evaluation criteria specified by the NCP in 40 CFR §300.430(e)(9) are: (1) overall protection of human health and the environment; (2) compliance with 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. Assessment of two of the nine criteria, State acceptance and community acceptance, is not completed until after comments on the Proposed Plan are received.

The NCP (40 CFR Section 300.430(e)(9)(iii)) categorizes these nine criteria into three types: (1) threshold criteria, (2) primary balancing criteria, and (3) modifying criteria. Each type of criteria has its own weight when it is evaluated. Threshold criteria are requirements that each alternative must meet to be eligible for selection as the preferred alternative, and include overall protection of human health and the environment and compliance with ARARs (unless a waiver is obtained). Primary balancing criteria are used to weigh effectiveness and cost tradeoffs among alternatives. The primary balancing criteria include long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; short-term effectiveness; implementability; and cost. Modifying criteria include State support agency acceptance and community acceptance. These assessments reflect the State (or support agency's) and community's apparent preferences among or concerns about alternatives.

Other than the No-action Alternative, each alternative addresses the remediation of contaminated sediment in the Spring Creek Arm of Keswick Reservoir. The consideration of alternatives that address contaminated sediments in the Spring Creek Arm without addressing contaminated sediment in other portions of the site or AMD in the Boulder Creek watershed is consistent with 40 CFR §300.430(a)(ii)(A), which identifies as a program management principle that "[s]ites should generally be remediated in operable units when necessary or appropriate to achieve significant risk reduction quickly, when phased analysis and response is necessary or appropriate given the size and complexity of the Site, or to expedite the completion of total Site cleanup."

In this section, the relative performance is evaluated and the advantages and disadvantages identified for each of the following alternatives:

? Alternative 1 - No Action
? Alternative 2 - In situ Subaqueous Sediment Cap
o 2A - Cap Full Extent of the Spring Creek Arm
o 2B - Cap Piles A, B, and C
? Alternative 3 - Full Dredge
o 3A - Disposal Cell Adjacent to Spring Creek Reservoir
o 3B - Disposal Cell Adjacent to Iron Mountain Road
? Alternative 4 - Partial Dredge
o 4A - Disposal Cell Adjacent to Spring Creek Reservoir
o 4B - Disposal Cell Adjacent to Iron Mountain Road
? Alternative 5 - Partial Dredge with In situ Subaqueous Sediment Cap over Pile C
o 5A - Disposal Cell Adjacent to Spring Creek Reservoir
o 5B - Disposal Cell Adjacent to Iron Mountain Road

Section 2.10.1 presents the comparative analysis of Alternatives 1, 2A, 2B, 3, 4, and 5. Section 2.10.2 presents the comparative analysis of the two disposal locations evaluated under Alternatives 3, 4, and 5. A summary of the comparative analysis is presented in Table 14.

2.10.1 Comparative Analysis of Alternatives 1,2A, 2B, 3, 4, and 5

Overall Protection of Human Health and the Environment

The overall protection of human health and the environment criterion 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.

Alternative 1, the No-action Alternative, provides inadequate protection of the environment, particularly the Sacramento River ecosystem. Under the No-action Alternative, unacceptable long-term environmental risks would remain for sediment erosion, movement, and deposition in sensitive areas of the Sacramento River. Uncontrolled flows from SCDD during major storm events, in conjunction with high flows from SCPP, have the potential to transport sediment within the Spring Creek Arm. Sediment erosion modeling results (see Section 2.5.7) indicate that if high flows coincide in both SCDD and SCPP, and the reservoir-pool level is down, sediment in Piles A, B, and C and the main Spring Creek Arm channel have a high potential for erosion. Discharge of contaminated sediment is capable of causing significant adverse impacts to the important fishery resources of the Sacramento River below Keswick Dam, including spawning areas that are critical for survival of two federal and state-listed species, Sacramento River Winter-run and Spring-run Chinook salmon. Early life stages of fish, such as the eggs and fry, would be particularly susceptible to the toxic contaminants in the sediment. The No-action Alternative provides only a continuation of restrictions on SCDD operations and Keswick Reservoir levels. These restrictions help to mitigate sediment erosion during normal operating conditions, but are not reliable or effective long-term controls for all potential operation scenarios. The deposition of significant quantities of toxic sediments into the spawning grounds of the Sacramento River for an extended period before a cleanup could be accomplished could jeopardize the survival of the entire Sacramento River salmon population.

All alternatives evaluated that include active remediation (i.e., sediment removal or containment) would reduce the metal loads and suspended solids discharged from the Spring Creek Arm to the Sacramento River and would allow protective water quality standards for the Sacramento River ecosystem to be met. Alternative 3 would provide the greatest protection of the environment and the Sacramento River ecosystem through the full removal of contaminated sediment in the Spring Creek Arm to the extent technically feasible and disposal in an engineered upland disposal cell. These actions would permanently and effectively prevent mobilization of contaminated sediment from the Spring Creek Arm and deposition of the sediment into important fishery spawning habitats.

Under Alternatives 2, 4, and 5, all or portions of the contaminated sediment would remain in place within the Arm. Under Alternatives 4 and 5, sediment most susceptible to erosion would be removed and disposed in an engineered upland disposal cell. Alternative 5 is considered to be more protective than Alternative 4 because engineering controls would be used to contain sediment remaining in the Arm following dredging. Under Alternative 5, sediment remaining the Spring Creek Arm would be capped; the subaqueous cap would be designed to withstand the greatest anticipated discharge to the Spring Creek Arm under low and high reservoir elevations. Under Alternative 4, limited institutional controls would be used to restrict the Keswick Reservoir operating range during rare release events that could cause erosion of remaining sediment. Sediment transport modeling results indicate sediment remaining in Pile C below an assumed removal elevation of 560 feet msl would be susceptible to erosion during flood events when the combined discharge from SCPP and SCDD approaches historical maximum flows. A combination of low Keswick Reservoir elevations and high SCPP discharge would be highly unlikely.

Under Alternative 2, contaminated sediment would be covered with a cap to prevent mobilization of sediment in the Spring Creek Arm. The subaqueous cap would be designed to withstand the greatest anticipated discharge to the Arm under low and high reservoir elevations. Cap components are expected to physically isolate sediment contaminants from the benthic environment. The effectiveness and permanence of the subaqueous cap would be entirely dependent on the adequacy of long-term maintenance and repair of eroded areas and long-term use restrictions to prohibit construction or dredging activities that could damage the integrity of the cap.

Alternative 2A would be more protective than Alternative 2B because the full extent of the Spring Creek Arm would be capped. Alternative 2B includes capping the sediment piles, which comprise 90 percent of the volume of contaminated sediment in the Spring Creek Arm. Alternative 2B is designed to minimize the potential for large releases of contaminated sediment from the Spring Creek Arm, but uncapped sediment, which comprises approximately 10 percent of the total volume in the Arm, might be transported into Keswick Reservoir over time.

It is uncertain whether a benthic community will be re-established in the Spring Creek Arm under any of the alternatives. Future releases of dissolved copper from Spring Creek Reservoir, which are not targeted by remedial actions evaluated for the Spring Creek Arm, might limit growth of aquatic plants following remedial action. Following removal of fine-grained sediment and collodial HMO precipitates under Alternatives 3, 4, and 5, remaining bottom material would be coarser and less susceptible to erosion. However, because of historical smelting activities conducted in the Spring Creek watershed, metals concentrations associated with the bottom material might still inhibit establishment of a benthic community.

Remedial actions in the Spring Creek Arm are expected to indirectly improve aquatic habitat in Keswick Reservoir by limiting future mobilization of contaminated sediment and redeposition into Keswick Reservoir.

Compliance with Applicable or Relevant and Appropriate Requirements (ARARs)

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. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable or relevant and appropriate. In addition to legally binding laws and regulations, EPA is to consider proposed standards and nonpromulgated advisories or guidance that, while not legally binding, provide useful information regarding the performance of the remedy. These other standards are referred to as "To Be Considered" standards or TBCs.

TABLE 14

Comparative Analysis Matrix

Iron Mountain Mine Record of Decision 5, Shasta County, California

Component Alternative 1
No Action
Alternative 2A
In situ Subaqueous Cap
over Full Extent of Arm
Alternative 2B
In situ Subaqueous
Cap over Piles A, B,
and C
Alternative 3
Full Dredge
Alternative 4 Partial
Dredge
Alternative 5 Partial
Dredge with In situ
Subaqueous Sediment Cap for
Pile C
Upland Dewatering/
Disposal Cell
adjacent to Spring
Creek Reservoir
Upland
Dewatering/
Disposal Cell
adjacent to Iron
Mountain Road
Description No further action.
Existing restrictions
on SCDD and Keswick
Reservoir operations
would be maintained.
Place cap over
contaminated sediment in
the Spring Creek Arm.
Place cap over
contaminated
sediment in Piles A,
B, and C.
Remove contaminated
sediment in Spring Creek
Arm to extent technically

feasible. Dewater and
treat dredge discharge.
Dispose of solids in
upland
dewatering/disposal cell.
Remove sediment in
Spring Creek Arm that is
most susceptible to
erosion. Dispose of
solids in upland
dewatering/disposal
cell.
Remove sediment in Spring
Creek Arm that is most
susceptible to erosion.
Place cap over sediment
remaining in Pile C.
Dispose of solids in upland
dewatering/disposal cell.
Alternatives 3A,
4A, and 5A
Alternatives 3B,
4B, and 5B
Overall
Protectiveness
Long-term risks of
sediment erosion,
migration, and
redeposition in
sensitive areas of
Sacramento River.
Discharge of
contaminated sediment
could cause
significant adverse
impacts to important
fishery resources.
Protective. Limits
mobilization of
contaminated sediment.
Requires long-term
maintenance and land use
restrictions to be
effective.
Less protective than
2A. Reduces

potential for large
releases of
sediment. Uncapped
sediment might be
flushed into Keswick
Reservoir over time.
Most protective
alternative. Removal of
sediment and disposal in
engineered upland
disposal cell would
permanently prevent
mobilization of
contaminated sediment.
Protective. Sediment
that is most susceptible
to erosion would be
removed. Limited
restrictions on Keswick
Reservoir operations
would be required to
prevent erosion of
sediment remaining in
Pile C when releases
from SCPP and SCDD
approach historical
maximum discharges.
Very protective. Partial
removal of sediment
combined with capping of
residual sediment would
minimize risk of
mobilization of
contaminated sediment.
Disposal cell would be constructed and
maintained to minimize long-term risks
of contaminant discharge to surface
water or groundwater.
ARAR Compliance Will not comply with
ARARs.
Would allow for compliance with water quality
goals below Keswick Dam. Capping would comply
with location-specific ARARs.
Would allow for
compliance with water
quality goals during

dredging. Dredging would
comply with location-and
action-specific ARARs.
Same as 3. Same as 3. Disposal cell construction and
maintenance, discharge of filtrate and
overflow, and wetlands surveys and
mitigation would comply with ARARs.
Disposal cell would require long-term
management. Disposal cell would be
constructed and maintained to minimize
long-term risk of contaminant releases.
Long-term
Effectiveness
Not effective. Longterm
risk of sediment
erosion. Existing
restrictions on SCDD
and Keswick Reservoir
operations are not
reliable long-term
controls.
Effective long-term. Cap
would limit mobilization
of sediment. Cap would
require long-term
maintenance and land use
restrictions to remain
effective.
Less effective than
2A. Uncapped
sediment might be
flushed into Keswick
Reservoir over time.
Extremely effective longterm.
Removal would
prevent mobilization of
contaminated sediment.
Small percentage of
sediment that is
infeasible to dredge
would remain in Arm and
require management.
Effective long-term.
Partial removal of
sediment would provide
long-term reduction of

risk of mobilization of
contaminated sediment.
Limited restrictions on
Keswick Reservoir
operations would be
required during rare
releases to Arm to
prevent erosion of
remaining sediment.
Very effective long-term.
Partial removal of sediment
combined with capping of
remaining sediment would
provide long-term reduction
of risk of mobilization of
contaminated sediment.
Located within
impacted watershed
and behind SCDD,
reducing long-term
risks to
groundwater or
surface water.
Located outside
of impacted
Spring Creek
watershed.
Reduction of
Toxicity,
Mobility, or
Volume through
Treatment
No reduction in
toxicity, mobility, or
volume through
treatment.
No reduction in toxicity, mobility, or volume
through treatment.
Dredge discharge would be
treated and dewatered to
reduce volume requiring
disposal and mobility of
metals. Target volume of
in situ sediment to be
removed and treated is
284,000 cy.

Dredge discharge would
be treated and dewatered
to reduce volume
requiring disposal and
mobility of metals.
Target volume of in situ
sediment to be removed
and treated is 158,000
cy. Approximately
126,000 cy would remain
Same as 4.

TABLE 14
Comparative Analysis Matrix
Iron Mountain Mine Record of Decision 5, Shasta County, California

Component Alternative 1
No Action
Alternative 2A
In situ Subaqueous Cap
over Full Extent of Arm
Alternative 2B
In situ Subaqueous
Cap over Piles A, B,
and C
Alternative 3
Full Dredge
Alternative 4 Partial
Dredge
Alternative 5 Partial
Dredge with In situ
Subaqueous Sediment Cap for
Pile C
Upland Dewatering/
Disposal Cell
adjacent to Spring
Creek Reservoir
Upland
Dewatering/
Disposal Cell
adjacent to Iron
Mountain Road

in Pile C.
Minimal risk to human health during
implementation. Short-term risks to environment
from resuspension and subsequent migration of
sediment during in-water work. Risks would be
mitigated using controls such as best management

practices, engineering design, and sediment
curtain barriers.
Short-term
Effectiveness
Does not meet remedial
action objectives.
Estimated as 3 years to
implement.
Estimated as 2 years
to implement.
Similar to 2. Estimated
as 3 to 4 years to
implement.
Similar to 2. Estimated
as 2 to 3 years to
implement.
Similar to 2.
Estimated as 3 years to
implement.
Minimal short-term
risks to community
during
implementation.
Disturbed seasonal
wetlands would be
impacted, requiring
mitigation
measures.
Greater shortterm
risks to
community during
implementation;
disposal site
readily
accessible.
Disturbed
seasonal
wetlands would
be impacted,
requiring
mitigation
measures.
Implementability Requires coordination
with Reclamation to
maintain existing
restrictions on SCDD

and Keswick Reservoir
operations
Technical challenges with cap placement due to
unique properties of sediment and high metals
concentrations of sediment and pore water.
Requires coordination with Reclamation to
implement land use restrictions.
Technical challenges with
dredging due to unique
properties of sediment,
digging depths up to 60
feet, and organic debris
and obstructions in Pile
C.
Most implementable
alternative involving
active remediation.
Lower digging depths
than 3.
Lower digging depths than
3. Technical challenges
with cap placement.
Requires mobilization of
dredging and capping
equipment.
Access road would
be flooded for
portions of the
year.
Might be subject
to more
stringent
construction
and/or long-term
monitoring
requirements.
Cost
Capital
Annual O&M
50-year Present
Value
$ 0
$ 0
$ 0
$ 11,300,000
$ 280,000

$ 17,900,000
$ 8,210,000
$ 195,000
$ 12,800,000
Alternatives 3A/3B
$26,000,000/$26,300,000
$123,000/$119,000
$28,900,000/$29,100,000
Alternatives 4A/4B
$18,600,000/$18,400,000
$106,000/$102,000
$21,100,000/$20,800,000
Alternatives 5A/5B
$20,800,000/$20,600,000
$160,000/$156,000
$24,500,000/$24,200,000
See costs for
specific
alternatives.
See costs for
specific
alternatives.
State Acceptance Not acceptable. Not
protective of the
environment.
Not acceptable. Concerns regarding the durability
and maintenance of cap material.
Acceptable. Acceptable. Acceptable. Concerns
expressed regarding
technical implementability.
Acceptable. Located
within impacted
watershed and
behind SCDD,
reducing long-term
risks to
groundwater or
surface water.
Not acceptable.
Increased risks
to human health
and the
environment.
Community
Acceptance
Not acceptable to most

community members. Not
protective of the
environment.
No comments were submitted regarding capping. Acceptable. Several
community members and the
City of Redding (Redding
Municipal Utilities)
expressed concerns
regarding short-term
environmental impacts
during dredging.
Acceptable. Not acceptable.
A community
member expressed
concerns
regarding
potential
impacts to the
community and
recreational
uses of the
area.

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. Compliance with the most significant chemical-, action-, and location-specific ARARs is discussed below.

Chemical-specific Applicable or Relevant and Appropriate Requirements. None of the remedial alternatives fully complies with chemical-specific water quality ARARs because none of the alternatives would alone achieve National toxics Rule (NTR), Basin Plan or CTR criteria in Spring Creek, its tributaries, or in portions of Keswick Reservoir under all circumstances following completion of the construction of the respective remedial alternative. These water bodies are impacted by remaining discharges of AMD from the IMM Site. Continued discharges of AMD from the IMM Site are not being addressed in this action, but are being addressed under remedial actions currently underway (e.g., SCRR) and will be considered under future remedial action decisions. Therefore, it would be appropriate to invoke an interim remedy ARARs waiver to the degree that it is anticipated these discharges may result in exceedances of water quality ARARs in Spring Creek and portions of Keswick Reservoir.

With respect to the CTR and Basin Plan water quality ARARs, the following analysis assumes that the remedial alternatives analyzed herein will not affect the remaining ongoing IMM AMD discharges. ARARs for zinc, copper and cadmium, for purposes of the following analysis, are assumed to be waived (once construction is complete) using the aforementioned interim action waiver. As stated above, EPA analysis subsequent to the issuance and implementation of remedial actions selected in this ROD is expected to address the issue of whether NTR, CTR and Basin Plan water quality ARARs can be met on a

Site-wide basis. Also, the ARARs discussed in the following comparative analysis are identified only for the purposes of analyzing remedial alternatives to address remediation of the Spring Creek Arm sediments. Nothing in this ROD amends or alters ARARs determinations made by EPA in prior RODs for this Site.

Under Alternative 1, no action would be taken to reduce the metal loads and suspended solids associated with contaminated sediment discharged from the Spring Creek Arm to the Sacramento River. A release of contaminated sediment from the Spring Creek Arm would not meet NTR, CTR and Basin Plan water quality criteria in the Sacramento River downstream of Keswick Dam.

Alternatives 2, 3, 4, and 5 would comply with chemical-specific ARARs for the Sacramento River, at the point of compliance during construction. These alternatives include active remediation (i.e., sediment removal or containment) that would reduce the metal loads and suspended solids discharged from the Spring Creek Arm to the Sacramento River and would allow protective water quality standards for the Sacramento River ecosystem to be met.

Location-specific Applicable or Relevant and Appropriate Requirements Alternative 1, the No-action Alternative, would not comply with location-specific ARARs. A release of contaminated sediment from the Spring Creek Arm would not comply with CDFG Code Section 5650, which prohibits discharge of contaminants "deleterious to fish, plant life, or bird life."

All alternatives involving active remediation would comply with location-specific ARARs. Proposed remedial actions, except no action, would increase the long-term protection of affected species. Subaqueous capping under Alternative 2, or dredging under Alternatives 3, 4, and 5, would comply with the Fish and Wildlife Conservation Act and the Fish and Wildlife Coordination Act, which require federal agencies involved in the structural modification of a natural stream or water body to take action to protect fish and wildlife resources that might be affected by the selected action.

Placement of fill within jurisdictional wetlands, sediment removal, discharge of filtrate and overflow from a dewatering/disposal cell, placement of capping material in the Spring Creek Arm, and surface-water diversions would require compliance with the substantive requirements in Section 404 of the Clean Water Act. Onsite CERCLA actions are exempt from obtaining permits that would otherwise be required under applicable laws and regulation, but actions proposed under Alternatives 2, 3, 4, and 5 would meet the substantive requirements.

The upland disposal cell proposed under Alternatives 3, 4, and 5 would be constructed in compliance with location-specific ARARs. Disturbed seasonal wetlands, as well as willow and willow/cotton wood riparian habitats, have been identified in the vicinity of both disposal locations and would be given special consideration according to ARARs. Location-specific ARARs allow for a project to be constructed that would impact wetlands, but would require special-status species surveys, wetlands mitigation, or other compensatory actions.

Action-specific Applicable or Relevant and Appropriate Requirements. Alternative 1 includes no active remediation; therefore, no action-specific ARARs would apply. No action-specific ARARs have been identified for the capping component of Alternative 2. Alternatives 3,4, and 5 would comply with action-specific ARARs during dewatering and disposal of dredged sediment.

Construction, monitoring, and maintenance of the upland disposal cell would comply with the relevant and appropriate requirements of the State of California Water Code §13172 and regulations promulgated thereunder (27 CCR) for a mining waste management unit. Discharge of filtrate and overflow from the upland dewatering/disposal cell would comply with the substantive requirements of the National Pollutant Discharge Elimination System (NPDES) permit program. The embankment structure of the dewatering/disposal cell would meet the criteria to be considered a Jurisdictional Dam by the California Division of Safety of Dams. As such, substantive requirements of the Dam Safety Act and Division 3 of the California Water Code are ARARs for the construction of the disposal cell embankment.

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 that will remain onsite following remediation and the adequacy and reliability of controls.

Each alternative, except the No-action Alternative, provides some degree of long-term protection. Alternative 3 would provide the greatest long-term effectiveness and permanence through the full removal of contaminated sediment in the Spring Creek Arm to the extent feasible and disposal in an engineered upland disposal cell. The disposal cell would be constructed and maintained to prevent contaminant releases to surface water or groundwater. The disposal cell would require long-term maintenance and management in the form of cover maintenance, collection and disposal of filtrate, monitoring, and inspections. Following dredging, it is estimated that a small percentage of residual contaminated sediment might remain in dredged areas because of technical difficulties with complete removal. Management of residual sediment would range from monitored natural recovery to limited capping effort, as necessary.

Under Alternatives 2, 4, and 5, all or portions of the contaminated sediment would remain in place within the Arm. Under Alternatives 4 and 5, sediment most susceptible to erosion would be removed. Alternative 5 would provide greater long-term protection than Alternative 4 because engineering controls (capping) would be used to contain sediment remaining in the Arm following dredging. Alternative 4 relies on limited institutional controls to restrict the Keswick Reservoir operating range during rare release events that could cause erosion of remaining sediment.

Alternative 2 relies solely on capping to prevent mobilization of sediment in the Spring Creek Arm. No sediment would be removed under Alternative 2. The effectiveness and permanence of Alternatives 2A and 2B is dependent entirely on the adequacy of maintenance of capping components and land use restrictions to prevent dredging or construction activities that could damage the integrity of the cap.

Alternative 2A would provide greater long-term effectiveness than Alternative 2B because the full extent of the Spring Creek Arm would be capped. Alternative 2B includes capping only the sediment piles. Alternative 2B is designed to minimize the potential for large releases of contaminated sediment from the Spring Creek Arm, but uncapped sediment, which comprises approximately 10 percent of the total volume in the Arm, might be transported into Keswick Reservoir over time. In addition, erosion of uncapped sediment in the Arm could undermine the edge of the cap under Alternative 2B. For this reason, Alternative 2B provides less long-term erosion protection and cap stability than Alternative 2A.

During the Sediment FS, EPA conducted an analysis to estimate the long-term stability of sediment contained in situ within the Spring Creek Arm following capping or partial removal under Alternatives 2, 4, and 5. Slopes of all sediment piles would be stable under static conditions. However, the slopes of Pile C could fail under strong earthquake conditions, under existing conditions, following capping, or following partial removal. To increase the stability of Pile C under strong earthquake conditions, additional controls may be needed, including dredging to flatten steep slopes or construction of a stone buttress at the base of Pile C. The stability of Pile C under strong earthquake conditions and the need for additional controls would be further evaluated in the remedial design.

Reduction of Toxicity, Mobility, or Volume through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy. This criterion refers to the preference for a remedy that uses treatment to reduce health hazards, contaminant migration, or the quantity of contaminants at the Site.

Alternative 1, the No-action Alternative, and Alternative 2, In situ Subaqueous Capping, do not include treatment as a component of the remedy.

Under Alternatives 3, 4, and 5, contaminated sediment is removed from the Arm by dredging, and the mobility and volume of contamination is reduced during treatment and dewatering of dredge discharge. Dredge discharge would be treated and dewatered to reduce the volume requiring disposal and to meet ARARs for discharge of filtrate and overflow to Spring Creek Reservoir. Although the toxicity of dewatered solids would not be reduced, the mobility of metals would be reduced by increased pH and resultant metals precipitation. The disposal cell would be engineered to minimize long-term impacts of contamination to groundwater and surface water.

A greater volume of dredge discharge is treated under Alternative 3 than under partial dredging in Alternatives 4 and 5. Under Alternative 3, dredging activities would target the full volume of contaminated sediment in the Spring Creek Arm, approximately 284,000 cy. Alternatives 4 and 5 include partial dredging to remove sediment most susceptible to erosion. Under Alternatives 4 and 5, the target volume of sediment to be removed under the conceptual design is 158,000 cy, which includes removal of Pile A, Pile B, sediment located in the channel outside of the pile boundaries, and approximately one-third of the volume of Pile C. Approximately two-thirds of Pile C (126,000 cy of sediment) would remain in the Spring Creek Arm following dredging as part of Alternatives 4 and 5.

Short-term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the community, and the environment during construction and operation of the remedy until cleanup levels are achieved.

Alternatives are estimated to require 2 to 4 years to implement. Capping activities under Alternative 2A are estimated to require 3 years to complete, and Alternative 2B would require 2 years. Dredging activities under Alternative 3 are estimated to require 3 to 4 years to complete. Alternative 4 is estimated to require 2 to 3 years to implement. Implementation of Alternative 5, including partial dredging and capping of sediments remaining in Pile C, is estimated to require 3 years to complete. The estimated times to implement each alternative assume a 60-day working window could be arranged each year when SCPP could be shut down. The timing and duration of in-water work would require further evaluation and consultation with Reclamation during remedial

design.
All alternatives evaluated that include active remediation and in-water work (i.e., dredging or placement of cap materials) could present short-term impacts to the environment during implementation of the remedial action. The magnitude of short-term impacts is expected to be similar among alternatives. Alternatives are expected to pose only minimal risk to the community or workers during remedial action.
In-water work, including placement of cap materials, dredging, prop-wash of vessels, and anchor placement can cause resuspension of sediment. The suspended sediment might be transported outside the construction zone and settle in other areas. Resuspension of contaminated sediment might impact aquatic biota adjacent to the construction zone. EPA will implement multiple controls during in-water work to mitigate risks to the environment by minimizing the disturbance and re-suspension of sediment and/or the migration of suspended sediment. These controls would limit water quality impacts resulting from in-water construction to short-term increases in suspended sediment in the construction area. In-water work would primarily be limited to periods when SCPP is not operating and no flow is being released from SCDD. This would facilitate construction, allow easier anchoring and movement of equipment, and limit migration of suspended sediment. Other methods to limit suspension and migration of contaminated sediment might include best management practices, engineering design, and sediment curtain barriers. Monitoring would be performed during remedial action to determine effectiveness of resuspension management and to allow early detection of potential problems.
Alternatives involving capping have additional concerns regarding potential short-term impacts to the environment. Capping material would need to be applied slowly and uniformly to avoid problems with bearing capacity or slope failures of the sediment piles. Uncontrolled release of a large amount of material or the buildup of a localized mound of cap material could result in a bearing capacity failure. If this occurs, cap material could penetrate into the contaminated deposit and could cause sediment to resuspend and disperse into the water column. Consolidation of underlying sediment during placement of cap material could result in a release of pore water and associated metals. Calculations indicate consolidation-driven advective flux of pore water during placement of cap materials would not result in a significant increase in metals concentrations in Keswick Reservoir.
Construction and operation of the dewatering/disposal cell under Alternatives 3, 4, and 5 would require additional considerations of potential impacts to the community and to the environment. It is assumed no intermediate cover would be placed over the disposal cell between dredging seasons under Alternatives 3, 4, and 5. Therefore, access restrictions and physical barriers around the disposal cell location would be important to reduce risks of exposure to the community and ecological receptors. Disturbed seasonal wetlands, as well as willow and willow/cottonwood riparian habitats, have been identified in the vicinity of both disposal locations evaluated under Alternatives 3, 4, and 5. Wetland impacts would occur as a result of disposal site construction at either location, and mitigation would be required.
Because no remedial action would be taken under Alternative 1, no additional short-term risks to the community or to workers would occur as a result of implementing the alternative. Similarly, no environmental impact from construction activities would occur. However, RAOs would not be met.

Implementability
Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are considered.

Technical Feasibility. The No-action Alternative, Alternative 1, requires no additional effort and has no technical feasibility issues. Implementation of any alternative evaluated that involves active remediation would present technical challenges, primarily resulting from the unique characteristics of fine-grained sediment and collodial HMO precipitates in the Spring Creek Arm. However, all alternatives evaluated are considered technically implementable. Of the alternatives that include active remediation, Alternative 4 would present the smallest number of technical challenges to implementation, and Alternatives 2 and 3 would be the most difficult alternatives to implement.

Placement of cap materials under Alternatives 2 and 5 would be technically difficult because of the fine-grained size and high moisture content of the sediment in the Spring Creek Arm and high metals concentrations of the sediment and pore water. Cap material would need to be applied slowly and uniformly to avoid problems with bearing capacity or slope failures of the sediment piles. The fine grained nature and high moisture content of the sediments make it likely that capping efforts would result in the mobilization of some quantity of fine grained sediments into downstream areas, reducing the overall effectiveness of this approach. Cap placement would present fewer technical challenges under Alternative 5 than Alternative 2 because the cap would be placed over a smaller area, the deeper sediments are more dense and compacted, and riprap would not be needed for erosion control.

Several engineering challenges would affect implementability of dredging and treatment and dewatering of dredge discharge under Alternatives 3, 4, and 5 because of the sediment and site characteristics. Submerged trees and vegetation are located in shallow areas (i.e., at depths less than 20 feet) along the eastern shore of Pile C (see Figure 4). Some of the trees remain upright, while others have fallen. The trees and vegetation are likely to affect dredging operations by limiting movement of the barge or dredging equipment. Methods for dealing with the obstructions will be investigated during the remedial design and may include using a mechanical clamshell dredge around the obstructions or removing trees and vegetation before dredging begins. During the remedial design, it may also be determined that a portion of the contaminated sediment in this area is infeasible to remove.

The sediment in the Spring Creek Arm has relatively low solids content; therefore, dredged material would consist of a low percent solids, requiring handling of large volumes of dredge discharge. Sediment from the top of the sediment piles has different characteristics than sediment from the bottom of the piles, resulting in different solids concentrations and treatment requirements for dredge discharge. Uncertainties exist regarding scale-up of information obtained from the treatability jar and column testing for application to full-scale dewatering of dredge discharge. These uncertainties would need to be further evaluated during the remedial design phase of a dredging remedial action. Dredging would be conducted in a phased approach with lower dredging rates the first year to allow refinement of dredging and dewatering processes and resolve remaining questions.

Partial dredging under Alternatives 4 and 5 would have fewer technical challenges than full removal under Alternative 3 because the dredging depth would be shallower and the abandoned railway trestle would provide less of an obstacle to partial removal of Pile C. Under full removal in Alternative 3, sediment in Pile C would be difficult to dredge because the depth of water and thickness of sediment would require dredging of sediment approximately 60 feet below the waterline. Removal efficiencies would be substantially reduced at these depths and might require modifications to a dredge. The deeper sediment in Pile C is located at the mouth of the Spring Creek Arm, which creates increased technical challenges regarding management of suspended sediment during dredging activities. Additionally, the presence of the abandoned railway trestle would complicate dredging operations in the vicinity of the trestle. Because only one-third of Pile C would be removed, the partial dredging operations under Alternatives 4 and 5 would be impacted significantly less than the full dredging operations under Alternative 3.

Administrative Feasibility. Alternative 1 includes continuation of existing restrictions on SCDD operations and Keswick Reservoir operating levels, which are feasible because those restrictions are required by the 1980 MOU, the 1993 Biological Opinion and Reclamation's Operational Criteria and Plan (OCAP).

All the alternatives that involve active remediation would require only minimal or no restrictions on Keswick Reservoir operating levels once the remedy is implemented, and would therefore present fewer administrative challenges than the no-action alternative. Alternative 4 includes new limited long-term restrictions on Keswick Reservoir operations to prevent mobilization of sediment remaining in Pile C. These restrictions would maintain reservoir elevations above 578 feet msl (the low end of current operations) during rare flood events when the combined discharge from SCPP and SCDD approaches historical maximum releases. Restrictions implemented under Alternative 4 would not be as stringent as existing restrictions and would occur only infrequently. As such, it is believed that implementation of these restrictions will be feasible through renegotiation of the 1980 MOU or by means of a separate agreement. After the completion of in-water work, no restrictions would be required on Keswick Reservoir operating elevations or the maximum SCPP discharge rates under Alternatives 2, 3, or 5. All alternatives include restrictions on the release schedule and criteria for the discharge of water from SCDD to the Spring Creek Arm to meet water quality criteria in the Sacramento River downstream of Keswick Dam. They also include requirements for low-flow releases from SCPP during SCDD releases to flush Spring Creek Reservoir water through the Spring Creek Arm.

Alternatives 2 and 5, which include placement of a large in situ subaqueous cap, require coordination with Reclamation for implementation of land use restrictions to prevent dredging or construction activities within the Arm that would compromise the integrity of the subaqueous cap.

For ease of implementation and to reduce the short-term impacts from sediment resuspension, placement of cap materials and dredging would primarily be restricted to periods when the SCPP could be shut down. Shutdown of SCPP would prevent Reclamation from generating power during this period; however, it is expected that there would be minimal loss in overall power generation, as no excess water would be discharged and power generation would only be deferred. Shutdown of SCPP would require scheduling and coordination with Reclamation. All the alternatives involving active remediation assume a 60-day shutdown period per year would be arranged. The timing and duration of in-water work would require further evaluation and consultation with Reclamation during remedial design.

Cost

The estimated cost of each alternative encompasses all engineering, construction, and O&M costs incurred over the life of the project. According to CERCLA guidance, cost estimates for remedial alternatives were developed with an expected accuracy range of -30 to + 50 percent.

The costs of remedial alternatives were compared using the estimated present value of the alternative. The net present value allows costs for remedial alternatives to be compared by discounting all costs to the year that the alternative is implemented. In the *Guide to Developing and Documenting Cost Estimates During the Feasibility Study* (EPA, 2000), EPA suggests that the period of analysis for present value analysis should be equivalent to the project duration, to provide a complete life cycle cost estimate of the remedial alternative. Most of the remedial alternatives developed for IMM sediment require longterm O&M activities, including surface and/or groundwater monitoring; restrictions on access, use, or power plant operations; and maintenance of constructed caps and covers. Therefore, 50 years was chosen as the period of analysis, rather than the standard assumption of 30 years.

For all alternatives, the net present value was calculated using the real discount rate found in Appendix C of Office of Management and Budget Circular A-94 (Office of Management and Budget, 2004). In that guidance document, the real discount rate based on the economic assumptions from the 2005 budget for programs with durations of 30 years or longer is 3.5 percent. A summary of the capital cost, annual O&M cost, and 50-year present value for each alternative is shown in Table 15.

TABLE 15

Cost Summary of Remedial Alternatives

Iron Mountain Mine Record of Decision 5, Shasta County, California

Alternative	**Capital Cost ($)**	**Annual O&M Cost ($)**	**50-Year Present Value ($)**
1 - No Action	0	0	0
2 - In situ Subaqueous Cap			
2A - Cap Full Extent of Spring Creek Arm	11,300,000	280,000	17,900,000
2B - Cap Sediment Piles A, B, and C	8,210,000	195,000	12,800,000
3 - Full Dredge with Disposal in Upland Dewatering/Disposal Cell			
3A - Disposal Cell Adjacent to Spring Creek Reservoir	26,000,000	123,000	28,900,000

3B - Disposal Cell Adjacent to Iron Mountain Road 26,300,000 119,000 29,100,000
4 - Partial Dredge with Disposal in Upland
Dewatering/Disposal Cell
4A - Disposal Cell Adjacent to Spring Creek Reservoir 18,600,000 106,000 21,100,000
4B - Disposal Cell Adjacent to Iron Mountain Road 18,400,000 102,000 20,800,000
5 - Partial Dredge with In situ Subaqueous Sediment Cap
for Pile C
5A - Disposal Cell Adjacent to Spring Creek Reservoir 20,800,000 160,000 24,500,000
5B - Disposal Cell Adjacent to Iron Mountain Road 20,600,000 156,000 24,200,000
Notes:
Detailed cost estimates and cost estimate assumptions are presented in Appendix B and Appendix C of the Sediment FS (EPA, 2004).
Fifty-year present value was calculated using a discount rate of 3.5 percent (Office of Management and Budget, 2004).

The No-action Alternative would require no new capital or operating costs, because no change would be made to existing conditions. Of the alternatives involving active remediation, Alternatives 3A and 3B would be the most expensive remedial alternatives. The most expensive costs incurred during implementation of Alternative 3 would be costs of hydraulic dredging and construction of the dewatering/disposal cell. Alternatives 4 and 5 would be less expensive than Alternative 3 because they include partial rather than full dredging of contaminated sediment in the Spring Creek Arm. Alternative 5 includes placement of an in situ subaqueous cap over sediment remaining in Pile C, which increases the burdened construction costs by $ 2.2 million and increases the net present value by $ 3.4 million in comparison to Alternative 4. In general, construction costs associated with capping under Alternative 2 would be less expensive than costs of sediment removal and disposal; however, annual maintenance costs would be more expensive. The net present value of Alternative 2B, which includes capping of the sediment piles only, is the least expensive remedial alternative evaluated, with a net present value of approximately half the cost of alternatives involving sediment removal.

State Acceptance

State acceptance refers to the State's position and key concerns related to the preferred alternative and other alternatives.

The State has expressed its support for the preferred alternative presented in the Proposed Plan, Alternative 4, Partial Dredge with Disposal in Upland Dewatering/Disposal Cell. Letters expressing concurrence with the preferred alternative were submitted by DTSC and CDFG during the public comment period. These letters are included in Appendix A of this ROD. RWQCB, CDFG, Reclamation, and DTSC verbally expressed their support for the preferred alternative during the presentation made at the 2004 Proposed Plan public meeting on August 25, 2004. The Administrative Record includes a transcript of the public meeting.

Prior to the release of the Proposed Plan, the State raised concerns about the need for adequate sediment containment safeguards (i.e., resuspension management) during sediment removal operations. In response to these concerns, EPA will implement several specific measures to ensure close coordination with State agencies during remedial design and construction, and to assure that contaminated sediments will be contained during dredging operations. These measures include collection of additional data on sediment engineering properties during remedial design, developing and implementing a monitoring program to provide early detection of potential problems, and implementing a phased dredging approach. Given these measures, and in conjunction with compliance with ARARs for dredging operations, the State has stated that the preferred alternative should not significantly impact water quality.

The State does not believe that Alternative 1, the no-action alternative, provides adequate protection of the environment. In the September 3, 2004, letter to Rick Sugarek/EPA, Donald Koch/CDFG stated "we [CDFG] believe the no-action alternative constitutes significant risk to the environment and that the proposed project needs to be completed." This letter is included in Appendix A of this ROD.

On page three of the CDFG May 14, 2004, letter to EPA, Mr. Koch expressed concerns with Alternative 2, In Situ Subaqueous Capping. The letter presented concerns regarding the durability and maintenance of the cap material, and concerns that absent monitoring and maintenance of the cap, the sediment might be subject to erosion or resuspension. The same letter expressed concerns regarding technical challenges with implementation of Alternative 5, specifically with the construction of the partial cap over sediment remaining in Pile C. This letter was submitted prior to the public comment period during the development of the remedial alternatives, and is included in the Administrative Record at EPA Records Center in San Francisco, California.

Community Acceptance

This criterion refers to the community's stated preferences through oral 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.

The public meeting held in connection with the August 2004 Proposed Plan was attended by approximately 40 people. EPA presented its preferred alternative, Alternative 4, Partial Dredge with Disposal in Upland Dewatering/Disposal Cell. During the public meeting, the majority of interested persons expressed their support for the preferred alternative presented in the Proposed Plan. One community member stated that the preferred alternative was cost-effective and would support improvements being made to Winter-run Chinook salmon habitat in the Sacramento River.

However, several community members expressed concerns regarding dredging and onsite disposal. These include:

? Potential impacts to adjacent land value

? Potential for release of toxic sediments and impacts to water quality during dredging

? Long-term monitoring requirements for the disposal cell

The City of Redding, Redding Municipal Utilities, expressed similar concerns regarding potential impacts to water quality in the Sacramento River during dredging operations and possible effects on the City of Redding's domestic water supply and wastewater treatment plant discharges. EPA believes that these concerns can be properly addressed, and has provided detailed responses to these concerns in the responsiveness summary, Part 3 of this ROD.

As discussed under the short-term effectiveness criterion, EPA will implement multiple controls during in-water work to mitigate risks to the environment by minimizing the disturbance and resuspension of sediment and/or the migration of suspended sediment. Inwater work will primarily be limited to periods when SCPP is not operating and no flow is being released from SCDD. This will facilitate construction, allow easier anchoring and movement of equipment, and limit migration of suspended sediment. Dredging will be implemented in a conservative, phased approach that allows lower production rates during the first year. Other methods to limit suspension and migration of contaminated sediment might include best management practices, engineering design, and sediment curtain barriers. Monitoring will be performed during remedial action to determine effectiveness of resuspension management and provide early warning of potential problems. Using these controls, EPA believes the preferred alternative will be implemented safely, effectively, and in compliance with ARARs.

A few community members proposed additional alternatives that they felt would be more protective than the preferred alternative. These alternatives involve technologies that were screened out in the Sediment FS based on technical implementability, effectiveness, and/or cost. EPA determined that alternatives proposed by community members would be technically challenging and very costly compared to the alternatives developed and evaluated in the Sediment FS.

2.10.2 Comparative Analysis of Potential Disposal Locations in Alternatives 3A, 3B, 4A, 4B, 5A, and 5B

This section presents a comparative analysis of the two disposal locations evaluated under Alternatives 3, 4, and 5. Alternatives 3 A, 4A, and 5A evaluate conveyance and disposal of dredged material in an upland disposal cell adjacent to Spring Creek Reservoir. Alternatives 3B, 4B, and 5B include conveyance and disposal in a cell adjacent to Iron Mountain Road.

Overall Protection of Human Health and the Environment

Overall protection of human health and the environment would be similar between the two disposal locations. The disposal cell would be constructed and maintained to minimize long-term potential of contaminant releases to surface water or groundwater and would require long-term maintenance and management in the form of cover maintenance, collection and disposal of filtrate, monitoring, inspections, and institutional controls.

Compliance with Applicable or Relevant and Appropriate Requirements

CERCLA §121(e), 42 USC §9621(e), states that no federal, state, or local permits are required for remedial actions conducted entirely onsite. Onsite refers to the areal extent of contamination and all suitable areas in proximity to the contamination necessary for implementation of the response action (EPA, 1988). Both potential disposal sites are onsite in accordance with this definition. Therefore, neither permits nor a permit equivalency process would be required, but project elements must meet any ARAR substantive requirements.

Construction and maintenance of the disposal cell at either location would comply with location- and action-specific ARARs. Construction, monitoring, and maintenance of the upland disposal cell would comply with the appropriate and relevant substantive provisions of State of California Water Code §13172 and regulations promulgated thereunder (27 CCR) for a mining waste management unit. The embankment structure of the dewatering/disposal cell would meet criteria to be considered a Jurisdictional Dam by the California Division of Safety of Dams, and as such, would comply with substantive requirements of the Dam Safety Act and Division 3 of the California Water Code.

Location- and action-specific ARARs require compliance with the substantive requirements in Section 404 of the Clean Water Act for placement of fill within Jurisdictional wetlands, sediment removal, discharge of filtrate and overflow from a dewatering/disposal cell, and surface water diversions. Discharge of filtrate and overflow from the dewatering/disposal cell would also comply with substantive requirements of the NPDES permit program.

Long-term Effectiveness and Permanence

The disposal cell would be constructed and maintained to prevent contaminant releases to surface water or groundwater. The disposal cell would require long-term maintenance and management in the form of cover maintenance, collection and disposal of filtrate, monitoring, and inspections.

The Spring Creek Reservoir site is located within the impacted Spring Creek watershed behind SCDD. This disposal location has reduced risks of contaminant migration in the unlikely event of a contaminant release from the onsite disposal cell. A contaminant release would flow into the Spring Creek Reservoir and would be contained and managed by current Reclamation operations. In contrast, the Iron Mountain Road location is located in an environmentally sensitive area outside of the impacted Spring Creek watershed, and would be subject to more stringent construction and/or long-term monitoring requirements.

Reduction of Toxicity, Mobility, or Volume through Treatment

Dewatering and disposal of dredge discharge in either disposal location would provide a similar reduction of mobility and volume of contamination.

Short-term Effectiveness

Short-term risks to the community during remedial action would be greater for disposal in a cell adjacent to Iron Mountain Road than disposal in a cell adjacent to Spring Creek Reservoir. The Iron Mountain Road disposal site would be located adjacent to areas that are easily and regularly accessed by the public. Restrictions to limit trespassing, including fencing or other controls, would be much more difficult to enforce for this location. Public access to the Spring Creek Reservoir site could be more easily restricted during implementation of the remedial action. The proposed site is remote and less accessible. This proposed site is within an area that is currently fenced, has signs posted and that is patrolled by Reclamation security.

Disturbed seasonal wetlands, as well as willow and willow/cottonwood riparian habitats, have been identified in the vicinity of both disposal locations. Wetland impacts would occur as a result of disposal site construction at either site, and mitigation would be required. Biological resource information presented in the Sediment FS indicates construction of the Spring Creek Reservoir disposal cell would result in fewer significant impacts to biological resources than the Iron Mountain Road disposal site. The Iron Mountain Road site supports a sensitive vegetation type (vernal pools). The species composition at the Iron Mountain Road site is more diverse in all habitats, the hydrologic function appears to be relatively intact, and the vegetation cover is generally more dense.

Based on the density and composition of site vegetation, the Iron Mountain Road site would be expected to support a more diverse assemblage of wildlife species. The habitat value of wetlands at the Iron Mountain Road site is therefore ranked higher than those at the Spring Creek Reservoir site. As a result, the Spring Creek Reservoir disposal site is considered the biologically preferred alternative for disposal of dredged sediment under Alternatives 3, 4, and 5.

Both proposed disposal sites have undergone substantial disturbance, and the likelihood of special-status species occurrence is low. However, surveys should be conducted for special-status plant and wildlife species during the remedial design phase to confirm their presence and/or absence.

Implementability

Technical Feasibility. Construction of an upland dewatering/disposal cell at either location would be readily implementable. The following discussion highlights specific technical issues related to the construction, access, and conveyance for the disposal cell at both locations.

The Iron Mountain Road disposal site requires more earthwork and ground preparation than the Spring Creek Reservoir disposal site. Current conceptual design of the Iron Mountain Road disposal cell includes construction of a center berm that allows Iron Mountain Road to continue on its existing alignment through the center of the disposal cell.

Construction of a dewatering/disposal cell at the Iron Mountain Road location would require traffic control, including rerouting of Iron Mountain Road during construction.

The Iron Mountain Road disposal location would cover two of three existing informal shooting ranges. Lead-contamination in the surface soils would need to be addressed during design and construction of the disposal cell at the Iron Mountain Road location.

Access would be much more limited for the Spring Creek Reservoir site than the Iron Mountain Road site. Seasonal access would be available adjacent to the Spring Creek Reservoir. The former access road would need to be rebuilt, and low areas would need to be filled. Access for construction equipment would need to be obtained on the existing road over SCDD. The access road to the Spring Creek Reservoir location could be under water during portions of the year between mid-December through late May. During periods when the access road is flooded, boat and barge access to the disposal site would be required for monitoring and any unanticipated maintenance, and a boat ramp would need to be constructed. Significant long-term maintenance of the access road would be required due to flooding and potential washout. In contrast, year-round road access would be readily available to the disposal site adjacent to Iron Mountain Road.

Dredge discharge would need to be pumped a greater distance, with a greater change in elevation, to the Spring Creek Reservoir disposal site than to the Iron Mountain Road disposal site. However, return water could be gravity-fed from the Spring Creek Reservoir disposal location over a shorter distance than that required for the Iron Mountain Road location. For the Iron Mountain Road disposal location, a return-water pump station and pipeline would be needed to convey return water from the disposal cell to Spring Creek Reservoir. Pipeline routing and placement would be more difficult for the Iron Mountain Road disposal location and would need to be incorporated into the new and existing design of the road and adjacent drainage ditches. The return-water pump station at the Iron Mountain Road disposal location and the return-water pipeline from either disposal location would require long-term maintenance and operation to convey any filtrate that is generated over time.

Administrative Feasibility. Construction and operation of a dewatering/disposal cell at the Spring Creek Reservoir location would be readily implemented from an administrative perspective. Some administrative challenges would exist for construction of an upland disposal cell along Iron Mountain Road.

Both potential disposal locations are on the IMM CERCLA site, and neither permits nor a permit equivalency process would be required, but project elements must meet the ARAR

substantive requirements.
Disturbed seasonal wetlands, as well as willow and willow/cottonwood riparian habitats, have been identified in the vicinity of both disposal locations and might require special-status species surveys, wetlands mitigation, or other compensatory actions according to location-specific ARARs. Mitigation options could include the creation of wetland mitigation in an approved offsite location, or the purchase of mitigation credits. The potential for onsite mitigation is limited, but would be investigated further during remedial design. The Iron Mountain Road disposal site supports a sensitive vegetation type (vernal pools) that could impact mitigation requirements and ratios.

Cost

Overall, the costs associated with dewatering and disposal of dredge discharge are similar for both disposal locations evaluated. The preliminary cost estimate indicates the burdened construction costs are within $250,000, and the 50-year present value is within $300,000 for the two disposal locations. The difference in costs is well within the range of error of the cost estimates.

State Acceptance

The State has expressed its support for the disposal cell location adjacent to Spring Creek Reservoir. The State prefers this location because it is in a watershed that has already been impacted by mining operations and public access could be more easily restricted. For these reasons, the State believes the disposal cell location adjacent to Spring Creek Reservoir presents lower risks to human health and the environment than the location adjacent to Iron Mountain Road.

Specifically, in the June 28,2004, letter to Rick Sugarek/EPA re *Comments on CH2M HILL's Agency Review Draft for the Iron Mountain Mine Sediment Feasibility Study for the Iron Mountain Mine Superfund Site, Redding, California*, Don Mandel/DTSC stated the following:

DTSC believes that if a remedy involving disposal is chosen the disposal cell should be located in the area behind Spring Creek Debris Dam. DTSC thinks the location for a disposal cell behind Spring Creek Debris Dam is superior to a location along Iron Mountain Road based on environmental data, security, long-term effectiveness, future operation and maintenance (O&M) costs and implementability.

Similarly, on page three of the May 14, 2004, letter to Rick Sugarek/EPA, Donald Koch/CDFG stated the following:

We prefer the disposal cell located in the Spring Creek watershed. This location poses fewer consequences to resources due to the degraded nature of the watershed from previous mine operations. It will also be easier to protect the public from wastes in the disposal cell when compared to the Iron Mountain Road location.

Finally, in the June 2, 2004 letter to Rick Sugarek/EPA re *Agency Review Draft, Iron Mountain Mine Sediment Feasibility Study, Redding California*, Phil Woodward/RWQCB stated the following:

The disposal of contaminated sediment behind SCDD keeps the material within the Spring Creek Drainage and behind SCDD where severe water quality impacts already exist. In the unlikely event of a discharge of wastes from the facility, the potential for impacting downstream waters is significantly reduced.

These letters were submitted during the development of remedial alternatives prior to the public comment period, and are included in the Administrative Record at EPA Records

Center in San Francisco, California.

Community Acceptance

During the public meeting, the community expressed its support for the disposal location adjacent to Spring Creek Reservoir. One community member expressed concerns regarding the potential disposal location along Iron Mountain Road. These concerns include potential impacts to residents in the Flat Creek watershed area and impacts to recreational uses of the area.

2.11 Principal Threat Waste

AMD generated at the IMM Site is considered to be a principal threat waste because it is highly toxic and presents significant risk to human health and the environment should exposure occur. Completed and ongoing remedial actions to control the sources of AMD through collection and treatment at the IMM treatment plant have significantly reduced the acidity and metals content in surface water from IMM. However, EPA has not selected a remedy that treats the source in a manner that prevents the formation of AMD because EPA is not currently aware of such an approach that could be effectively implemented at IMM. 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.

The contaminated sediment within the Spring Creek Arm is not considered to constitute a principal threat waste because the contaminated sediment can be contained in a reliable manner through the implementation of the selected remedy. The selected remedy uses ex situ physical and chemical treatment of dredge discharge as a significant portion of the remedy.

EPA has determined that the selected interim remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a practicable manner for the contaminated sediment in the Spring Creek Arm of Keswick Reservoir. EPA has determined the selected remedy represents the best balance of trade-offs in terms of the five balancing criteria, while also considering the statutory preference for treatment as a principal element, bias against offsite treatment and disposal, and considering State and community acceptance.

2.12 Selected Remedy

The EPA has selected Alternative 4A - Partial Dredge with Disposal in Upland Dewatering/Disposal Cell as described in the June 2004 Sediment FS (EPA, 2004). The major components of the selected remedy include:

? Removal of contaminated sediment to an elevation that minimizes contaminated sediment loss during most operational scenarios of SCPP, SCDD, and Keswick Reservoir

? Operational controls to restrict Keswick Reservoir operating levels during releases from SCPP and SCDD that could scour sediment remaining at greater depths in Pile C

? Continued restrictions on the release schedule and criteria for the discharge of water from SCDD to the Spring Creek Arm

? Limited management of residual sediment in Pile A, Pile B, or the main channel of the Spring Creek Arm that is technically infeasible to dredge and is susceptible to erosion; implemented as needed, and ranging from monitored natural recovery to capping

? Short-term monitoring and resuspension management during implementation of the remedial action
? Conveyance of dredge discharge from the Spring Creek Arm to the dewatering/disposal cell
? Ex situ physical and chemical treatment of dredge discharge to separate solids and liquids for disposal and achieve ARARs for discharge of filtrate and overflow
? Disposal of dewatered solids in an engineered upland disposal cell located adjacent to Spring Creek Reservoir
? Conveyance and discharge of return water from the disposal cell to Spring Creek Reservoir
? Long-term monitoring, disposal cell maintenance and institutional controls

2.12.1 Summary of Rationale for Selected Remedy

The selected remedy protects the environment from the exposure pathways that are being addressed in this interim action and achieves RAOs. The selected remedy removes contaminated sediment that would be susceptible to erosion under all operational scenarios of SCPP, SCDD, and Keswick Reservoir except under storm event and operational conditions that are extremely rare and very unlikely to occur. Partial dredging and disposal of dredge discharge in an engineered upland disposal cell will minimize the potential for mobilization of sediment from the Spring Creek Arm except under rare and unlikely conditions when the combined discharge from SCPP and SCDD approaches historical maximum releases and Keswick Reservoir is below an elevation of 578 feet msl. Operational restrictions for the SCPP, SCDD and Keswick Reservoir will be implemented to mitigate this risk scenario during rare discharge events.

The selected remedy minimizes the amount of sediment that requires dredging, dewatering, and disposal and is more technically feasible than other alternatives evaluated. Although full removal of sediment under Alternative 3 or partial removal and capping of sediment under Alternative 5 would provide a small increment of additional protection, these alternatives are more expensive and less implementable than the selected remedy, and the additional actions are not necessary to achieve RAOs.

The selected disposal cell location adjacent to Spring Creek Reservoir will be more protective of human health and the environment than the potential disposal cell location adjacent to Iron Mountain Road. The selected disposal location is within the impacted Spring Creek watershed behind SCDD. Therefore, this disposal location will have reduced long-term risks of contaminant migration in the unlikely event of a contaminant release from the engineered disposal cell. Public access to the selected disposal location will be restricted during remedial action, reducing short-term risks to human health. Construction of a disposal cell at either location is technically feasible and the estimated construction and maintenance costs are similar.

2.12.2 Description of Selected Remedy

The engineering components of the selected remedy are shown on Figure 7. The components of the selected remedy are discussed below. The selected remedy may change somewhat from what is described in this ROD as a result of the remedial design and construction processes. Changes to the remedy described in this ROD may be documented using a technical memorandum in the Administrative Record, an Explanation of Significant Differences, or a ROD Amendment, depending on the scope, performance, and costs

associated with the modification.
Sediment Removal - Dredging Sediment will be removed by dredging to an elevation determined to meet RAOs by minimizing contaminated sediment loss under most operational scenarios of SCPP, SCDD, and Keswick Reservoir. The Sediment FS conceptual design estimates that removal of sediment in the Spring Creek Arm to 560 feet msl will minimize erosion of sediment under the following condition:
? Combined release from SCDD and SCPP below 6,600 cfs and Keswick Reservoir elevation above 574 feet msl. Combined release of 6,600 cfs is equivalent to the upper end of SCPP capacity (4,900 cfs) plus the historical maximum discharge from SCDD (1,700 cfs).
Dredging of contaminated sediment to 560 feet msl is estimated to remove approximately 55 percent of the volume of contaminated sediment in the Spring Creek Arm (158,000 cy). Dredging to an elevation of 560 feet msl will remove Pile A, Pile B, sediment in the main channel of the Arm, and approximately one-third of Pile C. Approximately 126,000 cy of fine-grained sediment will remain in Pile C following dredging to an elevation of 560 feet msl. The removal elevation will be further evaluated during the remedial design.
Dredging will primarily occur when SCPP is not operating and no flow is being released from SCDD. Dredging when SCPP is not operating will allow easier anchoring and movement of the dredge and limit transport of suspended sediment during in-water work. The timing and duration when in-water work can occur without discharge from SCPP or SCDD will require further evaluation and consultation with Reclamation during remedial design.
Dredging in the Spring Creek Arm will be performed using a phased approach: Phase I (during the first year) and Phase U (performed the following years). The phased approach will allow determination of settling and dewatering characteristics of dredged material, production efficiencies, an evaluation of the environmental constraints, and implementability while dredging at lower rates during Phase I.

Information obtained during Phase I will assist in planning for Phase II. Performance of additional sampling and geotechnical testing during the design will assist in planning the phased approach. A pilot-scale dredging and dewatering study could be performed, if necessary, in conjunction with the phased dredging.

Operational and Institutional Controls

Continued use of existing operational/institutional controls and new operational or institutional controls will be implemented to meet the following performance goals:
1. Current operational controls pursuant to the Operations Criteria and Plan (OCAP) that require Reclamation to restrict Keswick Reservoir elevations during release events from SCPP and SCDD to minimize the potential for erosion of sediment in the Spring Creek Arm will be revised. Operational restrictions would be removed except for periods during rare storm events where continued operational restrictions are necessary to assure that remaining sediments do not erode into the environment.
2. Current OCAP operational controls will be continued that require Reclamation to operate SCDD releases to comply with water quality ARARs in the Sacramento River downstream of Keswick Dam, and to continue low-flow releases from SCPP as necessary to flush Spring Creek Reservoir water through the Spring Creek Arm.
3. A new institutional control will be required to restrict access to, and future use of, the portion of federal lands that will be used for the onsite disposal cell

location in order to prevent potential human exposure to contaminants. The institutional control will restrict land use at and in the immediate vicinity of the disposal cell by prohibiting residential use (and related uses) and by prohibiting intrusive activities that could damage the integrity of the cell.

Evaluations conducted by EPA as part of the Sediment FS indicate limited restrictions to maintain Keswick Reservoir pool elevation above 578 feet msl, when the combined discharge from SCPP and SCDD approaches or exceeds 6,600 cfs, will prevent erosion of contaminated sediment remaining after dredging. However, the actual restrictions will be further defined following completion of the dredging operations. Once the final sediment contours are known for sediment that will remain in place, detailed engineering analyses can be performed to determine the actual restriction that would be necessary.

The operational controls selected by this ROD and discussed above may be implemented through re-negotiation of the 1980 MOU (and related documents), or by means of a separate agreement between EPA, Reclamation and the State of California.

Limited Residual Management

Following dredging, a small percentage of sediment may remain in Pile A, Pile B, or the main channel of the Spring Creek Arm because it is infeasible to remove for reasons such as underwater obstructions. Residual sediment in Pile A, Pile B, or the main channel of Spring Creek Arm that is infeasible to dredge and is potentially eroded under the restricted operational scenarios described above will be managed to prevent scouring.

Residual management options allowed by the ROD will range from monitored natural recovery to limited capping efforts. The extent of residual management will be determined in the remedial design and following dredging. The extent of residual management required will be determined using methods such as bathymetric and geophysical surveys and detailed hydraulic modeling. The Sediment FS conceptual design estimates that 10 percent (1.5 acres) of the dredging footprint around Piles A and B may require a subaqueous cap to manage residual sediment. Residual management does not include management of sediment remaining in Pile C below the dredge elevation. This sediment will be managed using limited operational restrictions, as described above.

Short-term Monitoring and Resuspension Management during In-water Work

During implementation of the selected remedy, surface water will be monitored within and downstream of the Spring Creek Arm, and the discharge from the disposal cell will be monitored. Water quality monitoring criteria in Keswick Reservoir will be selected to demonstrate compliance with water quality ARARs at the point of compliance during implementation of the selected remedy. The monitoring program will be designed to provide early warning of potential problems. Water generated during dewatering of dredged sediment will comply with the substantive requirements of the NPDES permit program.

Resuspension management will include the use of multiple controls to minimize the resuspension of sediment and/or the migration or resuspended sediment. Resuspension management will be employed to meet water quality ARARs (most notably the turbidity standards in the RWQCB Basin Plan during dredging operations). Controls for resuspension management will be further defined in the remedial design stage and may include:

? **Best Management Practices (BMPs) to minimize resuspension.** BMPs used during dredging may include keeping the intake head of the dredge below the surface of the sediment being removed at all possible times; minimizing reverse purging of intake lines; and keeping intake lines at a depth to minimize erosion and resuspension if reverse purging is necessary. BMPs may also include limiting power to props, using caution when moving floating vessels and anchors, and using above-water deadhead anchor points.

? **Engineering design and in-water construction methods to minimize resuspension and events such as slope failures.** Engineering controls during dredging may include limiting the number of passes by the dredge, controlling the height and slope of the working face, and selecting appropriate dredging equipment. Dredging plans will consider sediment strength, and dredging will be designed to create stable slopes less than a predetermined horizontal: vertical ratio. Use of other methods to promote slope stability during dredging will be considered during design.

? **Use of a sediment curtain barrier to minimize migration of suspended sediment.** Both permeable and impermeable silt curtains will be considered and further evaluated in the remedial design.

Also, as discussed above, dredging will occur when the SCPP is not operating, and dredging will be implemented using a phased dredging approach. If potential problems are identified during Phase 1 dredging based upon water quality monitoring, a response action will be implemented and might include additional resuspension management controls, reduced dredging rates, or shutting down operations until the issues can be resolved.

Conveyance of Dredge Discharge

Dredge discharge will be transported by pipeline to the disposal location adjacent to Spring Creek Reservoir. Dredge discharge will be pumped approximately 350 vertical feet and a distance of 8,700 feet to the dewatering/disposal cell.

Ex situ Physical and Chemical Treatment of Dredge Discharge

Solids in the dredge discharge will be separated from liquid during dewatering. Results from the 2003 Treatability Study (CH2M HILL, 2004a) were used to develop the conceptual design for ex situ physical and chemical treatment of dredge discharge.

Lime and polymer will be added to the dredge discharge prior to dewatering. Lime will be added for pH adjustment and to improve overflow and filtrate water quality through metals precipitation. Polymer will be added as necessary for particle aggregation to aid in the settling of solids.

Treatability study results indicate overflow and filtrate water quality will meet Effluent Limitation Guidelines following adjustment of the pH of the dredge discharge to 9.0. The Sediment FS conceptual design assumed further clarification of filtration or overflow will not be required. Process control during dewatering will accommodate variable flow rates and changing ratios of top material to bottom material, resulting in variable polymer and lime requirements.

Filtrate and overflow from the dewatering/disposal cell will be collected and discharged to Spring Creek Reservoir. Treatability study results indicate one-stage gravity settling, in combination with polymer and lime addition, will achieve adequate settling and dewatering of dredge discharge. As part of a one-stage treatment process, dredge discharge will be pumped directly into the ultimate dewatering/disposal cell, and no intermediate settling pond will be designed. Using consolidation rates measured in the Treatability Study column tests, the design volume for the disposal cell is 195,000 cy, with 2 feet of additional freeboard elevation. This volume represents the volume requirements on the last day of dredging, and includes the volume of dewatered solids and the return water that will remain from the final 20 days of dredging. The one-stage treatment approach may be modified based on additional information that may be collected during remedial design; during pilot testing, if conducted; or during the Phase I operations.

Disposal in Engineered Upland Disposal Cell Adjacent to Spring Creek Reservoir

The disposal cell will be designed to comply with action-specific ARARs. The disposal cell will comply with appropriate and relevant construction, monitoring, and closure and post-closure maintenance requirements for new mining waste units under the State of California Water Code §13172 for California Title 27 Group B mining wastes. These requirements include the following:

? Flood protection - protected from 100-year peak streamflow

? Construction standards - underlain with an impermeable liner system (permeability equal to or less than 1 x 10-6 centimeters per second) and a blanket-type leachate collection and removal system

? Precipitation and drainage controls - designed for one 10-year, 24-hour storm; precipitation that is not diverted shall be collected and managed through the required leachate control and removal system, unless the collected fluid does not contain indicator parameters or waste constituents in excess of applicable water quality standards

? Monitoring - comply with conditions of 27 CCR §§20385-20430

? Closure - close in accordance with 27 CCR §21090 (a), (b), and (c)

The Sediment FS design estimates the top-of-berm elevation of the disposal cell to be 934 feet msl, which accommodates the design volume of 195,000 cy plus 2 feet of freeboard. The cell's area will be approximately 11.5 acres. Construction of the cell will require ground preparation to create a uniform slope for filtrate collection and to increase the available disposal volume of the cell. Fill will be required to construct the perimeter berm.

Road access to the Spring Creek Reservoir disposal location is limited by the steep topography of the surrounding area. Seasonal access will be available adjacent to the Spring Creek Reservoir in the location of the former access road used during construction of SCDD. The former access road will be rebuilt, and access for construction equipment will need to be obtained on the existing road over SCDD. A boat ramp may need to be constructed to provide boat and barge access for monitoring and emergency maintenance during periods when the access road is flooded.

Disturbed seasonal wetlands and willow riparian habitats have been identified in the vicinity of the Spring Creek Reservoir disposal location. Construction of the disposal cell will impact these wetlands, and special-status species surveys, wetlands mitigation, or other compensatory actions will be required as detailed during the remedial design.

Return-water Conveyance and Discharge to Spring Creek Reservoir

Water generated during dewatering of sediment will be collected as overflow and filtrate from the dewatering/disposal cell. A gravity return-water pipeline, or other conveyance structure, will convey return water (i.e., overflow and filtrate) approximately 3,000 feet from the disposal cell to the Spring Creek Reservoir.

Long-term Monitoring and Disposal Cell Maintenance

As part of the remedial design and remedial action for the disposal cell, a water quality monitoring and response program will be prepared and submitted for review by RWQCB in compliance with the substantive relevant and appropriate requirements of 27 CCR §§20385 through 20430. EPA will seek RWQCB comments on this monitoring program. Long-term monitoring will also include surface water quality monitoring to determine the continued effectiveness of the remedial action. The disposal cell will be closed and maintained in compliance with the substantive relevant and appropriate requirements of 27 CCR §21090 (a), (b), and (c).

2.12.3 Summary of Estimated Costs of Selected Remedy

Table 16 contains a summary of the estimated costs for components of the selected remedy.

TABLE 16
Cost Estimate Summary for Selected Remedy
Iron Mountain Mine Record of Decision 6, Shasta County, California

Description	**Cost (S)**
Construction Costs, Phase 1	
Mobilize	5,000,000
Mining plan	500,000
Reclamation plan	500,000
Phase I Bioremediation	10,000,000
Phase I Insitu mining	10,000,000
Phase I Milling and Hydrometallurgy	50,000,000
Phase I treatment and recovery of sludge wastes	10,000,000
Subtotal Phase I	86,000,000

TABLE 16
Cost Estimate Summary for Selected Remedy
Iron Mountain Mine Record of Decision 6, Shasta County, California

Description	**Cost (S)**
Construction Costs, Phase 2	
Mining, milling, and processing equipment	386,000,000
Mine reclamation	120,000,000
Subtotal Phase II	506,000,000
Phase I Indirect Costs	
Field Detail Allowance (2%)	2,000,000
Bonds/Insurance (5.0%)	5,000,000
Contractors' Overhead and Profit	included above
Engineering (12.0%)	10,000,000
Construction Management (7%)	6,000,000
License/Legal (2.2%)	2,000,000
Subtotal	25,000,000
Phase II Indirect Costs	
Field Detail Allowance (2.5%)	10,000,000
Bonds/Insurance (5.0%)	25,000,000
Contractors' Overhead and Profit	included above

Engineering (10%) 50,000,000
Construction Management (5%) 25,000,000
License/Legal (5%) 25,000,000
Subtotal 135,000.000

Total Estimated Costs, Phase I and II: 752,000,000

Any additional Costs are to be paid by the proceeds of minerals recovered and sold by the Owners.

2.12.4 Performance Criteria and Water Quality ARARs

The applicable numeric chemical-specific water quality standards promulgated in the National Toxics Rule (NTR), CTR, and RWQCB Basin Plan are selected as ARARs (as set out in Table 17) for the remedial actions selected in this ROD. ARAR determinations in this ROD do not alter or amend ARAR determinations in prior EPA RODs for this Site, including but not limited to ROD4 (1997).

The performance criteria for the dredging operations during implementation of the interim remedial action will include the following:

? Discharges of sediment from the Spring Creek Arm shall not cause exceedances of the chemical-specific ARARs (Table 17) at the compliance point, which will be located upstream of the drinking water intakes for the City of Redding.

The applicable numeric standards are presented in Table 17.

TABLE 17
Basin Plan and California Toxics Rule Water Quality Criteria for the Sacramento River below Keswick Dam
Iron Mountain Mine Record of Decision 6, Shasta County, California

Parameter	**Basin Plan Maximum Concentration (ug/L)a**	**California Toxics Rule Continuous Concentration (4-day Average) (ug/L) a**
Arsenic	10	150
Cadmium	0.22b	1.1b
Copper	5.6 b	4.1b
Iron	300	--
Zinc	16 b	54b a

aExpressed as dissolved concentrations.
bConcentration is dependent on hardness. Objectives presented assume a hardness of 40 mg/L
-- = no standard

? RWQCB Basin Plan turbidity standards at the point of compliance during dredging operations.

? Return water discharged from the disposal cell shall not exceed the relevant and appropriate Effluent Limitation Guidelines established for existing point sources at copper and zinc mines in 40 CFR §§440.102(a) and 440.103(a). The effluent limitations are:

- Cadmium - 0.10 mg/L maximum for any one day; 0.05 mg/L average of daily values/30 consecutive days
- Copper - 0.30 mg/L maximum for any one day; 0.15 mg/L average of daily values/30 consecutive days
- Lead - 0.6 mg/L maximum for any one day; 0.3 mg/L average of daily values/30 consecutive days
- Zinc - 1.5 mg/L maximum for any one day; 0.75 mg/L average of daily values/30 consecutive days
- pH - within the range of 6.0 and 9.0 at all times
- Total Suspended Solids (TSS) - 30 mg/L maximum for any one day; 20 mg/L average of daily values for 30 consecutive days

? Sediment that is susceptible to erosion shall be removed (or contained through residual management) to 560 feet msl or to an elevation determined by further analysis to prevent erosion under the following operational condition:

- Combined release from SCDD and SCPP up to 6,600 cfs and Keswick Reservoir elevation of 574 feet msl or greater. Combined release of 6,600 cfs is equivalent to the upper end of SCPP capacity (4,900 cfs) plus the historical maximum discharge from SCDD (1,700 cfs).

By meeting these performance criteria, the remedy will also achieve RAOs. When determining compliance with water quality ARARs in the Sacramento River downstream of Keswick Dam, metals concentrations will also be evaluated in upstream sources, including water released from SCDD and Shasta Dam. Monitoring data will be used to determine when or if exceedances of water quality criteria are caused by upstream sources rather than releases of sediment from the Spring Creek Arm.

However, the action selected in this ROD is an interim action that leaves some releases of hazardous substances unabated. EPA is relying on the ARARs waiver for "interim measures" (CERCLA §121(d)(4)(A); 40 CFR §300.430(f)(l)(ii)(C)(l)) for this remedial action. In particular, EPA anticipates that the remedy will improve water quality in the Spring Creek Arm and main body of Keswick Reservoir, but EPA does not anticipate that this remedy, in conjunction with the other remedies implemented to date, will be sufficient to ensure compliance with (1) the numeric, chemical-specific standards contained in the NTR, CTR and Basin Plan for copper, cadmium, or zinc, and (2) California Fish and Game Code §5650 (which prohibits discharge of contaminants "deleterious to fish, plant life, or bird life"). The EPA is therefore waiving compliance with those standards (following construction completion) for the interim remedial action to the extent those standards cannot be achieved by the remedy selected in this ROD in conjunction with the remedies implemented under prior RODs.

EPA is continuing to study the feasibility of implementing additional controls on the metal discharges from the Boulder Creek watershed at IMM, Operable Unit 6, and the down gradient impacts of these continuing discharges. EPA expects to be able to reach a cleanup decision that could include a no further action alternative, for these contaminant sources by September 2006. EPA further expects that this decision would be the final decision for EPA's IMM Superfund cleanup. The final ROD for the MM site would address all issues related to compliance of EPA's remedial action with water quality

ARARs on a site-wide basis.

2.12.5 Expected Outcomes of Selected Remedy

The selected remedy is anticipated to require to 2 to 3 years to implement. The schedule of the remedy is dependent on the timing and duration when in-water work can be performed without operation of SCPP and without discharge from SCDD. This section discusses expected outcomes following implementation of the selected remedy.

Removal of contaminated sediment in the Spring Creek Arm that is most susceptible to erosion, and disposal of dredged sediment in an upland disposal cell, will mitigate the risk for release events of contaminated sediment. Implementation of the selected remedy will protect important fishery spawning habitats in the Sacramento River ecosystem from the release of toxic metals associated with contaminated sediment in the Spring Creek Arm. The selected remedy will comply with water quality ARARs that are established to prevent toxicity in the Sacramento River ecosystem during implementation of the remedial action.

2.13 Statutory Determinations

Under CERCLA §121 and the NCP, EPA must select remedies that are protective of human health and the environment and comply with ARARs (unless a statutory waiver is justified). The selected remedy must also be cost-effective and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. In addition, CERCLA includes a preference for remedies that employ treatment that permanently and significantly reduces the volume, toxicity, or mobility of hazardous wastes as a principal element and a bias against offsite disposal of untreated wastes. The following sections discuss how the selected remedy meets these statutory requirements.

2.13.1 Protection of Human Health and the Environment

The selected remedy protects the environment from the exposure pathways that are being addressed by this remedial action. Risk evaluations conducted by EPA indicate that contaminated sediment and surface water in the Spring Creek Arm do not pose a current or future unacceptable risk to human health and welfare. Therefore, the selected remedy is aimed at protection of the environment.

The fishery resources and other sensitive aquatic species in the Sacramento River below Keswick Dam are the primary natural resources at risk from the mobilization of contaminated sediment from the Spring Creek Arm. The Sacramento River provides highquality habitat for spawning and rearing fish, including the Sacramento River Winter-run Chinook salmon (listed as endangered by the State of California), and the Sacramento River Spring-run Chinook salmon (listed as threatened). Removal of contaminated sediment from the Spring Creek Arm that is most susceptible to erosion, and disposal of dredged sediment in an upland disposal cell, will mitigate the risk for release events of contaminated sediment. The selected remedy will reduce the metal loads and suspended solids associated with contaminated sediment discharged from the Spring Creek Arm and will comply with water quality during implementation of the remedial action.

Metal contamination in IMM discharges and deposited sediment has resulted in ecologically significant impacts to benthic and aquatic communities in the Spring Creek Arm, including significant toxicity to invertebrates, plants, and amphibians. It is uncertain whether a benthic community will be re-established in the Spring Creek Arm following implementation of the selected remedy, or under any of the alternatives evaluated in the Sediment FS.

Copper concentrations in SCDD discharge will be reduced to 5 percent of the pre-1994 concentrations once remedies under ROD 4 are operational; however, continued releases of dissolved copper from Spring Creek Reservoir may still limit growth of aquatic plants following remedial action. Historical smelting activities conducted in the Spring Creek watershed have contaminated portions of the alluvial material below the fine-grained sediment and collodial HMO precipitates. Metals concentrations associated with the bottom material may still inhibit establishment of a benthic community following partial dredging. The selected remedy is expected to indirectly improve aquatic habitat in Keswick Reservoir by limiting future mobilization of contaminated sediment and redeposition into Keswick Reservoir.

Implementation of the selected remedy will pose short-term risks to the environment. Short-term risks to the environment during remediation include the potential for resuspension and movement of contaminated sediment during dredging. Multiple controls will be used to mitigate this risk by minimizing the resuspension of sediment and/or the migration of resuspended sediment. Resuspension management will be employed to meet water quality ARARs in the Sacramento River downstream of Keswick Dam during in-water work in the Spring Creek Arm. Controls for resuspension management will be further defined in the remedial design stage and may include:

? Conducting in-water work when SCPP is not operating to limit migration of suspended sediment

? A conservative, phased dredging approach to determine settling and dewatering characteristics of dredged material, production efficiencies, implementability, and effectiveness of resuspension management, while dredging at lower rates

? Best Management Practices (BMPs) during dredging, anchoring, and vessel operation to minimize resuspension

? Engineering design and in-water construction methods to minimize resuspension and events such as slope failures

? Use of a sediment curtain barrier to minimize migration of suspended sediment

? Monitoring of sediment resuspension and surface water quality during remedial action to provide early detection of potential problems

Public access to the selected disposal location adjacent to Spring Creek Reservoir will be restricted during remedial action to reduce potential exposure to contaminants. The disposal cell will be constructed and maintained to prevent contaminant releases to surface water or groundwater. The selected disposal location is within the impacted Spring Creek watershed behind SCDD, resulting in reduced long-term risks of contaminant migration in the unlikely event of a contaminant release from the engineered disposal cell.

2.13.2 Compliance with ARARs

The selected remedy will be designed to comply with ARARs in the manner described in the following sections.

Compliance with Chemical-specific ARARs

Chemical-specific ARARs for the selected remedy are listed in Table 17 and 18.

The selected remedy is expected to meet state and federal maximum contaminant levels at the point of compliance for Site related contaminants. The selected remedy is also expected to meet the RWQCB Basin Plan turbidity standard at the point of compliance during dredging operations.

The applicable numeric chemical specific water quality standards promulgated in the NTR, CTR and RWQCB Basin Plan, as set out in Table 17, are selected by this ROD as ARARs for the remedial actions selected in this ROD. ARAR determinations in this ROD do not amend or alter ARAR determinations in prior EPA RODs for this Site, including but not limited to ROD 4 (1997).

However, the remedial action selected in this ROD is an interim action that leaves some releases of hazardous substances unabated. EPA is utilizing the ARAR waiver for interim measures (42 U.S.C. Section 9621(d)(4)(A) and 40 C.F.R. Section 300.430(f)(l)(ii)(C)(l) as the basis to waive certain of the applicable numeric chemical specific water quality ARARs following construction completion. EPA expects that the remedy will meet these ARARs at the point of compliance during the construction of the remedial action. While EPA anticipates that the remedial action selected in this ROD will improve water quality in the Spring Creek Arm and Keswick Reservoir, EPA does not anticipate that this remedy, in conjunction with other remedies implemented to date, will be sufficient to ensure compliance with applicable numeric chemical specific ARARs for copper, cadmium and zinc. EPA anticipates that the final ROD for this Site will address compliance with these ARARs on a Sitewide basis. EPA is also employing the interim action waiver to waive compliance with provisions of SWRCB Resolution 92-49 and California Fish and Game Code Section 5650 (a narrative standard prohibiting discharge of contaminants "deleterious to fish, plant life, or bird life").

Location-specific ARARs

Location-specific ARARs for the selected remedy are listed in Table 19. Significant location-specific ARARs are those pertaining to the protection of endangered species, fisheries, wildlife habitat, and wetlands.

TABLE 18

Chemical-specific ARARs for Selected Remedy

Iron Mountain Mine Record of Decision 6, Shasta County, California

Remedy Components	Standard, Requirement, Criterion, or Limitation	ARAR Status	Description	Comment
Performance criteria for Sacramento River near City of Bedding's intake	National Drinking Water Standards (maximum contaminant levels [MCLs]) 40 CFR 300.430(e)(2)(l)(B) Safe Drinking Water Act	Relevant and appropriate	Establishes national primary	

drinking water standards to protect the quality of water in public water systems. MCLs represent the maximum concentrations of contaminants permissible in a water system delivered to the public. MCLs are generally relevant and appropriate when determining acceptable exposure limits for current or potential sources of drinking water.

National primary drinking water standards are health-based standards for public water systems (MCLs). The National Contingency Plan (NCP) defines MCLs as relevant and appropriate for water determined to be a current or a potential source of drinking water in cases where maximum contaminant level goals (MCLGs) are not ARARs. MCLs are enforced at the point where water is delivered to the public. For the IMM Site, the only location where MCLs are currently relevant and appropriate is the Sacramento River near the City of Redding's Jewel Creek intake.

California Safe Drinking Water Standards (MCLs)

State MCLs found in 22 CCR §64435 and §64444.5

Relevant and appropriate

Establishes primary MCLs for contaminants that can not be exceeded in public water systems. In some cases the California drinking water standards are more stringent than the federal MCLs. Like federal MCLs, state MCLs

are applicable as cleanup goals
for waters determined to be a
current or a potential source
of drinking water. State MCLs
are referenced in the Basin
Plan as the minimum standards
for waters with a beneficial
use of municipal or domestic
supply.
Performance criteria
for surface water at
IMM Site
National Toxics Rule (NTR)
and California Toxics Rule
(CTR) 40 CFR Part 131
Applicable,
but waived
as
discussed
in text
Establishes numeric aquatic life
criteria and human health
criteria for priority toxic
pollutants. This regulation is
applicable to inland surface
waters, bays, and estuaries in
California.
This standard establishes
criteria for surface water
quality. Standards for Site
related contaminants are
applicable to surface waters at
the IMM Site.
Discharge from
dewatering/disposal
cell
Standard, Requirement,
Criterion, or Limitation
State Water Resources
Control Board (SWRCB)
Applicable This resolution requires the
continued maintenance of highquality
water of the State. Water
quality may not be degraded below
Remedial actions that involve
discharges to surface water or

surface water drainage courses
must take into account the

TABLE 18
Chemical-specific ARARs for Selected Remedy
Iron Mountain Mine Record of Decision 6, Shasta County, California

Remedy
Components
Standard, Requirement,
Criterion, or Limitation
ARAR
Status Description Comment

Resolution 68-16 what is necessary to protect the
beneficial uses of the water
source.
protection of beneficial uses
and the maintenance of highquality
waters in the area.
Sediment removal and
treatment of dredge
discharge
SWRCB Resolution 92-49 Applicable,
but waived
as
discussed
in text
Section III. G of this resolution
states in part that dischargers
are required to clean up and
abate the effects of discharges
in a manner that promotes
attainment of background water
quality, or the best water
quality that is reasonable if
background levels cannot be
restored.
Remedial alternatives evaluated
must consider attainment of the
highest water quality that is
economically and technically
achievable, and protects
beneficial uses.
Performance criteria
for protection of
water quality
RWQCB's Water Quality
Control Plan for the

Sacramento River and San
Joaquin River Basins (Basin
Plan)
Applicable,
but waived
as
discussed
in text
The Basin Plan for the Sacramento
and San Joaquin River Basins,
dated December 9, 1 994,
establishes beneficial uses for
groundwater and surface water,
water quality objectives designed
to protect those beneficial uses,
and implementation plans to
achieve water quality objectives.
The narrative water quality
objectives and numerical
standards for the Sacramento
River described in the Basin
Plan, for Site related
contaminants, are considered
ARARs.

TABLE 19

Location-specific ARARs for Selected Remedy

Iron Mountain Mine Record of Decision 6, Shasta County, California

Location Standard, Requirement,
Criterion, or Limitation ARAR Status Description Comment

Historic property
managed or
controlled by a
federal agency
National Historic
Preservation Act (16 USC 470
et seq.; 36 CFR Part 800; 40
CFR 6.301 (b); Executive
Order 11593); National
Historic Landmarks Program
(36 CFR Part 65); National
Register of Historic Places
(36 CFR Part 60)
Applicable Federal agencies must identify
possible effects of proposed remedial
activities on historic properties
(cultural resources). If historic

properties or landmarks eligible for,
or included in, the National Register
of. Historic Places exist within
remediation areas, remediation
activities must be designed to
minimize the effect on such
properties or landmarks.
If historic properties are
identified and would be
impacted during
implementation of the
remedial action,
substantive requirements
would be applicable.
Archaeological and Historical
Preservation Act (16 USC 469
et seq., 40 CFR 6.301(c))
Applicable Establishes procedures to provide for
preservation of historical and
archeological data that might be
destroyed through alteration of
terrain, as a result of a federal
construction project or a federally
licensed activity or program.
Presence or absence of such data on
the site must be verified. If
historical or archaeological
artifacts are present in remediation
areas, the remedial actions must be
designed to minimize adverse effects
on the artifacts.
Area where action
may cause
irreparable harm,
loss, or
destruction of
significant
artifacts
Archaeological Resources
Protection Act of 1979 (16
USC 470aa-ii; 43 CFR 7)
Applicable Steps must be taken to protect
archaeological resources and sites
that are on public and Indian lands
and to preserve data. Investigators
of archaeological sites must fulfill

professional requirements. Presence
of archaeological sites is to be
determined.
The proposed remedial
alternatives will not alter
or destroy any known
prehistoric or historic
archaeological features at
the IMM site. However,
substantive mitigation
measures to protect the
area would be required if
such a discovery were
uncovered.
Critical habitat
upon which
endangered
species or
threatened
species depend
(Sacramento
River)
Endangered Species Act, 16
USC 1531 et seq., 50 CFR 402;
40 CFR 6.302(h))
Applicable Protects endangered or threatened
species and their habitat. If
endangered or threatened species are
in the vicinity of remediation work,
U.S. Fish and Wildlife Service
(USFWS) must be consulted, and the
remediation activities must be
designed to conserve endangered or
Winter-run Chinook salmon
(listed as endangered) rely
on spawning areas in the
Sacramento River. Remedial
actions must be sensitive
to the regulations that
protect listed species.

TABLE 19

Location-specific ARARs for Selected Remedy

Iron Mountain Mine Record of Decision 6, Shasta County, California

Location Standard, Requirement,
Criterion, or Limitation ARAR Status Description Comment

threatened species and habitats.

State waters that
support non-game
fish and wildlife
(Keswick
Reservoir and
Sacramento River)
Fish and Wildlife
Conservation Act (16 USC 2901
et seq.; 50 CFR 83)
Applicable Federal departments and agencies
required to use their statutory and
administrative authority to conserve
and promote conservation of non-game
fish and wildlife and their habitats.
Non-game fish and wildlife are
defined as fish and wildlife that are
not taken for food or sport, that are
not endangered or threatened, and
that are not domesticated.
Federal departments and
agencies are required to
use their authority to
conserve and promote nongame
fish and their
habitats.
Stream or water
body that will be
modified (Spring
Creek Arm)
Fish and Wildlife
Coordination Act (16 USC 661
et seq.; 40 CFR 6.302(g))
Applicable Requires adequate provisions for
protection of fish and wildlife
resources. Certain remedies may
result in the temporary or permanent
modification of naturally occurring
water bodies and may require the
construction of mitigated wetlands in
other areas.
Remedial actions resulting
in modifications to the
Spring Creek Arm require
compliance with substantive
provisions for protection
of fish and wildlife

resources.
Designated waters
(Sacramento
River)
Fish and Game Code Section 1
505
Applicable Requirements for the management,
control, and protection of spawning
areas which occupy state-owned lands,
to protect fish life in these areas.
Designates the State lands
of the Sacramento River
from Keswick to Squaw Hill
Bridge (near Vina) as prime
salmon and steelheadspawning
areas which are
used by salmon species
listed as threatened and
endangered. Substantive
requirements for the
management, control, and
protection of spawning
areas are applicable.
Fish and Game Code Sections
1600 and 1603
Applicable Requirements for construction by, or
on behalf of, any State or local
agency or public utility that will
change the natural flow or use
material from the beds or result in
disposal into designated waters.
Substantive requirements
are applicable.
Critical habitat
upon which
endangered
species or
Fish and Game Code Section
2081
Relevant and
appropriate
Permits CDFG to authorize taking of
endangered, threatened, or candidate
species under specific circumstances,
including when the authorized take is
Substantive requirements

related to taking of
endangered, threatened, or
candidate species are

TABLE 19
Location-specific ARARs for Selected Remedy
Iron Mountain Mine Record of Decision 6, Shasta County, California
Location Standard, Requirement,
Criterion, or Limitation ARAR Status Description Comment

threatened
species depend
(Sacramento
River)

for scientific, educational, or
management purposes, or when the
impacts of the authorized take shall
be minimized and fully mitigated.

applicable to the Chinook
salmon in the Sacramento
River.

Waters of the
Untied States
(Spring Creek
Reservoir,
Keswick
Reservoir, and
Sacramento River)

Clean Water Act (CWA)(Section
404) - Dredge or Fill
Requirements (33 USC 1251-
1376; 40 CFR 230)

Applicable

Establishes requirements that limit
the discharge of dredged or fill
material into waters of the United
States. EPA guidelines for discharge
of dredged or fill materials in 40
CFR 230 specify consideration of
alternatives that have fewer adverse
impacts and prohibit discharges that
would result in exceedance of surface
water quality standards, exceedance
of toxic effluent standards, and
jeopardy of threatened or endangered
species. Special consideration is
required for "special aquatic sites,"
defined to include wetlands.

Substantive requirements
are applicable to road
construction, sediment
removal, sediment disposal
and dewatering, placement
of capping material for
residual management, and
surface-water diversions.
Areas within 100-
year floodplain
Protection of Floodplains
(Executive Order 1 1988; 40
CFR 6.302(b); 40 CFR Part 6,
Appendix A)
Applicable
Requires federal agencies to evaluate
the potential effects of action they
may take in a floodplain to avoid the
adverse impacts associated with
direct and indirect development of a
floodplain.
Requirements are
potentially applicable if
remedial actions affect the
floodplain at the site.
Wetlands Protection of Wetlands
(Executive Order 11990; 40
CFR 6.302(a); 40 CFR Part 6,
Appendix A)
Applicable Requires federal agencies to take
action to avoid adversely affecting
wetlands, to minimize wetlands
destruction, and to preserve the
value of wetlands.
Disturbed seasonal wetlands
and willow riparian
habitats were identified
during a field
reconnaissance survey in
the disposal cell location
adjacent to the Spring
Creek Reservoir. Wetlands
protection and mitigation
requirements are applicable
to remedial actions that
impact existing wetlands.

Notes:
ARAR - applicable or relevant and appropriate requirement
CFR - Code of Federal Regulations
CDFG - California Department of Fish and Game
USFWS - U.S. Fish and Wildlife Service USC - U.S. Code
The selected remedy will be designed to prevent the release of metal-laden sediment so that such release no longer presents a threat of deleterious effects to fish life.
However, EPA does not anticipate that this remedy will ensure compliance with California Fish and Game Code §5650, which prohibits discharge of contaminants "deleterious to fish, plant life, or bird life." See the discussion of ARARs waivers in the preceding section.
Other releases from the IMM Site, such as releases from area sources in the Boulder Creek watershed and the existing sediments in Spring Creek Reservoir, may continue to result in the release of deleterious substances (primarily metals) into the surface waters of Spring Creek and Keswick Reservoir. Justification for an interim action ARARs waiver is presented at the end of Section 2.13.2.
The selected remedy shall address and is expected to comply with all other locationspecific ARARs listed in Table 19.
Areas that will be unavoidably impacted by the selected remedy include disturbed seasonal wetlands and willow riparian habitats in the disposal cell location. The EPA will consult with USFWS and the U.S. Army Corps of Engineers to develop appropriate mitigation measures.

Action-specific ARARs

The selected remedy shall address, and is expected to comply with, all action-specific ARARs. Action-specific ARARs for the selected remedy are listed in Table 20.
Significant action-specific ARARs include those relating to construction, monitoring, and maintenance of the upland disposal cell.
Construction, monitoring, and maintenance of the upland disposal cell will comply with substantive appropriate and relevant portions of the State of California Water Code §13172 and the substantive appropriate and relevant portions of regulations promulgated thereunder (27 CCR) for a mining waste management unit.
The embankment structure of the dewatering/disposal cell will meet the criteria for a Jurisdictional Dam by the California Division of Safety of Dams. As such, substantive requirements of the Dam Safety Act and Division 3 of the California Water Code are appropriate and relevant ARARs for the construction of the disposal cell embankment.
New discharges of treated water to surface waters must comply with the substantive appropriate and relevant portions of the National Pollutant Discharge Elimination System (NPDES) permit program. Because the discharge of return water from the dewatering/disposal cell will occur onsite, no permit will be required.
There are no technology-based effluent limitations specifically identified for inactive copper or pyrite mines. There are technology-based limitations for active coal, iron, copper, and zinc mines. Because the discharges of acid mine drainage from the underground mining at IMM are similar to the discharges from active open pit and underground copper mines, EPA has selected the effluent limitations for such copper mines as relevant and appropriate at the IMM Site for the discharge of return water from the dewatering system to the Spring Creek Reservoir.
The best practicable control technology (BPT) and best available technology economically

achievable (BAT) limits on discharges from existing point sources at copper and zinc mines are the following effluent limitations (40 C.F.R. §§440.102(a) and 440.103(a)), which will be met at the point of discharge:
The concentration of pollutants discharged in mine drainage from mines that produce copper or zinc... from open-pit or underground operations other than placer deposits shall not exceed:
? Cadmium - 0.10 mg/L maximum for any one day; 0.05 mg/L average of daily values/30 consecutive days

TABLE 20
Action-specific ARARs for Selected Remedy
Iron Mountain Mine Record of Decision 6, Shasta County, California

Remedy
Components
Standard, Requirement,
Criterion, or Limitation ARAR Status Description Comment

Contaminated
sediment dredge
discharge
RCRA Bevill Exclusion - RCRA
Section 3001(b)(3)(A)(ii),
42 USC 6921(a)(3)(A)(ii), 40
CFR 261.4(b)(7)
The Bevill exclusion, codified in
40 CFR §261.4(b)(7), provides that
"[s]olid waste from the
extraction, beneficiation and
processing of ores and minerals
(including coal), including
phosphate rock and overburden from
the mining of uranium ore" are not
hazardous wastes.
Sediment in the Spring Creek
Arm, and waste associated with
removal of such sediment, may
be excluded from hazardous
waste designation because they
are the result of historical
mineral extraction or
beneficiation at the Site.
Rule 3-2: Prohibits discharges of
air contaminants above specific
concentrations for any single
source.
Remedy components
that could generate
air contaminants

Shasta County Air Quality
Management District (AQMD)
Rules 3-2 and 3-16.
Applicable
Rule 3-16: Substantive
requirements are those of Health
and Safety Code Sections 41700 and
41701. No person shall discharge
from any source whatsoever such
quantities of air contaminants or
other material which cause injury,
detriment, nuisance, or annoyance
to any considerable number of
persons or to the public, or which
endanger the comfort, repose,
health, or safety of any such
persons or the public, or which
cause, or have a natural tendency
to cause, injury or damage to
business or property.
Requirements are applicable to
remedial activities that could
generate air contaminants,
including construction of the
onsite disposal cell, access
road and staging area
construction, and dewatering
and treatment of dredge
discharge.
Access and land use
restrictions for
the onsite disposal
cell
Land Use Covenants
Regulations
CCR, title 22, Section
67391.1 (a)
CCR, title 22, Section
Relevant
and
appropriate
Requires imposition of appropriate
limitations on land use by
recorded land use covenant when
hazardous substances remain on the
property at levels that are not

suitable for unrestricted use of
the land.
Requires that cleanup decision
Regulations will be relevant
and appropriate for access and
land use restrictions for the
onsite disposal cell.

TABLE 20
Action-specific ARARs for Selected Remedy
Iron Mountain Mine Record of Decision 6, Shasta County, California

Remedy
Components
Standard, Requirement,
Criterion, or Limitation ARAR Status Description Comment

67391.1(b)
CCR, title 22, Section
67391.1(d)
CCR, title 22, Section
67391.1(i)
CA Civil Code, Section
1471(a)&(b)
CA Health & Safety Code,
Section 25222.1
document contains an
implementation and enforcement
plan for land use limitations.
Requires that land use covenant be
recorded in the county where the
land is located.
Definitions
Specifies requirements for land
use covenants to apply to
successors in title to the land.
Water Code §13172 and
regulations promulgated
thereunder [27 CCR 22480(b)]
Relevant
and
Appropriate
Establishes three groups of mining
wastes:
Group A - Mining wastes that
must be managed as hazardous waste
pursuant to Title 22, provided the
RWQCB finds that such mining
wastes pose a significant threat

to water quality.
Group B - Mining wastes that consist of or contain hazardous wastes, that qualify for a variance under Title 22, provided that the RWQCB finds that such mining wastes pose a low risk to water quality; and mining wastes that consist of or contain nonhazardous soluble pollutants of concentrations which exceed water quality objectives for, or could cause, degradation of waters of the state.
Group C - Mining wastes from which any discharge would be in compliance with the applicable water quality control, including water quality objectives, other than turbidity.
EPA has determined that these wastes will be managed as Group B mining wastes.
Disposal cell
Mining closure requirements Applicable Group A and B waste piles

TABLE 20
Action-specific ARARs for Selected Remedy
Iron Mountain Mine Record of Decision 6, Shasta County, California

Remedy Components
Standard, Requirement, Criterion, or Limitation ARAR Status Description Comment

under Water Code §13172 close in accordance with 27 CCR §21090 (a), (b), and (c).
Group A and B surface impoundments - close in accordance with 23 CCR 21400(a) and (b)(1); some surface impoundments with clay liners may be closed in place.
Group A and B tailings ponds - close in a accordance with §21090(a), (b), and (c) and 21400(a)
Group C units - close" in a manner that will minimize erosion

and the threat of water quality
degradation from sedimentation."
dredge discharge will be
classified as Group B mining
wastes. Therefore, regulations
for new Group B waste piles are
applicable to the upland
disposal cell.
Discharges to
surface water from
disposal cell
National Pollutant Discharge
Elimination System (40 CFR
Part 122)
Applicable
The National Pollutant Discharge
Elimination System (NPDES) permit
program controls water pollution
by regulating point sources that
discharge pollutants into waters
of the United States.
Substantive requirements are
applicable to discharge from
the disposal cell. Onsite
CERCLA actions do not require a
permit. Substantive discharge
requirements that are relevant
and appropriate to discharges
resulting from management of
mining wastes are the National
Effluent Limitations Guidelines
for copper and zinc mining
operations at 40 CFR
§§440.102(a) and 440.103(a).
The National Dam Safety Act Relevant
and
Appropriate
Substantive provisions of the Act
encourage acceptable engineering
policies and procedures to be used
for dam site investigation,
design, construction, operation
and maintenance, and emergency
preparedness.
The disposal cell will require
construction of an embankment

structure. The embankment will
meet criteria to be considered
a Jurisdictional dam.
Substantive requirements are
applicable for construction of
the disposal cell embankment.
Disposal cell
embankment
Water Code §§6000 through
6501 and regulations
promulgated thereunder [23
CCR 301-333]
Relevant
and
Appropriate
Establishes authority of the State
to requires that a dam shall at
all times be designed,
constructed, operated and
maintained so that it shall not or
would not constitute a danger to

TABLE 20
Action-specific ARARs for Selected Remedy
Iron Mountain Mine Record of Decision 5, Shasta County, California

Remedy
Components
Standard, Requirement,
Criterion, or Limitation ARAR Status Description Comment

life or property.

Notes:
ARAR - applicable or relevant and appropriate requirement
CCR - California Code of Regulations
CFR - Code of Federal Regulations
EPA - U.S. Environmental Protection Agency
RCRA - Resource Conservation and Recovery Act
1 Copper - 0.30 mg/L maximum for any one day; 0.15 mg/L average of daily values/30 consecutive days
2 Lead - 0.6 mg/L maximum for any one day; 0.3 mg/L average of daily values/30 consecutive days
3 Zinc - 1.5 mg/L maximum for any one day; 0.75 mg/L average of daily values/30 consecutive days
4 pH - within the range of 6.0 and 9.0 at all times
5 Total Suspended Solids (TSS) - 30 mg/L maximum for any one day; 20 mg/L average of daily values for 30 consecutive days
Overflow and filtrate from the dewatering/disposal cell will be designed to meet the technology-based effluent limitations for copper and zinc mines.

2.13.3 Cost

In EPA's judgment, the selected remedy provides the best balance of cost and effectiveness in meeting NCP criteria for remedy selection for the alternatives that were developed and evaluated to assure the protection of human health and the environment. In making this determination, the following definition was used: "A remedy shall be cost effective if its costs are proportional to its overall effectiveness." (NCP §300.430(f)(l)(ii)(D)). This was accomplished by evaluating the "overall effectiveness" of those alternatives that satisfied the threshold criteria (i.e., were both protective of the environment and ARAR-compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness). Overall effectiveness was then compared to costs to determine cost effectiveness. The relationship of the overall effectiveness of the selected remedy was determined to be proportional to its costs, and hence the selected remedy represents a reasonable value for the money to be spent.

2.13.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to Maximum Extent Practicable

EPA has determined that the selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized EPA will implement specific measures to assure close coordination with State agencies in developing, implementing, and evaluating a monitoring program.

2.13.5 Preference for Treatment as a Principal Element

EPA is selecting a remedy that treats the source in a manner that prevents the formation of AMD.

2.13.6 Five-Year Review Requirements

The selected remedy will result in hazardous substances, pollutants, or contaminants remaining onsite above levels that allow for unlimited use and unrestricted exposure. This disposal location is
located on the IMM CERCLA site. Section 121(c) of CERCLA and the NCP at §300.430(f)(5)(iii)(C) therefore require EPA to conduct a statutory review no less often than each 5 years after initiation of remedial action to ensure that the remedy is protective of human health and the environment.

2.14 Documentation of Significant Changes from Preferred Alternative of Proposed Plan

. It was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

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PART 3: THE RESPONSIVENESS SUMMARY