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Environmental Protection
Agency

Office of
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Remedial Response

EPA/ROD/R08-91/055
September 1991

EPA

Superfund Record of Decision:

Central City-Clear Creek, CO

50272-101

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Third Remedial Action

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15. Supplementary Notes

16. Abstract (Limit: 200 words)

The Central City-Clear Creek site is an active mining facility in Central City, Clear Creek and Gilpin counties, Colorado. Land use in the area is predominantly commercial and recreational, and an artificial wetlands area is located onsite. The site lies within the 400-square mile drainage basin of Clear Creek, which serves as a drinking water source for several municipalities. Gold mining operations began onsite in 1859 and portions of the site became some of the most heavily mined areas of Colorado. Extraction of surface ores led to an increase in the depth of the mining and, consequently, drainage tunnels were constructed to control water drainage problems. Presently, six major mine drainage tunnels are thought to be principal discharge sources of acid mine water containing high concentrations of metals to surface waters including Clear Creek and its tributaries. In addition, over 21 mine tailings piles with an estimated total volume of over 2,000,000 cubic yards at numerous locations throughout the site are thought to be major sources of contamination. In response to site contamination, EPA has conducted three removal actions since 1987. In 1987, EPA conducted a removal action to prevent the collapse of a mine waste pile. Also in 1987, EPA conducted a second removal action, which

(See Attached Page)

17. Document Analysis a. Descriptors
Record of Decision - Central City - Clear Creek, CO
Third Remedial Action
Contaminated Media: gw
Key Contaminants: metals (arsenic, cadmium, chromium, lead)

b. Identifiers/Open-Ended Terms

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report) None	21. No. of Pages 104
	20. Security Class (This Page) None	22. Price

(See ANSI-Z39.18) *See Instructions on Reverse*

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EPA/ROD/R08-91/055
Central City - Clear Creek, CO
Third Remedial Action

Abstract (Continued)

involved connecting three residences with private wells to the municipal public water supply. In 1991, EPA conducted a third removal action, which involved removing uncontaminated mercury from a small trailer. Because of the complexity of the site, EPA divided the site into several operable units (OUs) for remediation. A 1987 Record of Decision (ROD) addressed OU1 and provided for passive treatment of acid mine water discharge from five discharging tunnels: National, Gregory Incline, Argo Tunnel, Big Five, and Quartz Hill tunnels. A 1988 ROD addressed OU2 and provided for the remediation of mine waste piles in the immediate proximity of the five discharging tunnels. This ROD supersedes the remedy provided for OU1 in the 1987 ROD by including active treatment of the Argo Tunnel and delaying a decision on treating the discharges from the Big Five, National and Quartz Hill tunnels, and the Gregory Incline. EPA will consider a subsequent ROD to address treatment of the remaining onsite tunnels pending further monitoring and treatability studies. The primary contaminants of concern affecting the ground water are metals including arsenic, cadmium, chromium, and lead.

The selected remedial action for this site includes constructing physical barriers for mine waste piles (to reduce metals loading to surface water and human health risks from ingestion or inhalation of metals); treating discharges from the Burleigh tunnel passively through the use of man-made wetlands; treating discharges from the Argo tunnel actively along with ground water pumped from the immediate area; providing an alternate water supply where needed; invoking an interim action waiver of ARARs for discharges from the National, Quartz Hill, and Big Five tunnels, and the Gregory Incline, and invoking a technical impracticality waiver for restoring ground water to MCLs; collecting discharges from the National and Quartz Hill tunnels, and Gregory Incline with final disposition to be established pending further monitoring and treatability studies; and implementing institutional controls. The estimated present worth cost for this remedial action is $23,510,000, which includes an annual O&M cost of $1,204,000 for 30 years.

PERFORMANCE STANDARDS OR GOALS: The passive treatment system will remove approximately 99.5% of the zinc, 99.84% of the copper, and 9.7% of the manganese from tunnel discharge. Active treatment will remove 100% of the zinc and manganese, and 99.84% of the copper.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VIII

COLORADO DEPARTMENT OF HEALTH

RECORD OF DECISION

CLEAR CREEK/CENTRAL CITY SUPERFUND SITE
OPERABLE UNIT #3
GILPIN AND CLEAR CREEK COUNTIES, COLORADO

SEPTEMBER 30, 1991

CLEAR CREEK/CENTRAL CITY SUPERFUND SITE
OPERABLE UNIT #3

DECLARATION FOR THE RECORD OF DECISION

Site Name and Location

Clear Creek/Central City Superfund Site Operable Unit #3, Clear Creek and Gilpin Counties, Colorado

Statement of Basis and Purpose

This decision document presents the selected remedial action for the Clear Creek/Central City Superfund Site Operable Unit #3, Clear Creek and Gilpin Counties, Colorado, chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (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), 40 CFR Part 300. This decision document explains the factual and legal basis for selecting the remedy for this Site, and is based on the administrative record for the Site.

The State of Colorado concurs with the selected remedy.

Assessment of the Site

Actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this Record of Decision, may present an imminent and substantial endangerment to public health, welfare, or the environment.

Description of the Remedy

The Clear Creek/Central City Superfund Site consists of three Operable Units which were designated to address heavy metals contamination associated with historic mining activity in the Clear Creek drainage basin. Operable Unit #1 was designated to address the discharge of acid mine water from five tunnels (National and Gregory Incline near Black Hawk, the Quartz Hill Tunnel southwest of Central City, and the Argo and Big Five Tunnels in Idaho Springs). The Operable Unit #1 Record of Decision was signed in September, 1987. Operable Unit #2 was designated to address remediation of mine waste piles in immediate proximity to the five discharging tunnels referenced above. The Operable Unit #2 Record of Decision was signed in March, 1988. Operable Unit #3 was originally designated to address control of surge events from the Argo Tunnel. The Record of Decision for Operable Unit #3 was delayed pending the outcome of the Phase II investigations.

In 1988 the Phase II investigation was initiated to take a comprehensive view of the approximately 400 square mile Clear

Creek drainage basin. This Record of Decision is for the Phase II investigations. This Record of Decision supersedes the Operable Unit #1 Record of Decision and includes a decision for the original Operable Unit #3. The Operable Unit #2 Record of Decision remains unchanged by this Record of Decision. For the purposes of Operable Unit designation, Operable Unit #3 is hereby redesignated and will be equivalent in meaning to the Phase II investigations.

The selected remedy for Operable Unit #3 addresses a portion of the principal threats remaining at the Site by treating highly toxic and highly mobile liquid wastes, i.e., acid mine discharges, which present significant risk to the environment. Treatment of the principal threats will include the use of an innovative emerging technology - passive treatment via constructed wetlands. This technology has been undergoing laboratory and pilot scale testing at the Site under the Superfund Innovative Technology Evaluation (SITE) program. The selected remedy addresses low level threat wastes by reliably managing source materials, i.e., mine tailings and waste rock material. The selected remedy addresses contaminated ground water.

The selected remedy for Operable Unit #3 at the Clear Creek/Central City Site is described below by its major components:

- Capping or physical barriers, and institutional controls for select mine waste piles.

- An alternate drinking water supply where required.

- Treatment of the Burleigh and Argo Tunnel discharges.

- A ground water pump and treat system in the Idaho Springs area to address non-point source metals loading to surface water.

- Reduction in the heavy metals load from Woods Creek.

- No action to control surge events from tunnels.

Additionally, this Record of Decision amends the Operable Unit #1 Record of Decision by:

- Use of the interim wavier of applicable or relevant and appropriate requirements for the discharge from the Big Five Tunnel.

- Collecting the discharges from the Gregory Incline, National and Quartz Hill Tunnels.

- Delaying a decision on treatment of the Gregory Incline, National and Quartz Hill Tunnels pending treatability studies and further delineation of the contamination sources in North Clear Creek. These studies will serve as a new operable unit for the Site, Operable Unit #4.

Statutory Determinations

The selected remedy is an interim action and is protective of human health and the environment, complies with Federal and State requirements that are legally applicable or relevant and appropriate to the limited scope action, and is cost effective. Although this interim action is not intended to address fully the statutory mandate for permanence and treatment to the maximum extent practicable, this interim action does utilize treatment and is thus a furtherance of that statutory mandate for this Site. Because this action does not constitute the final remedy for the Site, the statutory preference for remedies that employ treatment that reduces the toxicity, mobility, or volume as a principal element, although addressed to a great extent by this remedy, will also be addressed by the final response action. Subsequent actions are planned to address fully the threats posed by the conditions at the Site. Because this remedy will result in hazardous substances remaining on site, a review will be conducted within five years after commencement of remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. Because this is an interim action Record of Decision, review of this Site and of this remedy will be ongoing as the Environmental Protection Agency, and the State of Colorado continue to develop final remedial alternatives for the Site.

Jack W. McGraw
Acting Regional Administrator (Region VIII)
U.S. Environmental Protection Agency

9/30/91
Date

Thomas P. Dooby
Director, Office of Environment
Department of Health
State of Colorado

9/30/91
Date

CLEAR CREEK/CENTRAL CITY SUPERFUND SITE OPERABLE UNIT #3
DECISION SUMMARY FOR THE RECORD OF DECISION

TABLE OF CONTENTS

FIGURES and TABLES

CLEAR CREEK/CENTRAL CITY SUPERFUND SITE
OPERABLE UNIT #3

DECISION SUMMARY FOR THE RECORD OF DECISION

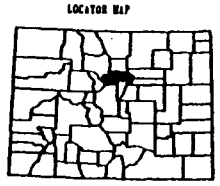
1.0 SITE NAME, LOCATION AND DESCRIPTION

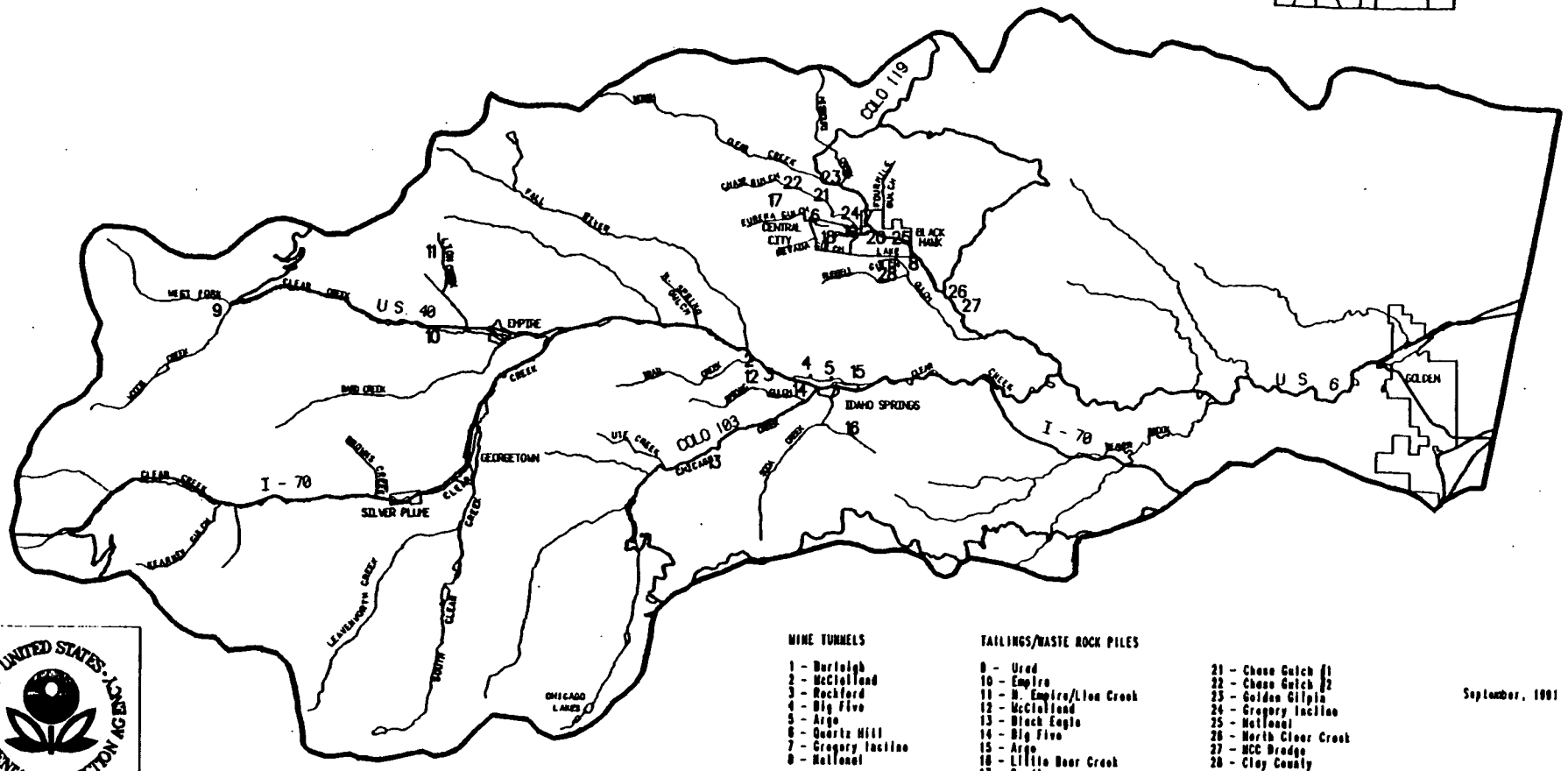
The Clear Creek/Central City Superfund Site (Site) is located approximately 30 miles west of Denver, Colorado. The Site boundary has not been narrowly defined because of the nature of the contamination at the Site. Extensive historical mining activity at the Site took place on a large number of small mining claims. In general, this resulted in the disposal of relatively small volumes of mine waste rock and tailings piles, which are distributed over a very large area. Additionally, numerous mine tunnels, which were constructed for ore haulage and mine water drainage, are found in the area. Consequently, the investigations at the Site involved identification and prioritization of contamination within the approximately 400 square mile drainage basin for Clear Creek. Figure 1-1 identifies those mine waste piles and mine tunnels which are currently considered priority locations for potential remedial action under the Clear Creek/Central City Superfund Site.

The Clear Creek drainage basin ranges in elevation from approximately 5,700 feet to over 13,000 feet. Annual precipitation in the drainage basin ranges between 16 - 18 inches. However, precipitation values two to three times greater than these values can be seen in localized areas. The drainage basin is dominated by a series of mountains and valleys. The steep hillsides exhibit shallow coarse soils, with ponderosa pine, juniper, and mountain mahogany grasslands the typical vegetation on south-facing slopes, and douglas fir communities typical on north-facing slopes. Aspen groves are also interspersed within these communities. Along valley bottoms blue spruce, aspen and narrow-leaf cottonwood are the typical vegetation, with willow and river birch at the edge of floodplains.

Clear Creek has three major tributaries - South, West, and North Clear Creek - as well as numerous smaller tributaries. Designated uses of Clear Creek include agriculture, recreation, and drinking. Recreational uses in Clear Creek include fishing, kayaking, rafting, and tubing. Clear Creek and its tributaries are classified as Cold Water Class I, and in a few cases Cold Water Class II due to limiting habitat for aquatic life. Clear Creek and its tributaries are used in whole or in part as a drinking water source by several municipalities including Georgetown, Idaho Springs, Black Hawk, Golden, Westminster, Thornton, and Arvada. Table 1.1-1 in Appendix B provides a summary of the use classifications for Clear Creek.

CLEAR CREEK BASIN, COLORADO
Site Map





MINE TUNNELS

1 - Burleigh
2 - McClelland
3 - Rockford
4 - Big Five
5 - Argo
6 - Quartz Hill
7 - Gregory Incline
8 - National

TAILINGS/WASTE ROCK PILES

9 - Urad
10 - Empire
11 - N. Empire/Lion Creek
12 - McClelland
13 - Black Eagle
14 - Big Five
15 - Argo
16 - Little Bear Creek
17 - Beadle
18 - Quartz Hill
19 - Gregory Gulch #2
20 - Gregory Gulch #1
21 - Chase Gulch #1
22 - Chase Gulch #2
23 - Golden Gilpin
24 - Gregory Incline
25 - National
26 - North Clear Creek
27 - NCC Dredge
28 - Clay County

September, 1991

Figure 1-1

The ground water system in the Clear Creek drainage basin has not been classified by the State of Colorado for a particular use. In addition, at this time the State of Colorado has not adopted standards in the basin for the contaminants of concern at the Site. There are approximately 4,367 permitted drinking water wells in Clear Creek and Gilpin Counties.

The Clear Creek drainage basin is located in Clear Creek and Gilpin Counties. The 1988 population estimates show 2,649 residents in Gilpin County and 7,379 residents in Clear Creek County. More densely populated areas include the towns of Silver Plume, Georgetown, Empire, and Idaho Springs in Clear Creek County; and Central City and Black Hawk in Gilpin County. In addition, a large number of the residents of both Counties live in smaller communities, or are dispersed throughout the Counties and live on small acreage.

Land uses in Clear Creek and Gilpin Counties include tourism, commerce, recreation, and to a limited extent, ranching and agriculture. Areas of both Counties were extensively mined in the past because of the abundance of precious and base metals. Active mines are still present at some locations in the Counties. In October 1991, limited stakes gaming will be permitted in the towns of Black Hawk and Central City. This will undoubtedly change the land use and population density in these areas.

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

2.1 SITE HISTORY

The Clear Creek/Central City Superfund Site is located on the east slope of Colorado's Front Range. The Colorado Mineral Belt transects the Site indicating the rich mineralization of the area. Precambrian gneisses and schists are the predominate host rock and are cut by a network of faults. Tertiary Age veins and stocks within the host rock are the sources of sulfide ores which contain deposits of several metals including gold, silver, iron, copper, lead, nickel, zinc, cadmium, manganese, as well as others.

Due to the rich mineralization of the area, portions of the Site became some of the most heavily mined areas of Colorado. There are well over 800 inactive mines and tunnels in Clear Creek and Gilpin Counties. Historically, it is estimated that over $110 million worth of mineral production, in "1900" dollars, occurred at the Site. Gold and silver accounted for the vast majority of the mining interest.

Mining activity in the area commenced in 1859 with placer gold being found at the mouth of Chicago Creek, and the first lode

discovery occurring in Gregory Gulch later that year. By the summer of 1860, almost all surface lodes had been claimed.

Extraction of surface ores led to an increase in the depth of mining. This increase in depth brought problems with water drainage, and miners began to encounter more durable sulfide ores which could not be milled with the same ease as the oxidized surface ores. To compensate for these problems, drainage tunnels were constructed and new milling techniques were developed.

Today most of these mine drainage tunnels are still functioning and discharge acid mine water, which contains high concentrations of heavy metals. Mine tailings from milling operations and waste rock from the development of the mines are present at numerous locations throughout the Site.

In September 1983, the Site was selected for addition to the Superfund National Priorities List due to the presence of heavy metals in the environment. Since that time, the Environmental Protection Agency (EPA) and the Colorado Department of Health (CDH) have conducted several studies in the area and have previously made certain decisions on cleanup alternatives for certain areas. These decisions are discussed in greater detail in Section 4.0.

Three removal actions were conducted at the Site by EPA's Emergency Response Branch. In March 1987, a removal action was initiated at the Gregory Incline to prevent the collapse of the mine waste pile. A collapse would have allowed the mine waste to slide into North Clear Creek, and EPA was concerned that a large load of metals-laden mine waste would wash downstream into Clear Creek and contaminate the municipal water supply of the City of Golden, Colorado. As part of the removal action EPA removed an old deteriorated wood crib retaining wall, decreased the slope of the mine waste pile, and constructed a gabion basket retaining wall. In Fall 1987, a removal action was initiated in the Idaho Springs area. This removal action involved connection of three residents to the City of Idaho Springs water supply. Prior to the removal action the residences had been served by private ground water wells which contained elevated concentrations of cadmium. In August 1991, a removal action was initiated approximately 1/4 mile north of Idaho Springs. This action involved removal of uncontaminated mercury from a small trailer. The mercury and a small amount of soil were placed in a ten gallon steel drum and shipped to a mercury recovery facility.

2.2 ENFORCEMENT ACTIVITIES

A potentially responsible party search was conducted as part of the earlier investigations at the Site. The search revealed

information on the ownership of the five discharging mine tunnels and five mine waste piles described in Section 4.0 under Operable Units #1 and #2. To date, no enforcement activities have resulted from this search.

EPA also initiated a potentially responsible party search as part of the Phase II investigations. This second search has not been completed and, therefore, no special notices have been issued. EPA does not believe that remedial action at the Site should be delayed pending finalization of the search and is proceeding with this Record of Decision. After finalization of the search, the status of the potentially responsible parties will be evaluated. If appropriate, EPA will notify potentially responsible parties of the selected remedy and will initiate negotiations for the implementation of the remedy. If the potentially responsible parties do not commit to performing the remedy in a timely manner, EPA may proceed with a fund-financed remedial design and remedial action and may attempt to recover EPA's response costs from the responsible parties. If it is determined that a potentially responsible party has little or no liability for the contamination at the Site, this information will be used to determine if a fund-financed remedial action will be initiated. A fund financed-remedial action would use Federal and State monies to perform the cleanup.

3.0 HIGHLIGHTS OF COMMUNITY PARTICIPATION

Community participation activities at the Site were conducted pursuant to Sections 113 (k)(13)(i-v) and 117 of the Comprehensive Environmental Response, Compensation, and Liability Act. The Colorado Department of Health (CDH), the lead agency for the Site, has developed and maintained an active community relations effort during the Phase II work to keep the public informed and to give the public an opportunity for input. The community relations effort involved the development of a Technical Review/Advisory Committee, which was composed of local citizens, downstream water users, and local, State and Federal officials. Project updates were mailed at project milestones to approximately 200 residents and interested citizens. In addition, County Commissioners and City Councils were updated at various times during the Phase II investigation.

Copies of the Site work plan, raw data packages, Remedial Investigation, Feasibility Study, and Proposed Plan were made available to the public at the Idaho Springs Library, Idaho Springs City Hall, Gilpin County Courthouse, EPA Library, and CDH offices. A public meeting was held on July 24, 1990, to hear comment on the Remedial Investigation report. A second public meeting was held on July 11, 1991, to hear comment on the Feasibility Study report. At these meetings members of the CDH and EPA provided information about the findings of the reports, including a detailed explanation of the preferred cleanup

alternative for the Site, and answered questions about the Site. Notice of both of these meetings were published in the Clear Creek Courant and the Weekly Register-Call newspapers. A 30-day comment period was provided for the Remedial Investigation report and a 60-day public comment period was provided for the Feasibility Study. A Responsiveness Summary was written to address public comments received during the comment period. A copy of the Responsiveness Summary is included as Appendix C of this Record of Decision.

This Record of Decision presents the selected remedial action for the Clear Creek/Central City Site Operable Unit #3, Clear Creek and Gilpin Counties, Colorado, which has been chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act, as amended by the Superfund Amendments and Reauthorization Act, and to the extent practicable, the National Contingency Plan. The decision for remediation of the Site is based on the Administrative Record. A copy of the Administrative Record Index is included as Appendix D of this document.

4.0 SCOPE AND ROLE OF OPERABLE UNIT WITHIN SITE STRATEGY

As with many Superfund sites, the problems at the Clear Creek/Central City Site are complex. In order to effectively address some of these problems, EPA organized work at the Site into separate working units known as Operable Units. The Clear Creek/Central City Superfund Site was organized into three Operable Units which were designated to address heavy metals contamination associated with historic mining activity in the Clear Creek drainage basin. A brief description of the three Operable Units is provided below.

Operable Unit #1 was designated to specifically address treatment of the acid mine drainage from five tunnels (National and Gregory Incline in Black Hawk, the Quartz Hill Tunnel southwest of Central City, and the Argo and Big Five Tunnels in Idaho Springs). The Feasibility Study for Operable Unit #1 was completed in 1987 and a Record of Decision was signed in September 1987. The Record of Decision selected passive treatment of the discharging acid mine water as the preferred remedial alternative, if passive treatment could be shown (via a two to three year study period) to be an effective treatment option. If it was determined that passive treatment systems were not effective, the Record of Decision allowed the flexibility to install active treatment or a combination of active and passive treatment systems. Implementation of the Record of Decision for Operable Unit #1 was delayed pending the outcome of the Phase II work, which is discussed below.

Operable Unit #2 was designated to specifically address remediation of mine tailings and waste rock in the immediate proximity of the five discharging tunnels referenced above. The Feasibility Study for Operable Unit #2 was completed in November 1987, and a Record of Decision was signed in March 1988. The Record of Decision selected runon control and slope stabilization (where applicable) as the preferred remedial alternative. Remedial action at two of the five mine waste piles (Gregory Incline and Argo Tunnel sites) was initiated in April 1990, and is complete. The Record of Decision for the Phase II work will not amend the original Record of Decision for Operable Unit #2.

Operable Unit #3 was originally designated to address control of surge events from the Argo Tunnel. A Feasibility Study was completed in August 1988. The Record of Decision for Operable Unit #3 was delayed until a more comprehensive evaluation of the Site could be obtained. This Record of Decision for the Phase II work includes a final recommendation for Operable Unit #3.

In June 1988, the EPA transferred the lead role for the Site to CDH. CDH then initiated the comprehensive evaluation of the Site via the Phase II Remedial Investigation and Feasibility Study. The Phase II work expanded the original study area to include the approximately 400 square mile Clear Creek drainage basin above Golden, Colorado. The reason for the expansion was to obtain a better understanding of the various contamination sources in the basin; to enable the State, EPA, and the local communities to make informed decisions as to what could and could not be done to control these sources; and to assess what effect these controls would have on Clear Creek. The Phase II Remedial Investigation was completed in September 1990; the Draft Phase II Feasibility Study was released for public comment in June 1991. This Record of Decision is for the Phase II investigations, it will supersede the Operable Unit #1 Record of Decision, and includes a final decision for the original Operable Unit #3. For the purposes of Operable Unit designation, Operable Unit #3 is hereby redesignated and will be equivalent in meaning to the Phase II investigations.

This Record of Decision for Phase II/Operable Unit #3 was intended to be the final response action for the Site. However, due to the complexity of the Site, and difficulties in attaining legally applicable or relevant and appropriate requirements, it will not be the final decision document for the Site. The cleanup plan outlined in this Record of Decision will be evaluated as it is being implemented to determine how effectively it eliminates or reduces the risks posed at the Site. This evaluation will take place no later than five years from the date of this Record of Decision. The information obtained during the evaluation will be used in conjunction with other pertinent Site data to determine what additional response

actions may be required. This point is discussed in further detail in Section 10.0 of this document.

5.0 SUMMARY OF SITE CHARACTERISTICS

5.0 INTRODUCTION

The Phase II Remedial Investigation for the Clear Creek/Central City Site focused on identifying the nature and extent of heavy metals contamination to the mainstem of Clear Creek and its major tributaries. Due to the large geographic size of the study area, an initial screening study was performed. Potential sources of contamination were prioritized based on their likelihood to threaten human health or the environment. The results of the screening and prioritization allowed for a focused study of the major sources of contamination at the Site.

Investigations at the Site have identified the following potential contaminants of concern: aluminum, arsenic, cadmium, chromium, copper, fluoride, lead, manganese, nickel, silver, zinc, and the indicator pH. In addition, mercury was evaluated in fish tissue, and beryllium was examined in air. The presence and concentration of these contaminants vary over time and location within the Site. In some cases at the time of sampling some of the contaminants of concern were not found to pose a threat to human health or the environment. This point is discussed in greater detail in the summary of Site risks in Section 6.0.

The potential major sources of contamination to the mainstem of Clear Creek and its major tributaries were identified to be eight discharging mine drainage tunnels, five of which were under Operable Unit #1, and 21 mine waste piles, five of which have an existing Record of Decision under Operable Unit #2 (see Figure 1-1). These sources of contamination, as well as the extensive natural mineralization throughout the Site, have contributed to contamination of both surface water and ground water.

A complete description of the extent of contamination can be found in the Phase II Remedial Investigation report. The significant findings of the Phase II Remedial Investigation are summarized by affected media and presented below.

5.1 SURFACE WATER

Surface waters at the Site are impacted by both direct discharges from mine drainage tunnels and from eroding mine waste piles (see Figure 1-1). A summary of the volumes and concentrations of contaminants of concern in mine waste piles can be found in Tables 6-5 and 6-6. A summary of the major impacts to surface water is presented below.

The mainstem of Clear Creek is directly impacted by acid mine drainage from the Burleigh, McClelland, Rockford, Big Five and Argo Tunnels; and from the McClelland tailings, and Big Five tailings and waste rock piles. The mainstem of Clear Creek is impacted by non-point source metals loading (ground water) in the Idaho Springs area. The mainstem of Clear Creek is also impacted by the tributaries described below.

The West Fork of Clear Creek is directly impacted by Woods Creek, which is impacted by discharges from the Urad Mine tunnel drainage (the Urad tunnel was plugged in 1989) and seepage from the Urad tailings and waste rock piles. Surface waters in the Lion Creek drainage (a tributary to West Clear Creek) contain elevated levels of metals.

The Empire tailings along West Clear Creek were studied during the Phase II Remedial Investigation, but were not shown to impact surface water.

Chicago Creek (a tributary to the mainstem of Clear Creek) is impacted by the Black Eagle mine waste pile.

Soda Creek (a tributary to the mainstem of Clear Creek) is impacted by the Little Bear tailings pile.

The North Fork of Clear Creek is impacted by acid mine drainage from the Quartz Hill Tunnel (via Gregory Gulch), the Gregory Incline, and the National Tunnel; and from the Golden Gilpin tailings, the Gregory Incline tailings and waste rock pile, and the North Clear Creek tailings. North Clear Creek is also impacted by the Gregory Gulch #1 and #2 tailings piles in Gregory Gulch, the Clay County tailings pile in Lake Gulch, the Chase Gulch #1 and #2 tailings piles in Chase Gulch, the Quartz Hill tailings pile in Nevada Gulch, and other sources which were not studied.

The impact on surface water from the North Clear Creek Dredge placer tailings could not be fully determined from an erosional standpoint, because they form the bottom and bank of a section of North Clear Creek.

The impact on surface water from the Boodle tailings could not be fully determined, due to the lack of stream flow in Eureka Gulch during sampling.

5.2 GROUND WATER

A total of 33 wells were sampled at the Site (14 drinking water wells and 19 monitoring wells which were located in or near tailings/waste rock piles) (see Figure 5-1). The 14 drinking water wells were selected for testing by announcing to the public, via the local newspapers, that CDH was interested in

Figure 5-1

sampling domestic wells in the area and that volunteers would receive a free analysis of their well water. Based on the level of response, CDH was able to accommodate each individual who requested a well sample.

The 19 monitoring wells were constructed in close proximity to mine waste piles and were drilled into bedrock and/or alluvium. The monitoring wells were constructed to evaluate the interaction between alluvial and bedrock ground water, and to determine the effect that mine waste piles are having on the local ground water quality.

In general, the results of the well sampling indicate that ground water at many locations in the study area contains elevated concentrations of metals. Several of the monitoring wells, and one of the drinking water wells, contained concentrations of some metals which exceeded drinking water and/or health based standards. A detailed summary of the contamination in well water is provided in Section 6.1.2.

The full extent of ground water contamination was not determined for the following reason: the ground water quality was determined to be highly variable at the locations which were sampled, and there is no discernable pattern of contamination; the Site encompasses approximately 400 square miles of mountainous terrain which contains numerous shallow unconfined aquifers, and numerous fractured bedrock aquifers.

5.3 MINE TAILINGS AND WASTE ROCK

During the Phase II Remedial Investigation, a total of 60 tailings and waste rock piles were inventoried at the Site utilizing area maps, aerial photographs, literature review of mining and milling history, and direct field observations. The inventoried piles were then ranked based on total volume, proximity to surface water, proximity to flood plain, and the size of the drainage basin above the piles. The ranking system yielded 12 sites that were investigated further (the results of the investigations are summarized in Tables 6-5 and 6-6). Samples were taken to determine slope stability at ten sites, while two sites were evaluated utilizing existing data. Samples to determine surface and subsurface chemistry were also taken at nine sites. In addition, sediment loading estimates for seven of the sites were performed based on a one-hour rainfall event.

Three sites were not evaluated for sediment loading due to relatively long distance to a flowing receiving stream, low slope angles (Empire and Boodle tailings), and site location within the stream channel (North Clear Creek Dredge).

Three additional mine waste piles were included in the Phase II Feasibility Study as a result of observations made during the

Phase II Remedial Investigation sampling efforts. The Chase Gulch #1 and #2 mine waste piles, in lower Chase Gulch, were added because of the poor water quality observed in Chase Gulch, particularly during high flow. These two piles were specifically selected because they are in direct contact with the stream. The North Clear Creek Tailings pile was added because of its close proximity to North Clear Creek and a large amount of sediment that was observed entering the Creek during a storm event. Since these three piles were added after the Phase II Remedial Investigation, no chemical or stability data are available.

It should also be noted that the Urad, Lion Creek, and North Empire Creek mine waste piles were to be evaluated (in the Phase II Remedial Investigation) with existing data. The existing data did not provide a high level of detail. Consequently, the specific risks for these piles were qualitatively evaluated.

Overall, the primary contaminants of concern in mine waste piles are arsenic, lead and zinc. Arsenic and lead are a concern with regard to human health risks, while zinc is of concern with regard to environmental risks.

5.4 AIR MEDIA

Mine waste piles at the Site contribute metals laden dust to the air. This contamination problem was studied in Central City. Central City was chosen because of the large volume of mine waste and the relatively dense population in this area of the Site.

An ambient air quality sampling program was performed in Central City, Colorado, from August 11, through November 13, 1989. The purpose of the study was to obtain direct measurements of metals concentrations in the air. Sampling was conducted every third day during the sampling period, resulting in a total of 29 sample days. For each sample day, one sample of all airborne dust particles, and one sample of respirable dust particles (particulate matter less than 10 microns in size), were collected. The dust particles were analyzed for arsenic, cadmium, beryllium, chromium, lead, nickel, and zinc. The concentrations of metals per volume of air was calculated, and the daily results were averaged to obtain a 4-month average for each metal. This 4-month average was extrapolated to a one year exposure using an arithmetic model. These one year values were then used to perform a human health risk assessment. The results of this sampling program are discussed in detail in Section 6.0.

6.0 SUMMARY OF SITE RISKS

A baseline risk assessment was conducted to evaluate potential human health and environmental risks associated with the existing contamination at the Site. Actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this Record of Decision, may pose an imminent and substantial endangerment to public health, welfare, or the environment. The following risk summary explains why this endangerment exists. The information presented in this section is a summary of the baseline risk assessment which was produced in conjunction with the Phase II Remedial Investigation reports.

Potential risks to human health are expressed in two ways. There are carcinogenic (cancer causing) risks associated with exposure to contaminants. Carcinogenic risks are expressed as the potential excess cancer incidence per a specific population size. There are also noncarcinogenic risks associated with exposure to contaminants, such as risks of birth defects, damage to the liver or kidneys, etc.

In order for a human being or any living organism to be at risk (carcinogenic or noncarcinogenic) from a contaminant, two things must be considered. First, the contaminant must be present at high enough concentrations to pose a risk. Second, the person or organism must be exposed via an exposure pathway. Once this information is obtained, a quantitative evaluation of risk can be performed.

The first step in the risk assessment process involves identifying the contaminants of concern and their concentrations. At the Clear Creek/Central City Site the contaminants of concern were identified by compiling a list of contaminants that where found in concentrations which exceeded typical background levels. As previously mentioned, the contaminants of concern at the Site are: aluminum, arsenic, cadmium, chromium, copper, fluoride, lead, manganese, nickel, silver, and zinc. In addition, mercury was evaluated in fish, and beryllium was evaluated in air.

The second step in the risk assessment process is to determine the pathway(s) by which a human or other living organism might become exposed to contamination. For human health, the exposure pathways which were identified and evaluated at the Site include: ingestion of surface water, incidental contact with surface water, ingestion of ground water, incidental ingestion of mine tailings and waste rock, inhalation of metals in air, and consumption of fish. The risk assessment for the Site included evaluating human exposure based on current and future residential uses. Additionally, exposure was evaluated based on reasonable maximum exposure scenarios in order to ensure that a

potential health risk was not overlooked. The exposure assumptions for human health are summarized by environmental medium in Section 6.1.

For environmental risk the exposure pathways which were evaluated include: exposure to contaminants in the water column, and contact with surface water stream sediments (for aquatic organisms).

Once an exposure pathway is established, risk is determined by combining the exposure (intake) of the contaminant with toxicity data for the contaminant. For carcinogens, this toxicity data is known as a Slope Factor, which is defined as the statistical 95% upper confidence limit on the slope of the dose-response relationship at low doses for a carcinogen. Dose-response relationships are determined from experimental data obtained from laboratory animals; this data is then extrapolated to human beings. EPA's acceptable excess cancer risk range is between 1 cancer incidence per 10,000 people and 1 cancer incidence per 1,000,000 people.

For noncarcinogens, risk is presented as a ratio of exposure (intake) to the Reference Dose for each contaminant for a given exposure pathway. The Reference Dose is the EPA's preferred toxicity value for evaluating noncarcinogenic effects. The sum of the ratios of all contaminants under consideration is called the Hazard Index. When the Hazard Index is greater than one it indicates that the contaminant is likely to present a risk to human health.

The Site risks are summarized below for each exposure pathway. Human health risks are discussed first, followed by a discussion of environmental risks. The general toxicological data and assumptions for each contaminant of concern are presented in Tables 6-1 (a), (b) and (c). For each exposure pathway, a brief summary of the other major assumptions which were used in calculating risk will be provided. In addition, the reader should note that some of the data tables presented later in this section provide a "risk-based target concentration" value. For carcinogens, this value corresponds to an excess cancer rate of 1 cancer incidence per 1,000,000 people. For noncarcinogens, this value corresponds to a Hazard Index of one.

When evaluating additive risks for carcinogens, the excess cancer risk is determined by summing the individual risks posed by a contaminant, regardless of the type of cancer caused by the contaminant. For noncarcinogenic additive risks, only chemicals that affect the same target organ are summed.

When reviewing the information in Tables 6-1 the reader will notice that lead is not listed in the "summary of toxic endpoints for chemicals of potential concern."

TABLE 6-1(a)

SUMMARY OF TOXIC HUMAN ENDPOINTS FOR CHEMICALS OF POTENTIAL CONCERN

Chemical (e)	Endpoint (a)	
	Carcinogenic (b)	Noncarcinogenic (c)
Arsenic	Skin cancer; lung cancer	Skin keratosis and hyperpigmentation
Beryllium	Cancer; lung cancer	NOAEL (d) (organ enlargement, cyanosis, skin lesions)
Cadmium	Respiratory tract cancer	Renal toxicity
Chromium (VI)	Lung cancer	NOAEL (d) (liver and kidney toxicity)
Copper	NA	Gastrointestinal irritation
Fluoride	NA	Dental fluorosis
Managanese	NA	CNS effects; reproductive effects (for subchronic exposure)
Mercury	NA	Kidney effects
Nickel	Lung and nasal cancer	Decreased body weight
Silver	NA	Skin and mucous membrane argyria
Zinc	NA	Anemia and reduced blood copper

(a) Endpoint upon which the toxicity criterion is based.

(b) When calculating additive risks for potential carcinogens, the individual cancer risk for each chemical, regardless of the type of cancer associated with each chemical, are summed.

(c) When calculating additive risks for noncarcinogens, the individual CDI:Rfd ratios are summed only for chemicals with the same endpoint (target organ). Therefore, for this assessment, CDI:Rfd ratios for arsenic, silver, and beryllium are summed, as are those for cadmium, chromium, and mercury. The individual CDI:RfD ratios for copper, fluoride, manganese, nickel, and zinc are not summed with any other chemical.

(d) Toxicity criterion based on a no-observed-adverse effect level. Toxic endpoints reported in the literature are listed in parentheses.

NA = Not applicable. Cancer slope factor not developed for this

TABLE 6-1(b)

SUBCHRONIC REFERENCE DOSES FOR CHEMICALS OF POTENTIAL CONCERN

Chemical	Subchronic Reference Dose (RfD) (a) (mg/kg-day)	Safety Factor (b)	Source (c)
Aluminum	--	--	--
Arsenic	1E-03	1	HEAST
Beryllium	5E-03	100	HEAST
Cadmium	--	--	--
Chromium (III)	--	--	--
Chromium (VI)	--	--	--
Copper	4E-02 (d)	--	HEAST
Fluoride	--	--	--
Iron	--	--	--
Lead	--	--	--
Manganese	5E-01	100	HEAST
Mercury			
inorganic & mercurial	3E-04	1,000	HEAST
inorganic & alkyl	3E-04	10	HEAST
organic (methyl)	3E-04	10	HEAST
Nickel	--	--	--
Silver	--	--	--
Zinc	2E-01	10	HEAST

(a) Oral subchronic RfD.

(b) Safety factors used to develop reference doses are the products of uncertainty and modifying factors. Uncertainty factors consist of multiples of 10, with each factor representing a specific area of uncertainty in the data available. The standard uncertainty factors include:

- a 10-fold factor to account for the variation in sensitivity among the members of the human population;
- a 10-fold factor to account for the uncertainty in extrapolating animal data to the case of humans;
- a 10-fold factor to account for the uncertainty in extrapolating from less-than-chronic NOAELs to chronic NOAELs; and
- a 10-fold factor to account for the uncertainty in extrapolating from LOAELs to NOAELs.

Modifying factors are applied at the discretion of the EPA reviewer to cover other uncertainties in the data.

(c) HEAST = Health Effects Assessment Summary Tables (6/1/89).

(d) Based on a drinking water standard of 1.3 mg/l; assuming a 70-kg person ingests 2 liters of water per day, 1.3 mg/l = 0.04 mg/kg/day. The Drinking Water Criteria Document for Copper concluded that toxicity data were inadequate for calculation of an RfD for copper.

-- = Subchronic RfD has not been developed for this chemical. In the absence of a subchronic RfD, the chronic RfD will be used to assess subchronic exposures.

TABLE 6-1(c)

CHRONIC HEALTH EFFECTS CRITERIA FOR CHEMICALS OF POTENTIAL CONCERN

Chemical	Reference Dose (RfD) (a) (mg/kg-day)	Safety Factor (b)	Source (c)	Slope Factor (d) (mg/kg-day)-1	Source (c)	Weight of Evidence (e)
Aluminum	--	--	--	--	--	D
Arsenic	0.001 (f)	1	HEAST	1.75	(g)	A
				[50] (h)	[IRIS]	[A]
Beryllium	0.005	100	HEAST	4.3	IRIS	B2
				[8.4] (h)	[IRIS]	[B2]
Cadmium	0.001 (food,i)	10	IRIS	[6.1] (h)	[IRIS]	[B1]
	0.0005 (water)					
Chromium (VI)	0.005	500	IRIS	[41] (h)	[IRIS]	[A]
Copper	0.04 (j)	--	HEAST	--	--	D
Fluoride	0.06 (k)	1	IRIS	--	--	D
Iron	--	--	--	--	--	D
Lead	--	--	--	--	IRIS	B2
Manganese	0.2	100	HEAST	--	--	D
	[0.0003] (l)	[100]	[HEAST]			
Mercury						
inorganic & mercurial	0.0003	1,000	HEAST	--	--	D
inorganic & alkyl	0.0003	10	HEAST	--	--	D
organic (methyl)	0.0003	10	IRIS	--	--	D
Nickel	0.02	300	IRIS	[1.7] (h,m)	[IRIS]	[A]
Silver	0.003	2	IRIS	--	--	D
Zinc	0.2	10	HEAST	--	--	D

(a) Oral reference dose except as noted.

(b) Safety factors used to develop reference doses are the products of uncertainty and modifying factors. Uncertainty factors consist of multiples of 10, with each factor representing a specific area of uncertainty in the data available. The standard uncertainty factors include:

- a 10-fold factor to account for the variation in sensitivity among the members of the human population;
- a 10-fold factor to account for the uncertainty in extrapolating animal data to the case of humans;
- a 10-fold factor to account for the uncertainty in extrapolating from less-than-chronic NOAELs to chronic NOAELs; and
- a 10-fold factor to account for the uncertainty in extrapolating from LOAELs to NOAELs.

Modifying factors are applied at the discretion of the EPA reviewer to cover other uncertainties in the data.

(c) IRIS = the chemical files of EPA's Integrated Risk Information System (as of 3/1/90); and HEAST = Health Effects Assessment Summary Tables (6/1/89).

(d) Oral slope factor except as noted.

(e) EPA weight of evidence classification scheme for carcinogens:

A = Human Carcinogen, sufficient evidence from human epidemiological studies;
B1 = Probable Human Carcinogen, limited evidence from epidemiological studies and adequate evidence from animal studies;
B2 = Probable Human Carcinogen, inadequate evidence from epidemiological studies and adequate evidence from animal studies; and
C = Possible Human Carcinogen, limited evidence in animals in the absence of human data.
D = Not classified.

(f) Under review by the RfD workgroup.

(g) Region VIII guidance. Personal conversation with Jim Lavelle, EPA Region VIII toxicologist (August 28, 1990).

(h) Inhalation slope factor.

(i) The cadmium RfD for food was derived assuming absorption from food is one-half that in water. Assuming that cadmium absorption from other non-aqueous material (i.e., soil) would be more similar to food than to water, the Rfd for food is used to evaluate potential exposure to cadmium in soils.

(j) Current drinking water standard of 1.3 mg/l; assuming a 70-kg person ingests 2 liters of water per day, 1.3 mg/l = 0.04 mg/kg/day. The Drinking Water Criteria Document for Copper concluded that toxicity data were inadequate for calculation of an RfD for copper.

(k) Value is for soluble fluoride.

(l) Inhalation reference dose.

(m) Value is for nickel sulfide.

-- = Criterion has not been developed for this chemical.

Lead was evaluated separately from the other contaminants of concern because of the increasing concern over its effects at low concentrations. Lead is a carcinogen at high concentrations, but of greater concern is the effect that lead has on the central nervous system at lower concentrations. Lead has been shown to cause learning disabilities and brain damage in humans. When lead is ingested or inhaled it eventually makes its way into the blood stream. Most scientists believe that small amounts of lead in the blood can cause effects in humans, and to prevent significant negative effects, exposure to lead should be reduced to the point where lead levels in the blood do not exceed 10 - 15 micrograms/deciliter.

A pharmacological model has been developed by researchers which predicts blood lead levels in humans based on various exposure patterns. This model is known as the Integrated Uptake/Biokinetic (IU/BK) Model. The IU/BK model was used at the Site, along with EPA guidance (Office of Solid Waste and Emergency Response Directive 9355.4-02, which recommends that lead concentrations in soil be cleaned up to 500 - 1000 milligrams/kilogram), to develop an action level for lead in mine waste piles. The action level of 500 milligrams/kilogram of lead was selected because, based on data collected at the Site, this concentration would ensure that approximately 95 percent of all people exposed under the maximum reasonable exposure scenario would maintain blood lead levels below 12.5 micrograms/deciliter. The 500 milligram/kilogram action level for lead is also consistent with the range specified by EPA guidance.

6.1 HUMAN HEALTH RISKS

6.1.1 Surface Water

Surface water at the Site is not expected to present a risk to human health from ingestion or recreational use based on the exposure scenarios evaluated in the risk assessment.
Table 6-2 (a) shows the comparison between risk-based target concentrations and the concentration of the contaminants at the municipal water diversion points. Table 6-2 (b) shows a comparison between risk-based target concentrations, based on ingestion of surface water while swimming, and the concentration of contaminants at several location within the Site. Ingestion of water from mine drainage tunnels and, in some cases, water in their immediate proximity could pose a risk to human health. However, this exposure scenario was not evaluated in detail because it is not considered to be a reasonable exposure scenario.

TABLE 6-2 (a)

COMPARISON OF RISK-BASED SURFACE WATER TARGET CONCENTRATIONS TO MAXIMUM SURFACE WATER CONCENTRATIONS AT MUNICIPAL DRINKING WATER DIVERSION POINTS: INGESTION OF DRINKING WATER

(Concentrations reported in ug/l)

Chemical (f)	Risk-Based Target Concentration (a)	Idaho Springs(b)	Black Hawk(c)	Georgetown(d)	Empire(e)
Cadmium	18	ND	0.5	0.5	ND
Copper	1,400	5	12	4	ND
Fluoride	2,100	300	ND	300	ND
Manganese	7,000	11	135	22	7
Zinc	7,000	5	177	81	24

(a) Based on noncarcinogenic effects.
(b) Sample SW-08
(c) Sample SW-48
(d) Sample SW-25
(e) Sample SW-32
(f) Only detected chemicals are evaluated for the contaminants of concern; aluminum and iron are not evaluated because health effects criteria are not available.

ND = Not detected.

TABLE 6-2 (b)

COMPARISON OF RISK-BASED SURFACE WATER TARGET CONCENTRATIONS TO MAXIMUM SURFACE WATER CONCENTRATIONS: INGESTION OF SURFACE WATER WHILE SWIMMING

(Concentrations reported in ug/l)

Chemical(c)	Risk-Based Target Concentrations(a)	CC1	CC2	CC3	CC4	South Fork Clear Creek	WF1	WF2	NF1	ChC1	FR1
Arsenic	9,100 37 (b)	ND	ND	ND	ND	ND	ND	ND	3	ND	ND
Cadmium	4,600	1	ND	0.9	1.2	0.5	3.7	0.2	19	ND	ND
Chromium	46,000	ND	ND	ND	ND	ND	ND	ND	59	ND	ND
Copper	370,000	30	42	3.2	5	4	7	ND	203	5	ND
Fluoride	550,000	600	630	900	400	300	4,800	500	300	300	ND
Manganese	1,800,000	714	895	1,040	18	22	10,000	114	4,580	11	30
Nickel	180,000	42	50	ND	30	ND	ND	ND	87	ND	27
Zinc	1,800,000	364	760	215	408	81	998	27	2,220	5	356

(a) Except as noted, all target concentrations derived based on noncarcinogenic effects.
(b) Target concentrations derived based on carcinogenic effects.
(c) Only detected chemicals are evaluated for the contaminants of concern; aluminum and iron are not evaluated because no health effects criteria are available.

ND = Not detected.
Refer to Clear Creek Phase II Remedial Investigation for sample station locations.
Risk based target concentrations for carcinogens are equal to an excess cancer incidence of 1 person per 1,000,000 people.

The assumptions for the surface water human health risk assessment were:

Ingestion - Surface water is ingested from the current municipal diversions; residents are assumed to ingest 2 liters of water each day for 30 years, and are assumed to weigh 70 kilograms; for carcinogens (arsenic) an absorption factor of 1 was used.

Recreational use - children between the ages of 9 and 18 swim in the creeks at the Site 3 times/week during the 12-week period from June through August (swimming during other periods of the year is unlikely due to low water and air temperature); children swim for 1 hour and ingest 50 milliliters of surface water per hour; children are assumed to weigh 45 kilograms.

6.1.2 Ground Water

As previously mentioned, a total of 33 wells were sampled at the Site (14 drinking water wells and 19 monitoring wells which were located in or near tailings/waste rock piles). The results of the sampling are presented in Tables 6-3 and 6-4, and the major findings are summarized below.

The results of the domestic well sampling program indicate that only one drinking water well (located in the Virginia Canyon area) exceeded primary drinking water standards (cadmium exceeded) and health based criteria (manganese exceeded). This well is not currently being used for drinking water. In four drinking water wells (located along the mainstem of Clear Creek), arsenic was below the primary drinking water standard, but was present in concentrations that present a potential excess risk of cancer ranging from 2 cancer incidences per 10,000 people to 7 cancer incidences per 100,000 people. Ten of the drinking water wells exceeded secondary drinking water standards for one or more contaminant. Secondary drinking water standards are not based on potential risks to human health. Secondary drinking water standards set limits for contaminants which affect the color, taste or odor of the water. However, secondary contaminants have been found at the Site at levels exceeding health-based criteria.

The results of the ground water samples taken from the 19 monitoring wells indicate the following: The three monitoring wells in the Empire area (West Clear Creek drainage) did not have high enough metals concentrations to pose a risk to human health. Along the Clear Creek mainstem, the alluvial ground water in or near tailings and waste rock piles had concentrations of cadmium, copper, fluoride, manganese, and zinc that could pose noncarcinogenic risks to human health if used as a drinking water supply.

TABLE 6-3

COMPARISON OF RISK-BASED GROUNDWATER TARGET CONCENTRATIONS TO MAXIMUM GROUNDWATER CONCENTRATIONS IN MONITORING WELLS: DRINKING WATER INGESTION

(Concentrations reported in ug/l)

Chemical (c)	Risk-Based Target Concentration (a)	Clear Creek Drainage	West Clear Creek Drainage	North Fork Clear Creek Drainage
Alluvium				
Arsenic	35	ND	ND	3.5
	0.047 (b)			
Cadmium	18	312	ND	42
Chromium	175	ND	ND	9
Copper	1,400	6,700	ND	690
Fluoride	2,100	2,900	500	2,100
Manganese	7,000	50,000	12	27,800
Nickel	700	688	ND	278
Zinc	7,000	60,100	25	34,300
Bedrock				
Arsenic	35	ND	NS	3
	0.047 (b)			
Cadmium	18	2.2	NS	78
Copper	1,400	4.1	NS	169
Fluoride	2,100	4,600	NS	600
Manganese	7,000	3,520	NS	26,900
Nickel	700	48	NS	208
Zinc	7,000	1,570	NS	23,200

(a) Except as noted, target concentrations derived based on noncarcinogenic effects.
(b) Target concentration derived based on potential carcinogenic effects.
(c) Only detected chemicals are evaluated for the contaminants of concern; aluminum and iron are not evaluated because health effects criteria are not available.

ND = Not detected.
NS = Not sampled.
Risk-based target concentrations for carcinogens are equal to an excess cancer incidence of 1 person per 1,000,000 people.

TABLE 6-4

COMPARISON OF RISK-BASED GROUNDWATER TARGET CONCENTRATIONS TO GROUNDWATER CONCENTRATIONS IN DOMESTIC WELLS: INGESTION

(Concentrations reported in ug/l)

Chemical(c)	Risk-Based Target Concentrations (a)	Clear Creek DW-04	DW-05	DW-06	DW-08	DW-09	DW-10	DW-12
Arsenic	35	ND	2.7	7.5	ND	1.3	ND	1.6
	0.047 (b)							
Cadmium	18	ND	ND	ND	ND	ND	NA	ND
Copper	1,400	5.6	ND	ND	ND	ND	6.6	1.2
Fluoride	2,100	600	500	1,800	700	1,800	700	1,600
Manganese	7,000	ND	3.5	293	118	27	2	1,510
Nickel	700	ND	ND	ND	ND	ND	ND	29
Silver	110	ND	ND	0.2	ND	ND	ND	ND
Zinc	7,000	7	4	14	37	37	77	50

Chemical(c)	Risk-Based Target Concentrations (a)	West Clear Creek DW-01	DW-02	North Clear Creek DW-03	Virginia Canyon DW-07	Spring Gulch DW-13	Fall River DW-11	DW-14
Arsenic	35	ND	ND	ND	ND	ND	ND	ND
	0.047 (b)							
Cadmium	18	5.7	ND	ND	28	ND	ND	ND
Copper	1,400	781	4.6	1.9	2.7	ND	8.5	ND
Fluoride	2,100	1,800	900	300	900	200	200	1,200
Manganese	7,000	6,550	ND	ND	18,500	153	3	240
Nickel	700	68	ND	ND	160	ND	ND	ND
Silver	110	ND	ND	ND	ND	ND	ND	ND
Zinc	7,000	516	15	183	18	18	22	8

(a) Except as noted, target concentrations derived based on noncarcinogenic effects.
(b) Target concentration derived based on carcinogenic effects.
(c) Only detected chemicals are evaluated for the contaminants of concern; aluminum and iron are not evaluated because health effects criteria are not available.

ND = Not detected.
NA = Not analyzed.
Refer to Clear Creek Phase II Remedial Investigation for sample station locations.
Risk-based target concentrations for carcinogens are equal to an excess cancer incidence of 1 person per 1,000,000 people.

In the Black Hawk and Central City area (North Clear Creek drainage), bedrock and alluvial ground water had concentrations of cadmium, manganese, and zinc which could pose noncarcinogenic risks if used as a drinking water supply. Arsenic concentrations in this area had an associated potential excess cancer risk of 9 cancer incidences per 100,000 people for alluvial ground water and 7 cancer incidences per 100,000 people for bedrock ground water.

The assumptions for the ground water human health risk assessment were: residents are assumed to ingest 2 liters of water each day for 30 years, and are assumed to weigh 70 kilograms; for carcinogens (arsenic) an absorption factor of 1 was used.

6.1.3 Mine Tailings and Waste Rock

The potential risk to human health from incidental ingestion of mine waste was evaluated as part of the Phase II risk assessment. Table 6-5 provides a summary of the surface composite data which was collected at the various mine waste piles. A review of the data shows that both arsenic and lead are at concentrations which pose a potential risk to human health. Table 6-6 provides a complete evaluation of human health and environmental risks posed by each mine waste pile. Although this section focuses on human health risks, Table 6-6 is presented here for the sake of convenience, and will also be referenced in the environmental risk assessment section.

The assumptions used for the human health risk assessment for incidental ingestion of mine waste were: children between the ages of 6 and 12 years of age are assumed to play on the mine waste piles 5 days/week during warmer months(July and August) and twice per week during the cooler months (May, June, September, and October) for a total of 72 days/year; children are assumed to ingest 100 milligrams of soil/day; children are assumed to weigh 31 kilograms; an absorption factor of 0.80 was used for arsenic.

6.1.4 Air

The results of the air sampling program conducted in Central City are shown on Table 6-7. Comparing the risk-based target concentrations to the concentrations measured under the average, and maximum plausible exposures indicates that there is a potential risk to human health. The combined excess carcinogenic risk range for inhalation of all contaminants is 4 cancer incidences per 100,000 people and 9 cancer incidences per 100,000 people for the average and maximum exposure scenarios, respectively. The greatest proportion of total inhalation excess cancer risk is attributed to chromium.

TABLE 6-5

COMPARISON OF RISK-BASED TAILINGS TARGET CONCENTRATIONS TO MAXIMUM TAILINGS/WASTE ROCK CONCENTRATIONS AT THE CLEAR CREEK SITE: INGESTION OF TAILINGS/WASTE ROCK

(Concentrations reported in mg/kg)

		Tailings / Waste Rock								Waste Rock		Waste Rock/ Surface Soil
Chemical(c)	Risk-based Target Concentrations (a)	Empire Tailings	McClelland Tunnel	Black Eagle Mill	Boodle Mill	Gregory	Clay County	NCC Dredge Tailings	Golden Gilpin	Little Bear	Boodle Mill	Golden Gilpin
Arsenic	1,600 11 (b)	4	12	630	37	106	132	188	106	236	69	33
Cadmium	1,600	ND	0.8	6	14	6.7	4.9	1.7	12	1	28	4.4
Chromium	7,900	15	14	24	20	16	42	48	20	6	13	83
Copper	63,000	82	58	790	225	623	319	108	386	270	312	172
Manganese	790,000	116	179	1,720	1,380	220	367	662	2,690	139	5,630	1,140
Nickel	31,000	5	9	12	14	9.3	28	24	11	4.4	20	38
Silver	4,700	ND	3	35	4	11	7.7	11	15	29	34	6
Zinc	310,000	36	147	1,740	3,120	411	1,240	200	2,040	375	5,830	929

(a) Except as noted, target concentrations based on noncarcinogenic effects.

(b) Target concentration based on potential carcinogenic effects.

(c) Only detected chemicals are evaluated for the contaminants of concern; aluminum and iron are not evaluated because no health effects criteria are available.

TABLE 6-6

SUMMARY OF RISKS - TAILINGS/WASTE ROCK PILES

			Environmental Risk					Human Health Risk		
Tailings/Waste Rock Pile	Receiving Stream	Volume Estimate (cubic yards)	Sediment Yield Rank*	Rank-Total Suspended Solids Mainstem/ Tributary*	Predicted Storm Return Period When Metals Concentrations Exceed Stream Standards*	Piles Which are Marginally Unstable	Proximity to Stream	Excess Cancer Risk Ingestion*	Average Surficial Lead Concentration mg/kg	Proximity to Population Center
Phase II RI										
Boodle Mill	Gregory Gulch/NCC	126,200	NE	NE	NE		Tailings in close proximity to gulch	5 in 1,000,000	2560WR	Above Central City - approx 0.5 mi from houses (active mine)
NCC Dredge Tailings	North Clear Creek	ND	ND	ND	ND		In stream bed/bank	1 in 100,000	1310	Along Highway 119 approx 400 yds from hotel & restaurant
McClelland Tunnel	Clear Creek	32,200	5	7/7	5.0 yr		In floodplain - boulders on edge of stream	9 in 10,000,000	106	Approx 0.25 miles from Dumont
NCC Tailings	North Clear Creek	60,000	ND	ND	ND	ND	In floodplain	ND	ND	Along Hwy 119 approx 100 yds from hotel & restaurant
Chase Gulch #1	Chase Gulch/NCC	10,000	ND	ND	ND		In floodplain	ND	ND	In Black Hawk
Chase Gulch #2	Chase Gulch/NCC	20,000	ND	ND	ND		In floodplain	ND	ND	In Black Hawk
Urad*	Woods Creek/West Clear Creek	ND	ND	ND			Woods Creek piped through tailings/waste rock	ND	ND	Approx 2 miles from houses
North Empire Creek	Lion Creek/West Clear Creek	ND	ND	ND	ND	ND	In/directly adjacent to stream	ND	ND	Approx 1-2 miles north west of Empire
Lion Creek	Lion Creek/West Clear Creek	ND	ND	ND	ND	ND	In/directly adjacent to stream	ND	ND	Approx 1-2 miles north west of Empire

See continuation of table on the following page for an explanation of abbreviations.

TABLE 6-6 (CONTINUED)

SUMMARY OF RISKS - TAILINGS/WASTE ROCK PILES

			Environmental Risk					Human Health Risk		
Tailings/Waste Rock Pile	Receiving Stream	Volume Estimate (cubic yards)	Sediment Yield Rank[a]	Rank-Total Suspended Solids Mainstem/ Tributary[a]	Predicted Storm Return Period When Metals Concentrations Exceed Stream Standards[b]	Piles Which are Marginally Unstable	Proximity to Stream	Excess Cancer Risk Ingestion[c]	Average Surficial Lead Concentration mg/kg	Proximity to Population Center
Phase II Fill										
Gregory Gulch #1	Gregory Gulch/NCC	43,900	7	4/3	All	X	In floodplain - steep slopes into stream	e	e	In Central City
Gregory Gulch #2	Gregory Gulch/NCC	32,400	6	3/2	All	X	In floodplain - steep slopes into stream	8 in 1,000,000	1260WR	In Central City
Clay City Tailings	Russell Gulch/NCC	106,800TL 175,000WR	1	1/1	All	X	In Lake Gulch - 3.5 miles from NCC	8 in 1,000,000	1670	Approx. 1 mile south Black Hawk
Golden Gilpin	North Clear Creek	73,000	4	2/4	All		In floodplain - wooden crib wall upstream of Black Hawk surface water diversion	8 in 1,000,000	1030TL 613WR	In Black Hawk
Black Eagle Mill	Chicago Creek/Clear Creek	340,600	2	5/5	All		In floodplain - steep slopes into stream	5 in 100,000	2670	Approx. 0.25 miles from houses; working mine fenced off at entrance
Little Bear Creek	Soda Creek/Clear Creek	143,500	3	6/6	All Soda Creek 1.0 yr Clear Crk		On Soda Creek - approx. 2.3 miles from Clear Creek	2 in 100,000	1900WR	Approx. 1.5 miles from houses; (abandoned mine)
Empire Tailings	West Clear Creek	ND	ANI	ANI	ANI		Tailings do not abut stream	3 in 10,000,000	11.5	In Empire - used for bicycle riding

[a] Ranked from highest (1) to lowest (7)

[b] Storm event return periods above this value exceed existing stream standards. "All" indicates that sream standards are exceeded for any storm event which occurs at a frequency of every 18 or more days.

[c] Stated potential excess cancer risk is due to the presence of arsenic in the waste material

[d] Urad tailing and waste rock piles are contempory engineered structures; designed to pass 85% of the maximum probable precipitation event. A stability and erosion analysis was not performed at the site. Based on existing data, risks to surface water from collapse or erosion appear to be remote. However, review of the AMAX Inc. discharge permit indicates underdrains from these waste piles are a source of metals loading to Woods Creek.

[e] Human health risks from: Gregory Gulch #1 are believed to be similar to Gregory Gulch #2 because the waste was generated from the same mill.

ANI = Assumed no impact for reasons stated under "Proximity to Receiving Stream"

NE = Not evaluated in Remedial Investigations (Phase I or Phase II)

ND = No Data Available (see Text for explanation)

TL Tailings

WR Waste Rock

NCC North Clear Creek

RI Remedial Investigation

TABLE 6-7

COMPARISON OF RISK-BASED AIR TARGET CONCENTRATIONS
TO CENTRAL CITY ANNUAL AVERAGE AND MAXIMUM RESPIRABLE
AIR CONCENTRATIONS: DUST INHALATION

(Concentrations reported in ug/m3)

Chemical	Risk-based Target Concentrations (a)	Respirable Concentrations	
		Annual Average	Annual Maximum
Arsenic	0.00011	0.00059	0.0018
Beryllium	0.00065	0.0010	0.0010
Cadmium	0.00089	0.00078	0.0012
Chromium	0.00013	0.0040	0.0079
Nickel	0.0032	0.010	0.019

(a) All target concentrations derived based on potential carcinogenic effects.
Risk-based target concentrations are equal to an excess cancer incidence of 1 person per 1,000,000 people.

The assumptions used for the human health risk assessment for inhalation of dust were: residents are assumed to be exposed to the contaminants in the dust 24 hours/day for 365 days/year for 30 years, and breathe 30 cubic meters of air/day; 30% of the inhaled arsenic is absorbed in the lung; all chromium is in the hexavalent form; residents weigh 70 kilograms.

6.1.5 Ingestion of Fish

The risk associated with ingesting fish caught within the Site was evaluated, and the results are shown in Table 6-8. The results show that mercury and cadmium levels in the fish tissue are well below the risk-based target concentrations. Therefore, ingestion of fish from Clear Creek does not appear to present a risk to human health. It should be noted that cadmium and mercury were specifically evaluated because, with the exception of zinc, these two contaminants accumulate in fish to a greater degree than the other contaminants of concern. Because of zinc's low toxicity to humans, it is unlikely to pose a threat to human health.

The assumptions used for the human health risk assessment for ingestion of fish were: residents eat fish from Clear Creek three times/week during the 20-week main fishing season (May through September) and once per month for the remainder of the year, for a total of 67 meals/year; a total of 0.284 kilograms of fish/meal is eaten; residents eat fish from the Site for 30 years and weigh 70 kilograms.

6.2 ENVIRONMENTAL RISKS

Determining potential risks to environmental organisms is greatly influenced by the affected environmental medium. At the Clear Creek/Central City Site, the surface water medium represents the primary risk to organisms because it presents a direct exposure pathway and has contamination at relatively high concentrations. Since aquatic organisms live their life cycle in water, they are at the greatest potential risk at the Site. The Phase II baseline risk assessment evaluated the potential risk to aquatic macroinvertebrates and to the sensitive fish populations which currently inhabit, or would normally be expected to inhabit, Clear Creek and its tributaries. The fish species which were evaluated include rainbow, cutthroat, brook, and brown trout. In addition, aquatic toxicity testing of surface water using surrogate laboratory aquatic species was conducted as part of the Phase II Remedial Investigation. This testing provided a direct measurement of potential risk to aquatic life.

It should be noted that there has been an effort to establish a greenback trout population in Bard Creek, which is a tributary to Clear Creek.

TABLE 6-8

COMPARISON OF RISK-BASED FISH TISSUE TARGET CONCENTRATIONS
TO MAXIMUM FISH CONCENTRATIONS: INGESTION OF FISH

(Concentrations reported in mg/kg)

Chemical	Risk-Based Target Concentration (a)	CC1	CC2	CC3	CC4
Cadmium	1.3	0.082	0.052	0.064	0.047
Mercury	0.4	0.030	0.025	0.049	0.034

(a) Based on noncarcinogenic effects.
Refer to Clear Creek Phase II Remdial Investigation for sample station locations.

The greenback trout is on the threatened and endangered species list. Remedial actions at the Site are not expected to impair any of the efforts to establish the greenback trout in Bard Creek.

Due to the large amount of data collected at numerous sampling locations, no attempt will be made to present all of the data in this document. Only the major findings of the risk assessment will be provided here. Individuals interested in evaluating all of the location-specific data can find it in Section 1 of the Appendix for the Phase II Remedial Investigation.

6.2.1 Macroinvertebrate Risks

Water Column

Acute effects to macroinvertebrates are expected in the upper portions of North Clear Creek, Gregory Gulch, and Lion Creek. Iron concentrations in the lower section of Clear Creek, upper section of Fall River, upper section of West Clear Creek, Woods Creek, Ute Creek, Four Mile Gulch, Soda Creek, lower North Clear Creek, Gregory Gulch, and Chase Gulch may be lethal to some species of macroinvertebrates. The eight mine tunnel discharges identified in Figure 1-1 are expected to be lethal to many species of macroinvertebrates.

Stream Sediments

An evaluation of potential risks to macroinvertebrates posed by contaminated stream sediment was conducted at the Site. Metal concentrations in sediments were measured at several Site locations. In general the results indicate that both tunnel discharges and tailings and waste rock piles are increasing the metals load in the sediments immediately downstream of the sources. The benthic macroinvertebrate community was sampled and shown to decrease in abundance and diversity downstream of the contamination sources. Results of solid phase sediment toxicity testing indicate that, in some locations, the sediment is chronically toxic to the macroinvertebrate population.

6.2.2 Risk to Other Aquatic Life

Water Column

The remainder of the environmental risk discussion will focus on potential risks to other aquatic life at the Site. The contaminants of concern and their concentration in surface water vary with time and the location in the drainage basin. Acute toxicity testing of water quality showed that conditions are toxic to Ceriodaphnia and fathead minnows during both low and high flow. Although metals concentrations are generally higher during low flow conditions, high flow conditions were sometimes

more acutely toxic to Ceriodaphnia and fathead minnows. This is likely due to factors other than metals concentrations such as pH, hardness, and alkalinity. The eight mine tunnel discharges were tested and shown to be acutely toxic to Ceriodaphnia and fathead minnows.

Additionally, potential risk to aquatic life was evaluated by comparing instream concentrations of the contaminants of concern to values necessary to protect aquatic life - State of Colorado table value standards and literature derived values (State of Colorado table value standards are equally as or more protective than Federal water quality criteria for aquatic life). The results of this comparison indicate that zinc concentrations consistently exceed aquatic life criteria and State of Colorado table value standards at many locations in the basin. In addition, copper, cadmium, and manganese concentrations frequently exceed State of Colorado table value standards, along specific stream segments. A more specific summary showing contaminants, and the locations in the drainage basin where the contaminants exceed State of Colorado table value standards is presented below. Please note that the segments are based on the Colorado stream standards designations.

- Segment 1 - Clear Creek mainstem and tributaries from headwaters to Silverplume: cadmium, copper, zinc, lead.
- Segment 2 - Clear Creek mainstem and tributaries from Silverplume to Argo tunnel: cadmium, copper, zinc, lead, iron, manganese, nickel. Aluminum, fluoride, and pH are also exceeded in the Argo, Big Five, McClelland, and Rockford tunnel discharges.
- Segment 3a - All of South Clear Creek to confluence with Clear Creek: Cadmium standard was exceeded by 0.1 part per billion during high flow only. This exceedance is not considered significant.
- Segment 4 - West Clear Creek to confluence with Woods Creek. No contaminants of concern exceeded aquatic life standards.
- Segment 5 - West Clear Creek mainstem from Woods Creek to confluence with Clear Creek: cadmium, manganese, zinc.
- Segment 6 - Mad Creek tributary to West Clear Creek. No contaminants of concern exceeded aquatic life standards.
- Segment 7 - Woods Creek mainstem: manganese, zinc.
- Segment 8 - Lion Creek mainstem: cadmium, copper, zinc, iron, manganese.
- Segment 9 - Fall River mainstem: manganese, nickel, zinc.
- Segment 10 - Chicago Creek mainstem: No contaminants of concern exceeded. Zinc exceeded in Ute Creek a tributary to Chicago Creek.

- Segment 11 - Clear Creek mainstem from Argo Tunnel to Golden: copper, zinc, lead.
- Segment 12 - Tributaries to the Clear Creek mainstem from Argo to Golden excluding North Clear Creek. No significant tributaries identified, therefore not sampled.
- Segment 13 - North Clear Creek mainstem and tributaries: cadmium, copper, zinc, arsenic, iron, manganese, nickel.

In addition to evaluating direct stream concentrations of contaminants, Revised Soil Loss Equation computer modeling of runoff from mine waste piles was conducted to evaluate the impact that contaminated runoff would have on the receiving stream. The results of this modeling are presented in Section 6.1.3 in Table 6.6. In general, the results indicate that the majority of the mine waste piles cause an exceedance in State stream standards for very low intensity rainfall events. For clarity it should be noted that state table value standards have been adopted on many of the stream segments at the Site. In these cases the state stream standard is also the Colorado state table value standard. However, when this is not the case the State has set site specific numeric standards which, in general, are greater than state table value standards. This fact does not significantly alter the conclusions shown in Table 6.6. Also, as noted in Table 6.6, several of the mine waste piles are marginally unstable, and the collapse of these mine waste piles would likely pose a threat to aquatic life.

In determining potential risks to aquatic life from ground water that is tributary to surface water, two areas were identified as playing an important role. The Argo Tunnel area ground water has a substantial impact on surface water. The precise location of the ground water impact in the Argo Tunnel area is not known, but appears to be largely due to ground water from the Virginia Canyon area. Further delineation of the ground water impact in the vicinity of the Argo Tunnel will take place during Remedial Design for Operable Unit #3.

The second important potential ground water impact on surface water is taking place along North Fork Clear Creek between Gregory Incline and Russell Gulch. The exact location of this ground water impact was not identified during the Phase II Remedial Investigation. Consequently, it is not known whether the impact is confined to a relatively small area or occurring over a large diffuse section of the stream, and it is not completely known how large a role other sources of surficial mine waste may be playing in this area.

Stream Sediments

Arsenic, cadmium, copper, lead, and zinc concentrations were

measured in stream sediments at eight locations at the Site and compared to trout toxicity data. The results indicate that one or more of these contaminants pose a potential chronic risk to trout from exposure to stream sediments in the mainstem of Clear Creek, upper West Clear Creek, upper North Clear Creek, Gregory Gulch, and Fall River. These risks are expected to affect trout reproduction and/or early life stages.

6.3 TUNNEL SURGE EVENTS

In addition to the potential Site risks described above, the Phase I and II Remedial Investigations identified surge events from mine drainage tunnels as a potential risk. A surge event is defined as a sudden, short-term increase in the discharge of acid mine drainage from a tunnel. Surge events are believed to result from tunnel roof falls which form small dams that can retain water within the tunnel. When sufficient water pressure builds up behind these dams, they can collapse causing a short-term increase in the tunnel discharge. The frequency, duration, magnitude, and potential risk resulting from surge events are not well understood and have not been well documented.

7.0 DESCRIPTION OF REMEDIAL ACTION ALTERNATIVES

Remedial action alternatives in the Feasibility Study report were evaluated in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act, as amended by the Superfund Amendments and Reauthorization Act, and the National Contingency Plan. Prior to evaluating remedial action alternatives, several preliminary evaluations occurred. Remedial action objectives were identified on the basis of the Site characterization results. A broad range of response actions and technologies were initially considered and screened based on relative effectiveness, implementability, and cost. These criteria were utilized to reduce the number of technologies being considered to those which show the most promise, and which cover an appropriate range of approaches to remediation. After screening the technologies, remedial action alternatives were then developed out of various combinations of technologies.

A description of remedial technologies which were eliminated from undergoing detailed analysis can be found in the Phase II Feasibility Study. In general, these technologies were eliminated because they were either technically infeasible, or when compared to similar technologies, were less effective, more costly, and/or more difficult to implement.

Prior to describing the remedial action alternatives for the Site, it is important to point out that the development of cleanup alternatives was limited to a selected number of stream segments (see Section 6.2.2 for the list of stream segments at

the Site). The process that was used to select stream segments that require remedial action is discussed below.

As pointed out in Section 6.2.2 there are several stream segments in the Clear Creek basin where Colorado state table value standards have been established as the stream standard. When this is not the case, state numeric standards have been established as the stream standard. These numeric standards are generally greater than Colorado state table value standards. Appendix B provides summary tables which show state stream standards and Colorado state table value standards.

As previously mentioned, Colorado state table value standards are equally or more protective than Federal Water Quality Criteria. Therefore, stream segments which did not exceed Colorado state table value standards were not evaluated because no risk is present. When a stream segment was shown to exceed Colorado state table value standards an evaluation was made to see if the state stream standard was also exceeded. If the state standard was not exceeded and was considered to be protective of the designated uses of the stream, based on site specific considerations such as the geologic and geographic characteristics of the area, then the stream segment was not considered for remediation. Using this criterion it was determined that remedial action was not required for South Clear Creek and Ute Creek (tributary to Segment 10).

For stream segments where water quality exceeded Colorado state table value standards and/or State stream standards, an evaluation of the physical characteristics of the stream and the types and concentration of the contaminants present was performed to see if a substantial threat to the environment exists. An evaluation of the results of the aquatic toxicity testing was also used when this data was available. Using these criteria, it was determined that cleanup alternatives would not need to be developed for Fall River (Segment 9), Browns Creek (tributary to Segment 1), and North Spring Gulch (tributary to Segment 2). This point is discussed in further detail below for each of these streams.

Fall River exceeded state standards for three contaminants. The chronic standards for nickel and manganese were only slightly exceeded, and the acute standard for zinc was exceeded. However, aquatic toxicity testing of samples collected from Fall River showed little to no toxicity. A non-point source cleanup of mine waste was recently completed on Fall River by the Colorado Mined Land Reclamation Division under its abandoned mined land program. It is expected that this effort will reduce the concentration of contaminants in Fall River to levels which will meet stream standards.

Browns Creek is a small tributary to Clear Creek. During low

flow it discharges approximately 0.75 cubic feet per second. The water quality in Browns Creek only exceeded state standards for lead. The lower portion of Browns Creek is very steep as it passes over rock fragments and exposed bedrock. This portion of Browns Creek does not appear capable of supporting aquatic life due to the lack of adequate habitat. For these reasons the water quality in Browns Creek was not judged to be a substantial risk to the environment.

North Spring Gulch is a very small tributary to Clear Creek. During low flow it discharges 0.17 cubic feet per second. The water quality in North Spring Gulch only exceeded state stream standards for zinc. Due to its low discharge and the gradient of the stream channel, North Spring Gulch provides little to no physical habitat for higher forms of aquatic life. For these reasons North Spring Gulch was not judged to be a substantial threat to the environment.

Trail Creek is a small tributary to Clear Creek. During low flow it discharges 0.28 cubic feet per second. Trail Creek was not shown to significantly impact Clear Creek, but state stream standards for cadmium, copper, lead, and zinc were exceeded in Trail Creek itself. A remedial action alternative was not developed for Trail Creek.

Lion Creek is a small tributary to West Clear Creek. During low flow it discharges 0.28 cubic feet per second. State standards for metals have not been set for Lion Creek because it provides very poor physical habitat. Applying State table values standards to Lion Creek is not considered appropriate because of its low discharge and steep gradient. Lion Creek was not shown to significantly impact West Clear Creek, but it does contain concentrations of cadmium, copper, iron, manganese, and zinc which exceed State table value standards. For this reason, a remedial action alternative was developed for Lion Creek. However, due to insufficient data, no remedial action was chosen.

At this time, a definitive decision can not be made regarding the significance of and, if necessary, the appropriate remedial action for, Trail and Lion Creeks. EPA and CDH will continue to evaluate the impact of these streams after implementing this Record of Decision.

A total of six remedial action alternatives were developed and evaluated in detail in the Phase II Feasibility Study. During the development of the Proposed Plan a seventh alternative was developed using various components of the six feasibility study alternatives. The seven alternatives encompass various combinations and levels of cleanup for surface water, ground water, and tailings and waste rock contamination at the Site. In addition, a method for controlling surge events was developed

independent of the seven alternatives. This provided decision makers the ability to add or eliminate the "surge event control" component of a potential cleanup plan to any of the seven alternatives.

Common components of all alternatives, except no action, are: reduction of the metals load from Woods Creek to the levels established in the EPA National Pollutant Discharge Elimination System permits for the Urad and Henderson Mines; engineering and institutional controls at active milling sites; treatment of one or more tunnel discharges; and a method for addressing potential human health risks from ingesting ground water. In addition, each alternative involves contamination remaining on-site. The Comprehensive Environmental Response, Compensation, and Liability Act requires that the Site be evaluated no less than every five years when contamination remains on-site. If indicated by the evaluation, remedial action would be implemented at that time to remove or take additional action to control contamination.

Risk to human health from ingestion of ground water at the Site would be addressed under each alternative, except no action, by providing an alternative water supply (municipal or bottled water or wellhead treatment) where existing drinking water wells exceed primary maximum contaminant levels or health-based criteria for secondary contaminants for the contaminants of concern at the Site. Water well users would be allowed to have their well water sampled for heavy metals at no expense, provided that the sampling request is made within two years of the signing date of the Record of Decision for the Site. In addition, in order to be eligible for well sampling, and if necessary, an alternate drinking water supply, it must be determined that the ground water became contaminated as a result of mining activity. This determination will be performed on an individual basis once the request for sampling has been made. Future wells drilled at the Site would not be eligible for testing or an alternative water supply. EPA and CDH will employ a public education program alerting residents to the potential risks associated with contaminated ground water and will explore a notification program through the State Engineer's Office and Gilpin and Clear Creek Counties. In addition, CDH and EPA will explore a notification program for new residents to the Counties who purchase existing homes.

Although the ground water in the area has not been classified for use, Federal and Colorado primary drinking water standards and Colorado ground water regulations have been identified as relevant and appropriate at the Site because of the present and possible future use of ground water as a drinking water supply. In addition, health-based standards, for contaminants of concern that do not have primary standards, will be used to ensure protection of human health. Treatment of the ground water

throughout the approximately 400 square mile study area is considered technologically impracticable from an engineering standpoint. The extensive natural mineralization of the area and the multiple potential sources of contamination preclude removal of all potential contamination sources and restoration of the aquifers. Furthermore, restoration of fractured bedrock aquifers and multiple alluvial aquifers is considered technically impracticable due to, ineffectiveness of treatment technologies, and the need for multiple treatment units which would not be effective in removing the sources of contamination, respectively. For these reasons, the relevant and appropriate requirements will be waived according to the criteria established in the National Contingency Plan. However, protectiveness of human health will be provided via an alternate drinking water supply which will meet relevant and appropriate requirements and health-based standards.

In the case of arsenic, where the health-based level is lower than the primary drinking water standard the primary drinking standard will still be used. A number of factors are taken into consideration when setting the primary drinking water standard for a contaminant. These factors include determining if the contaminant occurs naturally at elevated concentration, evaluating limitations of treatment technologies, and economics. These factors have been considered by EPA's drinking water program and form the basis for maintaining the drinking water standard for arsenic at its current level.

With regard to compliance with legally applicable or relevant and appropriate requirements most of the alternatives, with the exception of the no action alternative, will need to meet similar requirements. A summary of the legally applicable or relevant and appropriate requirements which are common to each alternative is provided below. A complete list of the legally applicable or relevant and appropriate requirements which will be considered at the Site are also included as Appendix B.

The relevant and appropriate requirements for controlling erosion and contaminant loading to surface waters from mine waste piles are state table value standards, and state stream standards are considered legally applicable, because runoff from these piles could result in an exceedance of these standards. Federal storm water regulations are also considered relevant and appropriate for controlling erosion from mine waste piles.

The Clean Water Act requires technology-based requirements to be applied when setting effluent limitations from treatment units constructed at the Site. Since effluent based guidelines have not been promulgated for releases from Comprehensive Environmental Response, Compensation and Liability Act sites, technology-based treatment requirements are determined on a case-by-case basis using Best Professional Judgement to

determine Best Available Technologies/Best Management Practices. The technology-based effluent limitations will be compared to effluent limitations derived from the in-stream goal of state table value standards. The water-quality based effluent limitations will be calculated based on stream segment, low stream flow, waste load allocations, and background contaminant concentrations. The results of this comparison will be evaluated to determine which of the two limitations are considered the most appropriate based on the conditions at the Site. Additionally, Section 304(l) of the Clean Water Act requires the development of an Individual Control Strategy for significant point sources of contamination. The Individual Control Strategy will consist of a wasteload allocation, total maximum daily load, a "statement of basis" explaining the derivation and criteria used to develop effluent limits, and monitoring and reporting requirements. These requirements of the Clean Water Act are considered relevant and appropriate for the treatment systems for inactive mine discharges.

The Comprehensive Environmental Response, Compensation and Liability Act and National Contingency Plan state a statutory preference for alternative or resource recovery technologies. However, in the case where an innovative technology, such as passive treatment using constructed wetlands, is employed the discharge may not achieve either technology- or water-quality based effluent limitations for certain contaminants. In this situation, in order to assure protectiveness, a goal of achieving no acute toxicity at the "end-of-pipe" will be considered.

Colorado Solid Waste Regulations will be considered relevant and appropriate to all nonhazardous waste presently at the Site, or to any nonhazardous material that is subsequently generated at the Site as a result of treatment. The Colorado and Federal Hazardous Waste Regulations will be legally applicable if treatment unit sludge becomes hazardous by definition. It may be possible to invoke an exclusion from hazardous waste regulations for some of the treatment sludge. If this is the case, then the Colorado and Federal Hazardous Waste Regulations would be considered relevant and appropriate rather than legally applicable. The Colorado Solid Waste Regulations will be considered relevant and appropriate for design considerations for man-made wetlands.

A short description of the remaining components of the seven alternatives, and the surge event control component, are presented below.

Control of Surge Events - would involve rehabilitation of 14 high surge potential tunnels, as identified in the Remedial Investigation report, to a point where a flow control tunnel plug could be installed. These surge control plugs would be

designed to allow a controlled flow of acid mine water through the plug. If large tunnel roof falls were present in the mine tunnels and created dams which pond mine water behind them, and if the ponds became large enough to break through the dams, the surge control plug would allow for a controlled release of the previously impounded water.

The potential legally applicable or relevant and appropriate requirements for control of surge events would be state stream standards and state table value standards because such an event could result in exceedance of these standards. Control of the surge event would ensure that an exceedance would not take place.

Capital Cost -	$ 10,070,000
Annual Operation and Maintenance Cost -	$ 16,200
Total Cost (30 year total present worth) -	$ 10,300,000
Implementation Time - 1.5 years	

Alternative 1 - No Action
The no action alternative provides a baseline for comparing other remedial actions at the Site. The no action alternative assumes that no remedy is implemented to control risk posed by the contaminated media at the Site. This alternative would involve periodic monitoring and evaluation of Site risks.

Capital Cost -	$ 30,000
Annual Operation and Maintenance Cost -	Not Applicable
Total Cost (30 year total present worth) -	$ 80,000
Implementation Time - No remedial action implemented.	

Alternative 2 - This alternative combines engineering and institutional controls and slope stabilization of mine waste piles with passive treatment at eight discharging mine tunnels. Sedimentation ponds would be installed in Lion Creek and Gregory and Lake Gulches. Risk to human health from ground water would be addressed by providing an alternate water supply (where necessary).

Engineering and institutional controls would be implemented to limit human exposure to contaminants at the Site. Engineering and institutional controls at mine waste piles would involve installing fences completely around the perimeter of the piles and invoking use restrictions. For active milling sites, use restrictions would be tied to existing state and/or federal permit and operational requirements.

Engineering and institutional controls would be implemented at all mine waste piles that pose an excess cancer risk greater than 1 cancer incidence per 100,000 people (cancer risk is due to arsenic in the mine waste) and/or that contain more than 500 mg/kg of lead.

Using these criteria, engineering and institutional controls would be implemented at Gregory Gulch #1 and #2, Clay County, Golden Gilpin, Black Eagle, Little Bear, and Boodle Mill. Since there is no chemistry data for the North Clear Creek tailings, and the Chase Gulch #1 and #2 mine waste piles, it was conservatively assumed that metals concentrations would be high enough to require fencing. However, it should be emphasized that prior to any remedial design, this assumption would be verified by sampling.

The North Clear Creek Dredge tailings are located in, and along, a specific section of North Clear Creek. The extent of contamination in this section of North Clear Creek was not clearly defined during the Phase II Remedial Investigation. This area of North Clear Creek will need to be evaluated in further detail in the future.

Slope stabilization of mine waste piles would involve regrading piles (where possible) to increase slope stability and reduce ponding on, and erosion from, the piles. Where pile grading is not possible, barriers such as culverts or retaining walls would be installed. Storm water runon control would be implemented under both options.

Passive treatment systems, utilizing man-made wetlands, would be implemented at the Burleigh, McClelland, Rockford, Big Five, Argo, National, Quartz Hill Tunnels, and Gregory Incline. The passive treatment systems would reduce heavy metals loading to Clear Creek and North Clear Creek.

Passive treatment systems will remove approximately 99.5 % of the zinc, 99.84 % of the copper, and 9.7 % of the manganese from each of the discharges. Approximately 785 cubic yards of metals precipitates will be removed from the discharges per year via aeration/sedimentation prior to treatment by the eight passive treatment units, and 95,290 cubic yards of metals laden-wetland substrate will need to be removed and disposed of approximately every seven years.

Approximately 6,890 cubic yards of sediment from sedimentation ponds would be generated each year.

Capital Cost -	$ 13,292,000
Annual Operation and Maintenance Cost -	$ 240,000
Total Cost (30 year total present worth) -	$ 23,890,000
Implementation Time - 1.5 years	

Alternative 3 - This alternative contains all components of Alternative 2, except it eliminates the sediment ponds in Gregory and Lake Gulches, and adds soil capping where feasible. Soil caps would be implemented to more effectively reduce human health ingestion and inhalation risks and to prevent erosion of

the waste piles by surface water. Specifically, soil caps would be installed at Gregory Gulch #1 and #2, Clay County, Boodle Mill, McClelland tailings, North Clear Creek tailings, and Chase Gulch #1, and a non-soil cap would be installed on the north side of Quartz Hill. Where required, the toe of the mine waste piles will be moved away from surface water drainages and, if necessary, rip-rapped.

Where pile regrading is not feasible due to restrictive topography or at active mills (Golden Gilpin, Black Eagle, Chase Gulch #2, and Little Bear), physical barriers such as retaining walls or culverts would be installed to prevent erosion from entering streams. Under this alternative, McClelland tailings and Boodle Mill tailings would also be relocated away from the stream.

The elimination of the sedimentation pond in Gregory Gulch will reduce the amount of sediment collected to 5,480 cubic yards/year.

Colorado Solid Waste Regulations will be considered relevant and appropriate for the capping of mine waste piles.

Capital Cost -	$ 13,632,000
Annual Operation and Maintenance Cost -	$ 229,000
Total Cost (30 year total present worth) -	$ 24,080,000
Implementation Time - 1.5 years	

Alternative 4 - This alternative contains all components of Alternative 3 with two modifications. First, the Argo Tunnel discharge would be piped to an active treatment plant (rather than passive treatment). Secondly, the combined flow of National Tunnel and Gregory Incline would be treated with an active treatment plant (rather than passive treatment).

The addition of active treatment under this alternative results in slightly higher removal efficiencies for some metals in the mine discharges which will be treated actively. Specifically, active treatment will remove approximately 100 % of the zinc, 99.84 % of the copper and 100 % of the manganese from the mine discharges that are treated actively. Contaminant residuals are expected to be 15 cubic yards/year of metal precipitates, which will be removed from the mine discharges via aeration/sedimentation prior to treatment by the five passive treatment units; 28,880 cubic yards of metal laden wetland substrate will need to be removed every seven years; 3,300 tons/year of lime sludge precipitates will need to be disposed.

Colorado Solid Waste Regulations will be considered relevant and appropriate for the capping of mine waste piles.

Capital Cost -	$ 9,638,000
Annual Operation and Maintenance Cost -	$ 1,547,000
Total Cost (30 year total present worth) -	$ 33,400,000
Implementation Time - 2.5 years	

Alternative 5 - This alternative contains all components of Alternative 3 with one addition: treatment of ground water near the Argo Tunnel in order to reduce its impact on surface water. A pump and treat system would be installed, and the extracted ground water would be passively treated along with the Argo Tunnel discharge.

The addition of passive ground water treatment increases the amount of metal-laden substrate to 128,290 cubic yards per seven years.

Colorado Solid Waste Regulations will be considered relevant and appropriate for the capping of mine waste piles.

Capital Cost -	$ 15,432,000
Annual Operation and Maintenance Cost -	$ 249,000
Total Cost (30 year total present worth) -	$ 28,630,000
Implementation Time - 2.0 years	

Alternative #6 - This alternative involves excavation, transport, and on-site consolidation of the Gregory Gulch #1 and #2, Clay County, Boodle, Little Bear, McClelland, the North side of Quartz Hill, North Clear Creek tailings, and Chase Gulch #1 waste piles; engineering and institutional controls and physical barriers would be constructed at Golden Gilpin, Black Eagle, and Chase Gulch #2. An active treatment plant would be installed to treat the Argo Tunnel discharge and the extracted ground water near the Argo Tunnel. An active treatment plant would be installed to treat the National and Gregory Incline discharges, and passive treatment systems would be installed to treat the other five tunnel discharges.

The addition of active treatment under this alternative results in slightly higher removal efficiencies for some metals in the mine discharges which will be treated actively. Specifically, active treatment will remove approximately 100 % of the zinc, 99.84 % of the copper and 100 % of the manganese from the mine discharges that are treated actively. Contaminant residuals are expected to be 15 cubic yards/year of metal precipitates which will be removed from the mine discharges via aeration/sedimentation prior to treatment by the five passive treatment units; 28,880 cubic yards of metal-laden wetland substrate will need to be removed every seven years; and 4,855 tons/year of lime sludge precipitates will need to be disposed.

Colorado Solid Waste Regulations will be considered relevant and appropriate for the consolidation/capping of mine waste piles.

Capital Cost -	$ 20,294,000
Annual Operation and Maintenance Cost -	$ 1,872,000
Total Cost (30 year total present worth) -	$ 50,820,000
Implementation Time - 7.5 years	

Selected Alternative - The Selected Alternative combines institutional controls and runoff barriers for mine waste piles at active mill sites, and soil capping of the other mine waste piles (see capping description under Alternative 3 for more detail) with passive treatment of the Burleigh Tunnel, and active treatment of the Argo Tunnel discharge including ground water in the area of the Argo Tunnel. A pump and treat system will be installed, and the extracted ground water will be treated along with the Argo Tunnel discharge.

Capping of mine waste piles will not be implemented for a maximum of one year to allow a final opportunity for owners to come forward with a remedy which would be considered equally or more protective, such as remining or reprocessing. It will still be possible for an owner or their agent to remove and reprocess or remine mine waste after a waste pile is capped. However, the action must not exacerbate the contamination and the final reprocessing or treatment residuals must be disposed of at a facility which meets applicable or relevant and appropriate requirements. Additionally, the excess costs associated with removing the cap in order to gain access to the mine waste, and subsequent site restoration will be incurred by the owner or their agent.

No action will be taken at the McClelland and Rockford Tunnels.

The interim action waiver of applicable or relevant and appropriate requirements will be invoked for the Big Five Tunnel discharge.

Limited action will be taken on the discharges from the Quartz Hill and National Tunnels, and the Gregory Incline. This limited action will involve collecting the discharges and piping them to a location below the Black Hawk/Central City waste water treatment plant. Further evaluation of the extent of contamination in North Clear Creek and an evaluation of innovative treatment technologies, which would meet the requirements of the Clean Water Act, would be completed prior to making a final decision on these discharges.

Risk to human health from ground water are addressed by providing an alternative water supply where contaminants of concern in drinking water wells exceed primary drinking water standards or health based standards where there are no primary standards. In the case of lead and copper, if an exceedance of the lead or copper standard is determined to be the result of

the water distribution system, rather than the result of contaminated ground water, then the property will not be considered eligible for an alternate drinking water supply.

No action will be taken to control surge events.

The Selected Alternative assumes that the metals load from Woods Creek will be reduced to the levels specified in the EPA National Pollutant Discharge Elimination System permits for the Urad and Henderson Mines.

A passive treatment system will remove approximately 99.5 % of the zinc, 99.84 % of the copper, and 9.7 % of the manganese from the Burleigh Tunnel discharge. Active treatment will remove approximately 100 % of the zinc, 99.84 % of the copper and 100 % of the manganese from the Argo Tunnel discharge and the extracted ground water in the area of the Argo Tunnel. Contaminant residuals are expected to be 14,085 cubic yards of metal-laden wetland substrate which will need to be removed and disposed of approximately every seven years, and 3,495 tons/year of lime sludge precipitates will need to be disposed.

Colorado Solid Waste Regulations will be considered relevant and appropriate for the capping of mine waste piles.

Capital Cost -	$ 5,560,000
Annual Operation and Maintenance Cost -	$ 1,204,000
Total Cost (30 year total present worth) -	$ 23,510,000
Implementation Time - 1.5 years	

8.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

The Comprehensive Environmental Response, Compensation, and Liability Act and National Contingency Plan require that Remedial Action Alternatives be profiled against nine evaluation criteria. A description of the nine criteria is provided below.

1. **Overall Protection of Human Health and the Environment** addresses whether or not a remedy provides adequate protection and describes how risks posed through each pathway are eliminated or reduced, or controlled through treatment, engineering controls, or institutional controls.

2. **Compliance with Applicable or Relevant and Appropriate Requirements** addresses whether or not a remedy will meet all federal and state environmental laws or regulations and/or provide grounds for a waiver.

3. **Long-term Effectiveness and permanence** refers to the ability of a remedy to provide reliable protection of human health and the environment over time.

4. **Reduction of Toxicity, Mobility, or Volume Through Treatment** refers to the preference for a remedy that reduces health hazards, the movement of contaminants, or the quantity of contaminants at the Site.

5. **Short-term Effectiveness** addresses the period of time needed to complete the remedy, and any adverse effects to human health and the environment that may be caused during the construction and implementation of the remedy.

6. **Implementability** refers to the technical and administrative feasibility of a remedy. This includes the availability of materials and services needed to carry out a remedy. It also includes coordination of Federal, State, and local governments to work together to clean up the Site.

7. **Cost** evaluates the estimated capital, operation, and maintenance costs of each alternative in comparison to other equally protective alternatives.

8. **State Acceptance** indicates whether the State of Colorado agrees with, opposes, or has no comment on the selected alternative.

9. **Community Acceptance** includes determining which components of the alternatives interested persons in the community support, have reservations about, or oppose.

It is important to understand that the National Contingency Plan assigns different levels of importance to the preceding nine evaluation criteria: The first two criteria, overall protection of human health and the environment, and compliance with legally applicable and relevant and appropriate requirements, are considered threshold criteria. This means that in order for a cleanup alternative to be considered for implementation it must, at a minimum, satisfy these two criteria or provide justification for invoking a waiver of the requirement(s). Evaluation criteria three through seven are known as primary balancing criteria, and are used to identify the alternative(s) which provide the best combination of individual criteria. Evaluation criteria eight and nine are known as modifying criteria and are used in conjunction with the primary balancing criteria to identify the preferred cleanup alternative. The modifying criteria are generally determined after public comment, and may be used to modify the preferred cleanup alternative.

The seven cleanup alternatives for the Site were profiled against the nine evaluation criteria, and the results are summarized in Table 8-1. Some of the key differences between the alternatives are discussed in greater detail below.

TABLE 8-1

COMPARISON OF ALTERNATIVES BASED ON NINE EVALUATION CRITERIA

CRITERIA	Selected Alternative Capping With Passive Treatment at Burleigh and Active at Argo Including Ground Water Near Argo	Alternative 1 No Action	Alternative 2 Institutional/Slope Stabilization With Passive Treatment of 8 Mine Discharges	Alternative 3 Capping With Passive Treatment of 8 Mine Discharges	Alternative 4 Capping With Passive Treatment of 5 and Active Treatment of 3 Mine Discharges	Alternative 5 Capping With Passive Treatment of 8 Mine Discharges and Ground Water Near Argo Tunnel	Alternative 6 On-site Consolidation With Passive Treatment of 5 and Active Treatment of 3 Mine Discharges and Ground Water Near Argo Tunnel
1. OVERALL PROTECTIVENESS							
Human Health	Low residual waste pile ingestion and inhalation risk.	Does not provide additional protection of human health and aquatic life.	Moderate residual waste pile ingestion and inhalation risk.	Low residual waste pile ingestion and inhalation risk.	Low residual waste pile ingestion and inhalation risk.	Low residual waste pile ingestion and inhalation risk.	Lowest residual waste pile ingestion and inhalation risk.
Environment	High reduction in sediment loading; moderate reduction in metals loading to surface waters.		Low reduction in sediment loading; moderate reduction in metals loading to surface waters.	High reduction in sediment loading; moderate reduction in metals loading to surface waters.	High reduction in sediment loading; high reduction in metals loading to surface waters.	High reduction in sediment loading; higher reduction in metals loading to surface waters.	High reduction in sediment loading; highest reduction in metals loading to surface waters.
2. COMPLIANCE WITH ARARs (a)	Meets risk based air and soils levels at capped piles.	Does not meet risk based levels for soil or air.	Reduces potential exposure to tailings.	Meets risk based air and soils levels at capped piles.	Same as Alternative 3.	Same as Alternatives 3 and 4.	Same as Alternatives 3, 4 and 5.
	Meets stream standards on Clear Creek. Does not meet table value standards below West Clear Creek.	Does not meet state stream or table value standards.	Meets stream standards on Clear Creek, except for ~ 5 miles near Argo Tunnel; does not meet table value standards below West Clear Creek.	Same as Alternative 2 and prevents runoff from capped piles from impacting streams.	Same as Alternative 3, except for additional manganese removal.	Same as Alternatives 3 and 4, except ground water treatment at Argo Tunnel area allows stream standards to be met; does not meet table value standards below West Clear Creek. Manganese removal is less than Alternative 4.	Same as Alternative 5, except greater manganese removal.
Criteria to be Considered - Colorado Division of Wildlife Species Specific Toxicity Data	CLEAR CREEK Brown trout protected throughout. Brook trout protected throughout. Rainbow trout protected to West Clear Creek.	Brown trout protected from Burleigh to Argo Tunnel. Brook trout protected everywhere except Argo area. Rainbow trout not protected below Burleigh.	Brown trout protected except for Argo area and marginally protected below Argo. Brook trout protected except ~ 5 miles below Argo. Rainbow trout protected to West Clear Creek.	Same as Alternative 2.	Same as Alternatives 2 and 3.	Brown trout protected throughout. Brook trout protected throughout. Rainbow trout protected to West Clear Creek.	Same as Alternative 5.

ARARs - legally applicable or relevant and appropriate requirements

(a) No alternatives are capable of reducing metals concentrations on North Clear Creek to levels which meet stream or aquatic life standards. No alternatives are designed to treat ground water from drinking water wells. All alternatives, except no action, provide alternate water supplies where required. West Clear Creek meets stream and aquatic life standards if discharges to Woods Creek are treated to the EPA discharge permit limitations.

TABLE 8-1 (CONTINUED)

COMPARISON OF ALTERNATIVES BASED ON NINE EVALUATION CRITERIA

CRITERIA	Selected Alternative Capping With Passive Treatment at Burleigh and Active at Argo Including Ground Water Near Argo	Alternative 1 No Action	Alternative 2 Institutional/Slope Stabilization With Passive Treatment of 8 Mine Discharges	Alternative 3 Capping With Passive Treatment of 8 Mine Discharges	Alternative 4 Capping With Passive Treatment of 5 and Active Treatment of 3 Mine Discharges	Alternative 5 Capping With Passive Treatment of 8 Mine Discharges and Ground Water Near Argo Tunnel	Alternative 6 On-site Consolidation With Passive Treatment of 5 and Active Treatment of 3 Mine Discharges and Ground Water Near Argo Tunnel
2. Continued - Criteria to be Considered	NORTH CLEAR CREEK ——— No species protected under any alternative ——— WEST CLEAR CREEK						
	see comment under alternatives 2-6	No species protected for ~ 4 miles below Woods Creek; then Brook trout protected to Clear Creek confluence.	Providing that discharges to Woods Creek are treated to the EPA discharge permit limitations, all trout species would be protected.				
3. LONG-TERM EFFECTIVE-NESS AND PERMAN-ENCE (b)	Moderate reliability of risk reduction provided by capping waste piles. Moderate reliability of passive treatment systems as they are a relatively new technology. High reliability of active treatment systems. Moderate reliability of ground water active treatment.	Does not reduce or manage human health or environmental risks.	Risk reduction controls of fencing and grading of piles have lower reliability than other alternatives. Moderate reliability of passive treatment systems as they are a relatively new technology.	Moderate reliability of risk reduction provided by capping waste piles. Moderate reliability of passive treatment systems as they are a relatively new technology.	Same as Alternative 3, except higher reliability of active treatment systems.	Same as Alternative 3, with the addition of low to moderate reliability of ground water passive treatment.	Higher reliability of risk reduction from waste piles because they would be consolidated in one place. Active treatment provides higher reliability for environmental risk reduction; passive treatment provides moderate reliability. Moderate reliability of ground water active treatment.
4. REDUCTION IN TOXICITY, MOBILITY AND VOLUME	see comment under alternatives 2-6	No treatment of wastes under this alternative.	All alternatives, except Alternative 2, reduce the mobility of contaminants in the mine waste piles. Alternative 6 (on-site consolidation of waste pile) would reduce mobility of contaminants more than the other alternatives. Passive and active treatment are essentially equal in the amount of contamination treated, except for manganese removal. Passive treatment is reversible if pH changes. Active treatment is irreversible. Alternatives 5 and 6 treat the largest volume of water due to the addition of ground water treatment in the Argo Tunnel area.				
5. SHORT-TERM EFFECTIVE-NESS	Low to moderate risk to the community and environment from dust and sediment loading to streams, respectively, during constuction.	No risk to the community or environment during implementation of this alternative.	Low to moderate risk to the community and environment from dust and sediment loading to stream, respectively, during construction.	Same as Alternative 2.	Same as Alternatives 2 and 3.	Same as Alternatives 2, 3 and 4.	Slightly higher risk to community and environment due to increased construction activity and longer time for completion.
Time until Remedial Action Objectives are Completed	1.5 years	No remedial action objectives implemented.	1.5 years	1.5 years	2.5 years	2.0 years	7.5 years

(b) All alternatives, except no action, provide moderately reliable protection of human health from ingestion of contaminated ground water.

TABLE 8-1 (CONTINUED)

COMPARISON OF ALTERNATIVES BASED ON NINE EVALUATION CRITERIA

CRITERIA	Selected Alternative Capping with Passive Treatment at Burleigh and Active at Argo including Ground Water Near Argo	Alternative 1 No Action	Alternative 2 Institutional/Slope Stabilization With Passive Treatment of 8 Mine Discharges	Alternative 3 Capping With Passive Treatment of 8 Mine Discharges	Alternative 4 Capping With Passive Treatment of 5 and Active Treatment of 3 Mine Discharges	Alternative 5 Capping With Passive Treatment of 8 Mine Discharges and Ground Water Near Argo Tunnel	Alternative 6 On-site Consolidation With Passive Treatment of 5 and Active Treatment of 3 Mine Discharges and Ground Water Near Argo Tunnel
6. IMPLEMENTABILITY	see comment under alternatives 2-6	Easy to implement monitoring requirements.	All alternatives are considered moderately easy to implement. Ground water restrictions and institutional controls will require a moderate degree of coordination between federal, state and local government. The equipment, personnel, technology and land required to implement passive treatment are more difficult to obtain in comparison to active treatment. The addition of ground water treatment under the Preferred Alternative and Alternatives 5 and 6 make these alternatives slightly more difficult to implement.				
7. COST (c)							
Capital	$5,560,000	$30,000*	$13,272,000	$13,632,000	$9,638,000	$15,432,000	$22,218,000
Annual Operation & Maintenance	$1,204,000	-	240,000	229,000	1,547,000	249,000	1,910,000
Total (30 year net present worth)	$23,510,000	$480,000*	$23,890,000	$24,080,000	$33,400,000	$28,630,000	$50,820,000
8. STATE ACCEPTANCE		The State of Colorado concurs with the Selected Alternative.					
9. COMMUNITY ACCEPTANCE		See explanation in text.					

*Includes annual monitoring and inspection, and $40,000 for a Public Health Evaluation every 5 years.

(c) Cost estimates are not included for providing an alternative water supply where necessary. See Section 8.7 for these cost estimates.
The cost estimates for tunnel surge control plugs are not included in the above estimates. See Section 7.0 for a description of these cost estimates.

Please notice in Table 8-1, under criterion number two, there is a heading entitled "criteria to be considered". The information presented under this heading is based on species-specific toxicity differences for aquatic organisms. It is generally agreed that state table value standards are protective of the most sensitive aquatic species, including rainbow trout. However, concentrations of metals in streams which exceed state table value standards may still be protective of other trout species, such as brown and brook trout. Consequently, when state table value standards are not met by a cleanup alternative, there still may be an environmental benefit if the alternative is protective of brook and/or brown trout. Each cleanup alternative was evaluated with this fact in mind.

During the Phase II Remedial Investigation a water quality computer model of the Clear Creek drainage basin was developed (Water Quality Simulation Program, Version 4). This model was developed to project and evaluate the overall effectiveness of each individual alternative. The results of this modeling effort helped form the basis for selecting the Preferred Alternative and are presented in Appendix A.

8.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

As shown in Table 8-1, Alternatives 3,4,5,6, and the Selected Alternative are the most effective in reducing ingestion and inhalation risks posed by mine waste. By providing soil caps at mine waste piles where feasible, the risk to human health is essentially eliminated. Alternative 6 is considered to be the most effective in reducing human health risks because most of the mine waste would be consolidated in one disposal site. However, providing that the individual soil caps on the mine waste piles are properly maintained, and their integrity is not compromised, this difference in effectiveness would be minimal. Where waste piles can not be capped, institutional and engineering controls will be used to reduce risk under each alternative, except no action.

Each alternative, except no action, is equally effective in reducing the risk to human health posed by ingestion of ground water. Risk to human health under all alternatives, except no action, is reduced by providing an alternative drinking water supply where required.

With regard to environmental risks, all alternatives, except no action and Alternative 2, provide a high reduction in sediment loading to surface water. Runoff from the mine waste piles is controlled by capping or physical barriers depending on the specific circumstances at each pile.

All alternatives, except no action, involve various combinations of active and passive treatment of drainage from mine tunnels to

control risks to aquatic life. Active treatment is more effective than passive treatment in removing manganese from the mine discharges. Consequently, more manganese is removed from the Argo, National, and Gregory Incline discharges under Alternatives 4 and 6 than under the other alternatives. More manganese is removed from the Argo discharge under the Selected Alternative than under Alternatives 1,2,3 and 5. The additional manganese removal is important in reducing aquatic life risk posed by manganese only for the Gregory Incline discharge because of its large manganese load. The addition of ground water treatment under Alternatives 5, 6 and the Selected Alternative allows for a reduction in risk to aquatic life in this area of Clear Creek.

Utilizing trout species-specific toxicity data, the Selected Alternative, and Alternatives 5 and 6 provide protection of both brook and brown trout throughout the mainstem of Clear Creek; rainbow trout would be protected in the mainstem of Clear Creek from the headwaters to approximately the confluence with West Clear Creek.

Alternatives 2,3 and 4 provide protection of brook and brown trout on the mainstem of Clear Creek everywhere except for the Argo Tunnel area; rainbow trout would be protected in the mainstem of Clear Creek from the headwaters to approximately the confluence with West Clear Creek.

In West Clear Creek Alternatives 2,3,4,5,6 and the Selected Alternative provide protection of all trout species, provided that the Woods Creek discharge is treated to the level specified in the EPA National Pollutant Discharge Elimination System Permits CO - 0041467 and CO - 0000230 for Climax-Urad and Climax-Henderson, respectively.

Alternative 1 does not provide protection of brown trout below Argo Tunnel, and brook trout are not protected near Argo Tunnel. Rainbow trout are not protected below Burleigh Tunnel. On West Clear Creek, no species of trout are protected for approximately four miles below Woods Creek's confluence with West Clear Creek, then brook trout are protected to the confluence with Clear Creek.

No alternatives are capable of reducing contaminant levels in North Clear Creek to levels which would be protective of any species of trout.

8.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Alternatives 3,4,5,6 and the Selected Alternative meet risk-based air and soils levels for the capped piles. Where pile capping is not feasible, risk from ingestion will be controlled

by engineering controls. The risk from inhalation is not expected to exceed risk-based air levels for the uncapped piles.

In general, the ground water at the Site is not impacted by any large point sources of contamination. The rich mineralization of the Site contributes to a naturally elevated level of the contaminants of concern in the ground water. This phenomenon has been exacerbated by the historic mining and subsequent acceleration in the weathering of mineralized rock. However, it is not possible to accurately determine cause-effect relationships because of complex hydrologic and geochemical processes, and the large number and different types of ground water aquifers at the Site. Consequently, treatment of ground water to Maximum Contaminant Levels, State Ground Water Standards, or health-based standards is considered to be technically impracticable from an engineering standpoint.

Implementation of the Selected Alternative (as well as Alternatives 5 & 6) will result in attainment of Colorado stream standards for the mainstem of Clear Creek. Colorado state table value standards may not be meet on the mainstem of Clear Creek below the West Clear Creek confluence. EPA and CDH will monitor the effectiveness of the Selected Alternative after implementation to determine if state table value standards will be met in this section of Clear Creek. If state table value standards are not met, EPA and CDH will determine whether it is possible to meet state table value standards or will seek to develop a site specific state standard which is protective of the uses of Clear Creek.

Implementation of Alternatives 1-4 will not result in attainment of stream standards in the area of the Argo Tunnel. Zinc standards for North Clear Creek will not be attained through implementation of any of the alternatives (i.e., treatment of the identified point sources). The requirements of the Clean Water Act for the Quartz Hill, Gregory Incline, and National Tunnel will be waived on an interim basis pending further evaluation of contaminant loading to North Clear Creek.

8.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

With regard to mine waste piles, Alternative 6 provides slightly higher reliability of long-term risk reduction because most mine waste piles would be consolidated in one place. Alternatives 3,4,5 and the Selected Alternative provide moderate reliability in reducing risk. Alternative 2 provides a lower degree of reliability of risk reduction because mine waste pile regrading and fencing are less effective than capping in reducing erosion and human exposure. Alternative 1 is least effective because it does not manage or reduce risk.

With regard to treatment of surface water, all alternatives, except no action, require the ongoing operation and maintenance of treatment systems. These treatment systems will remain effective and permanent, as long as they are properly operated and maintained. The use of passive treatment systems for mine drainage is an emerging technology and, therefore, considered less reliable than active treatment. Because the Selected Alternative and Alternatives 4 and 6 involve the use of active treatment at one or more discharges, they would be considered slightly more reliable for treating the mine discharges than the other alternatives.

The treatment of ground water in the Argo Tunnel area is considered moderately reliable in reducing contaminant loading to surface water. Since there is no single direct source of contamination, it is expected that contaminated ground water will continue to be present at the Site for an indefinite period of time. As with surface water treatment, ground water treatment will remain effective and permanent, as long as the treatment system is properly operated and maintained.

Providing an alternative drinking water supply, where required, will be effective in reducing long-term risk to human health. Future ground water users at the Site will be responsible for taking appropriate measures to reduce their risks if required. This component of the ground water remedy, for each alternative, is considered to have a moderate to low reliability in reducing future risks.

8.4 REDUCTION OF TOXICITY, MOBILITY OR VOLUME THROUGH TREATMENT

The no action alternative does not implement any action to reduce the toxicity, mobility or volume of contaminants.

With regard to contaminants in mine waste piles, the Selected Alternative and Alternatives 3-6 reduce the mobility of contaminants in the mine waste piles. Alternative 6 would reduce potential mobility of contaminants in mine waste to the greatest extent because the majority of the waste would be consolidated in one lined disposal cell. Alternative 2 does not reduce the mobility of contaminants in the mine waste piles because the piles are recontoured but not capped.

With regard to mine tunnel discharges the treatment units implemented under the Selected Alternative and Alternatives 2-6 are effective in reducing the toxicity of the mine discharges. The mobility of the contaminants are also reduced since they are removed from a liquid phase and converted to a solid phase. The passive and active treatment systems are essentially equal in the amount of contamination treated, except active treatment removes approximately 50-90 percent more manganese than passive treatment. Therefore, the Selected Alternative and Alternatives

4 and 6 remove more manganese from the discharges than the other alternatives. Passive treatment can be reversible if the pH decreases significantly. Alternatives 2, 3 and 5 rely exclusively on passive treatment of mine discharges. Active treatment is not reversible. Alternatives 5 and 6 treat the largest volumes of water due to the addition of ground water treatment in the area of the Argo Tunnel. Alternatives 2 - 4 treat equal volumes of water. The Selected Alternative does not treat as many tunnel discharges as Alternatives 2 - 4, but the addition of ground water treatment near Argo Tunnel reduces the difference in the total volume of water treated between the Selected Alternative and Alternatives 2 - 4.

8.5 SHORT-TERM EFFECTIVENESS

Because no remedy is implemented under no action, this criteria is not applicable to Alternative 1.

There is low risk to the community and moderate risk to the environment during implementation of all the alternatives. Alternative 6 has a slightly higher risk to the community and environment in comparison to the other alternatives due to the increased construction activity, and longer time for completion associated with excavation, transportation, and consolidation of select mine waste piles.

During all construction activities at the Site engineering controls will be implemented to prevent contamination of surface water and to minimize airborne dust.

8.6 IMPLEMENTABILITY

The no action alternative is considered easy to implement because it only involves monitoring requirements.

The equipment, personnel, and technology requirements for installing passive treatment systems make them more difficult to implement in comparison to active treatment systems. Additionally, passive treatment systems require large areas of flat land. This makes passive treatment more difficult to implement than active treatment. Consequently, alternatives that rely exclusively on passive treatment (Alternatives 2, 3 and 5) are considered more difficult to implement than the Selected Alternative and Alternatives 4 and 6. Alternatives 4 and 6 would be more difficult to implement than the Selected Alternative because they involve construction of five passive systems rather than one passive system.

The addition of ground water treatment under the Selected Alternative and Alternatives 5 and 6 make these alternatives slightly more difficult to implement.

8.7 COST

Cost includes capital construction and operation and maintenance costs.

Cost ranks as follows from lowest to highest:

	Alternative	Total Present Worth
1	No Action	$ 480,000
	Selected Alternative Capping of mine waste piles with passive treatment at Burleigh and active treatment at Argo including ground water	$ 23,510,000
2	Institutional controls/slope stabilization of mine waste piles with passive treatment of 8 mine discharges	$ 23,890,000
3	Capping of mine waste piles with passive treatment of 8 mine discharges	$ 24,080,000
5	Capping of mine waste piles with passive treatment of 8 mine discharges and ground water near Argo Tunnel	$ 28,630,000
4	Capping of mine waste piles with passive treatment of 5 and active treatment of 3 mine discharges	$ 33,400,000
6	On-site consolidation of mine waste piles with passive treatment of 5 and active treatment of 3 mine discharges and ground water near Argo Tunnel	$ 50,820,000

These costs are the estimated thirty year total present worth of the alternatives including direct and indirect capital costs, monitoring costs, and annual operation and maintenance costs. A nine percent annual discount rate was used for calculating total present worth.

As shown in Table 8-1 on page 48, active treatment involves significantly higher annual operation and maintenance costs. Therefore, the Selected Alternative and Alternatives 4 and 6 have significantly higher annual operation and maintenance costs.

The cost for providing an alternate water supply has not been included in the above costs summary. The full extent of the ground water contamination has not been determined at this time, consequently, a precise estimate of cost can not be made. For planning purposes, a very rough estimate of cost was performed

based on the following assumptions: There are 4,367 wells which will need to be sampled. Seven percent of these wells (312 wells) will be eligible for an alternate water supply. There are four people using each of the 312 wells and each person consumes four liters of water every day. The alternate water supply will be bottled water at a average cost of $0.66 per gallon. The costs which result from these assumptions are as follows: Annual cost $ 158,860; total present worth cost (30 year) $ 2,057,075, which includes a one time sampling cost. These cost estimates are considered very conservative and it is anticipated that the actual costs will be much lower than these projections.

8.8 COMMUNITY ACCEPTANCE

Many members of the local community continue to question whether the Site should have been designated a Superfund site. They acknowledge that there is metals contamination at the Site, but do not feel that the problems are severe enough to warrant a Superfund designation. Nevertheless, overall the local communities (Gilpin and Clear Creek Counties) support the Selected Alternative. The communities generally support the idea of taking effective and reliable action on the tunnel discharges that significantly impact surface water. They do not fully support treating discharges that have little to no impact on surface water. The communities support the idea of providing an alternate drinking water supply where necessary and were pleased that a proactive approach is being taken to control this exposure pathway. The communities support capping of mine waste piles and like the idea of allowing two years for property owners to remine/reprocess the mine waste.

Downstream water users support the Selected Alternative, but generally do not feel it goes far enough. They would like to see treatment at all mine discharges. They felt that the remedy focused too narrowly on protection of aquatic life, and should also aim at reducing the total metals load in addition to reducing concentrations.

The general acceptance of the Selected Alternative by the local community was important in the decision to not modify any of the key components of the remedy. The request by downstream water users to treat all mine tunnel discharges, regardless of the effect on instream metals concentrations, and the data which was submitted discussing metals loading to a downstream reservoir (Standley Lake) will be important factors to consider when evaluating the remedial action options for North Clear Creek.

A detailed summary of responses to public comment is provided as Appendix C of this document.

8.9 STATE ACCEPTANCE

State acceptance typically assesses the comments of the State on EPA lead projects. As the lead agency the State has participated fully in the remedy selection process. CDH and EPA jointly agree that the Selected Alternative is the most appropriate remedy for the Site.

9.0 SELECTED CLEANUP ALTERNATIVE

The objectives of the remedial action are to eliminate or reduce the potential for exposure of present and future populations to elevated risk factors based on contaminants which are in excess of applicable or relevant and appropriate requirements, or which pose unacceptable risk using the one in ten thousand to one in a million risk range specified in the National Contingency Plan. An additional objective is to provide protection of aquatic life in the surface waters at the Site.

Specifically, the objectives of the Selected Alternative include:

- preventing incidental ingestion of mine waste posing an excess risk of 1 cancer incidence per 100,000 people or greater, and preventing incidental ingestion of mine waste containing more than 500 milligrams/kilogram of lead;
- reducing the excess cancer risk due to inhalation of dust containing heavy metals;
- preventing ingestion of ground water having contaminant concentrations in excess of Primary Drinking Water Standards, or exceed health-based levels for contaminants which have no Primary Drinking Water Standards for the contaminants of concern at the Site.
- preventing collapse of unstable mine waste piles through slope stabilization.
- reducing erosion from mine waste piles to the point where stream standards are not exceeded by storm water runoff from the mine waste pile.
- reducing contaminant loading from the mine drainage tunnels, for the contaminants of concern at the Site, to levels which will allow state stream standards, and state table value standards (where they have been determined to be relevant and appropriate) to be met.

Section 10.0 of this document, entitled "Statutory Determination", provides a discussion of how the Selected Alternative achieves these objectives. Prior to this discussion, a brief summary of the process that was used to choose the selected cleanup alternative is provided.

In selecting the preferred cleanup alternative for the Site the first step was to eliminate those alternatives which were least effective in protecting human health and the environment, and did not achieve legally applicable or relevant and appropriate requirements. Using this criteria, the following cleanup alternatives were eliminated from further consideration:

Alternative 1 "no action" was eliminated as a Site wide remedy because it does not provide adequate protection of human health and aquatic life, and it does not achieve legally applicable or relevant and appropriate requirements.

Alternative 2 "institutional control and slope stabilization, and passive treatment of the eight mine discharges" was eliminated from further consideration because it would not reduce the ingestion and inhalation risks to human health, and it would not reduce environmental risks posed by erosion of mine waste piles to the same degree as the other alternatives.

Alternative 3 "capping of mine waste piles and passive treatment of the eight tunnel discharges"; and Alternative 4 "capping of mine waste piles, active treatment of the other five tunnel discharges" were eliminated from further consideration because they do not allow Colorado stream standards to be met below Argo Tunnel. In addition, Alternatives 3 and 4 do not protect aquatic life (only one species protected below Argo Tunnel) to the same extent as Alternative 5 and the Selected Alternative.

Alternative 5 "capping of mine waste piles and passive treatment of the eight tunnel discharges including ground water in the Argo Tunnel area" provides a high degree of human health and environmental protection. This alternative meets legally applicable requirements on Clear Creek and is protective of two species of trout below Argo Tunnel. This alternative was eliminated from further consideration because a protective, but more cost effective, alternative was developed.

Alternative 6 "on-site consolidation of mine waste piles; active treatment of the Argo Tunnel and Argo area ground water and National and Gregory Incline, and passive treatment of the other five mine discharges" was eliminated from further consideration for the following reasons: On-site consolidation of the mine waste would take three to five times longer to implement in comparison to the other alternatives, and the cost of consolidation the tailings is at least four times more than the other alternatives.

This additional cost is not justified because significant additional protection of human health and the environment is not provided by this alternative. Also, the short-term risks are greatest under Alternative 6, due to the longer implementation time. If it is shown that some consolidation of waste piles can

be done more cost effectively or more quickly than assumed, then consolidation would be considered for implementation under the Selected Alternative.

The Selected Alternative, as described in Section 7.0, was developed by identifying and retaining the critical components of Alternatives 5 and 6, and eliminating the components which do not provide significant additional protection of human health and the environment. The goal for developing the Selected Alternative was to select a remedy that would provide the same level of protection as Alternatives 5 and 6, but if possible, at a lower cost. With regard to protection of human health, it was determined that all components of Alternatives 5 and 6 were necessary to reduce health risks at the Site. In the case of environmental protection, it was determined that several environmental components of Alternatives 5 and 6 could be eliminated without reducing the effectiveness of the cleanup plan.

Specifically, with the use of computer modeling (see Appendix A), it was shown that the contaminant loading from the McClelland, Rockford and Big Five tunnels do not pose unacceptable risks to aquatic life in the mainstem of Clear Creek, and that these discharges do not impair achievement of the water quality standards in Clear Creek. The modeling results indicate that the contaminant loading from these discharges is small enough that treatment of the discharges does not provide additional protection of aquatic life (based on current metals loading rates in the basin). Therefore, no action will be taken on these three discharges at this time.

As previously mentioned, the interim waiver of applicable or relevant and appropriate requirements will be invoked for the Big Five discharge. The Big Five discharge is currently designated a priority discharge under Section 304(l) of the Clean Water Act. This designation was made because the Big Five was originally identified as a discharge which was impairing the attainment of the water quality standards for Clear Creek. The results of the Phase II/Operable Unit #3 Remedial Investigation and Feasibility Study indicate that the Section 304(l) designation needs to be reevaluated by the EPA and State of Colorado water quality programs. The interim waiver will be utilized to allow time for this reevaluation, and allow time for the development of a wasteload allocation for the Argo Tunnel Individual Control Strategy which may include other nearby point sources such as the Big Five Tunnel. If it is determined that the Big Five discharge can be removed from the Section 304(l) priority list, then no action will be taken on this discharge under the Superfund program.

On North Clear Creek the results of the computer modeling indicate that, based on existing information, treatment of the

Gregory Incline, National and Quartz Hill Tunnel discharges does not reduce contaminant loading to a point where aquatic life would be protected. Consequently, at this time the overall effectiveness of treating these discharges is questionable, and treatment does not attain a level of benefit which is proportional to the cost of treatment. Therefore, treatment of these three discharges will not be implemented under this Record of Decision. The EPA, in conjunction with CDH, will continue to evaluate these three discharges under a new Operable Unit in order to develop a cleanup plan which will meet legally applicable or relevant and appropriate requirements and provide a balance between the cost of treatment and the benefit derived.

The decision to take limited action on the North Clear Creek discharges was made for two reasons. First, piping these discharges away from town would reduce the potential for direct human exposure to the discharges. Second, collecting these discharges would minimize the potential for impacting future land development associated with the legalization of gaming in the Black Hawk/Central City area. An additional benefit of collecting these discharges is that it will allow for a better understanding of the possible sources of non-point metals loadings in the Black Hawk area.

The Selected Alternative selects active versus passive treatment at the Argo area for several reasons. First, due to the large volume of contaminated water in this area the passive treatment option did not provide as high a level of reliability as desired. Second, based on existing information, if a passive treatment system were installed, it would require a very large area of prime land (approximately 7 acres) and may conflict with local land use.

It was determined that no action would be taken to control mine tunnel surge events. Since the frequency, duration, magnitude and effect of these events have not been shown to pose unacceptable risks to human health or the environment, there is not adequate justification at this time to support implementation of surge control plugs at the fourteen high surge potential tunnels. If a surge event were to occur, and if it resulted in exceedance of drinking water standards in Clear Creek, potential downstream water users can be notified to take appropriate action to ensure that the water is not used or, if necessary, is treated to drinking water standards. It should be pointed out that the potential for increased flow from mine tunnels will be considered when designing the treatment units for the Argo and Burleigh discharges under the Selected Alternative.

10.0 STATUTORY DETERMINATIONS

Remedial actions selected at Superfund sites must be protective of human health and the environment. The Comprehensive Environmental Response, Compensation, and Liability Act also requires that the selected remedy for the Site comply with legally applicable or relevant and appropriate requirements established under State and Federal laws, or justify a waiver of the requirement. The selected remedy must be cost effective and utilize permanent treatment technologies or resource recovery technologies to the maximum extent practicable. The Act also contains a preference for remedies which include treatment as a principal element. The following sections discuss how the selected remedy meets these requirements.

The selected remedy meets the statutory requirements of Section 121 of the Comprehensive Environmental Response, Compensation, and Liability Act.

10.1 PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

The selected remedy for the Site protects human health and the environment through the following engineering controls:

- Capping of mine waste piles where feasible, and access restrictions at active mill sites or where capping is not feasible. This will prevent human exposure to mine waste piles which present an excess carcinogenic risk of more than 1 cancer incidence per 100,000 persons (this equates to an arsenic concentration of 130 milligrams/kilogram or greater), and will prevent human exposure to mine waste piles with concentration of lead at 500 milligrams/kilogram or greater. Where capping is not feasible runoff barriers will be provided to reduce the amount of erosion entering surface water from the mine waste pile.

  The carcinogenic risk level at the Site is due to the presence of arsenic in the mine waste piles. The background concentration of arsenic at the Site represents an excess carcinogenic risk of one person in one million. The potential excess carcinogenic risk level of one cancer incidence per 100,000 people was selected to ensure that the concentration of arsenic at this risk level was clearly distinguishable from background concentrations. In addition, the one excess cancer incidence per 100,000 people risk level represents the statutory median risk value that Superfund cleanups should achieve.

  The decision to take remedial action on mine waste piles with concentrations of lead at 500 milligrams/kilogram or greater was made based on <u>both</u> the use of the Integrated Uptake/Biokinetic Model which estimates blood lead levels

in children under various exposure situations, and EPA guidance (Office of Solid Waste and Emergency Response Directive 9355.4-02) which recommends levels of 500 - 1000 milligrams/kilogram (see lead discussion in Section 6.0 for more detail).

- Providing an alternate drinking water supply for water wells when concentrations of the contaminants of concern exceed primary Maximum Contaminant Levels, and when concentrations exceed health-based standards for contaminants with no primary standards, will reduce risks to human health. Water wells drilled more than two years after the signing of this Record of Decision will not be eligible for an alternate drinking water supply. Potential risks to future users of ground water will be controlled through public education. Future ground water users will be informed of the potential for encountering contaminated ground water and the options available to reduce their risks should contaminated ground water be encountered. Future ground water users will be financially responsible for the costs of testing and any remedial action which they may decide is necessary.

- The air quality investigation in the Central City area showed that the potential risk of inhalation of dust containing heavy metals could not be attributed to any individual or group of mine waste piles. Consequently, the amount of risk reduction can not be quantitatively determined. Since the selected cleanup alternative involves capping of mine waste piles where possible, the inhalation risk at each of the capped piles will be eliminated and the overall risk reduced. Furthermore, the reasonable maximum potential excess carcinogenic risk estimate of 9 cancer incidences per 100,000 people for the air exposure pathway is currently within the risk range which should be attained by Superfund cleanups.

The selected remedy for the Site protects human health and the environment through treatment of the following surface water discharges:

- The environmental risks associated with contaminated surface water at the Site will be controlled through treatment of the mine drainage tunnels, and treatment of the contaminated ground water near the Argo Tunnel. Treatment of the Burleigh and Argo Tunnel discharges, and contaminated ground water in the Argo tunnel area, will reduce contaminant loading to surface water to a level which will allow Colorado state stream standards to be met. Also, as discussed in the comparative analysis section, the treatment of these sources of contamination will allow for additional protection of brown, brook and rainbow trout.

The reduction of contaminant loading from Woods Creek will be achieved under active National Pollutant Discharge Elimination System discharge permits. This reduction in contaminant loading is expected to provide protection of brook, brown and rainbow trout in West Clear Creek.

The Selected Alternative may not achieve Colorado state table value standards on Clear Creek below the West Clear Creek confluence. EPA and CDH will monitor the effectiveness of the remedy after it is implemented to determine if state table value standards are achieved. If they are not achieved, an evaluation will be made to determine if additional cleanup is required, or, it may be determined that a site-specific state stream standard can be established which is protective of the uses of Clear Creek.

The reduction in point source contaminant loading and the reduction in erosion from mine waste piles will reduce the amount of contaminated sediment in the surface waters at the Site. Because the risks to aquatic life from this exposure pathway are relatively small, it is anticipated that the Selected Alternative will effectively reduce this risk.

Potential environmental risks posed by the Gregory Incline, National, and Quartz Hill Tunnels will not be completely addressed under this Record of Decision. The interim remedy wavier of legally applicable or relevant and appropriate requirements will be used to defer a final decision on these discharges. The interim remedy waiver will also be used for the Big Five Tunnel discharge. These points are discussed in detail in Section 10.2.

During implementation of the selected remedy appropriate engineering controls will be used to control dust generation, sediment loading to surface water, and other risks which will be present during implementation of the selected remedy. Therefore, no unacceptable short-term risks will result from implementation of the selected remedy.

10.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The selected remedy will attain legally applicable or relevant and appropriate requirements (ARARs) for the exposure pathways which are addressed by the selected remedy.

The limited action of collecting the Gregory Incline, National, and Quartz Hill Tunnels is not considered the final action for these discharges. This limited action is considered to be an interim measure and will become part of a total remedial action

which will attain legally applicable or relevant and appropriate requirements. The interim waiver of requirements is being used because, based on existing information, the treatment of these three discharges does not reduce contaminant loading to a point where aquatic life would be protected. Consequently, at this time the overall effectiveness of treating these discharges is questionable, and treatment does not attain a level of benefit which is proportional to the cost. EPA, in conjunction with CDH, will continue to evaluate these three discharges under a new Operable Unit in order to develop a cleanup plan which will met legally applicable or relevant and appropriate requirements and provide a balance between the cost of treatment and the benefit derived. A Record of Decision for the new Operable Unit is expected within three years from the signing of this Record of Decision.

The interim remedy waiver will be used for the Big Five Tunnel discharge to allow time for a reevaluation of its designation as a priority discharge under Section 304(l) of the Clean Water Act. If it is determined that the Big Five discharge can be removed from the Section 304(l) list, then no action will be taken under the Superfund program.

The following summarizes the primary legally applicable or relevant and appropriate requirements for the Site, and how the selected remedy will attain the requirements. Appendix B identifies the legally applicable or relevant and appropriate requirements for the Site in detail.

10.2.1 Contaminant-Specific Requirements

The Safe Drinking Water Act, 40 CFR Part 141, Colorado Primary Drinking Water Regulations, 5 CCR 1003-1, are considered relevant and appropriate for ground water at the Site. The Act and Regulations establish Maximum Contaminant Levels for some of the contaminants of concern at the Site. The selected remedy does not seek to restore ground water at the Site to Maximum Contaminant Levels because it is not technically feasible to control the sources of heavy metals contamination at the Site, and it is technologically impracticable from an engineering standpoint to treat fractured bedrock aquifers and the numerous discrete alluvial aquifers within the 400 square mile study area. The selected remedy will attain these requirements by providing an alternative drinking water supply which meets Maximum Contaminant Levels, where required.

The Federal Solid Waste Disposal Act, Subtitle C, sets requirements for identification of hazardous wastes and is considered relevant and appropriate for the mine waste at the Site if the waste is determined to be characteristic for metals. The Act would be considered legally applicable for any new non-exempt hazardous waste which may be generated at the Site. The

selected remedy will attain these requirements if hazardous waste is generated or encountered.

Contaminant specific ARARs for surface water at the Site include the Federal Clean Water Act, the Colorado Water Quality Control Act, Colorado Basic Standards and Methodologies for Surface Water, Colorado Classifications and Numeric Standards, South Platte River Basin, et al. The sections of these ARARs that define effluent limitations are considered legally applicable. The use of Colorado state table value standards to establish levels of cleanup/effluent limitations are considered relevant and appropriate. The selected remedy will attain legally applicable requirements instream and will attain relevant and appropriate requirements at the point of discharge from treatment units, based on the instream dilution.

10.2.2 Location-Specific Requirements

The Federal Endangered Species Act and Colorado Wildlife Nongame, Endangered, and Threatened Species Act are considered legally applicable and, in part, set requirements for the protection of greenback trout, golden eagles, and migratory birds. The selected remedy will comply with these ARARs.

The Federal Executive Order for Protection of Wetlands, Executive Order on Flood Plain Management, Fish and Wildlife Coordination Act,and Section 404 of the Clean Water Act establish requirements and restrictions when altering waters of the United States and riparian and wetland areas. These requirements are legally applicable ARARs at the Site, and the selected remedy will comply with these requirements.

Federal and State historical and archaeological acts require protection of historical resources and places and are considered legally applicable at the Site. The selected remedy will comply with these requirements to the extent possible. Documentation of historical resources will be performed, as necessary, at mine waste piles which will be altered by capping and/or slope stabilization.

10.2.3 Action-Specific Requirements

Federal and State solid waste acts and regulations establish technical requirements for capping of mine waste piles and construction of solid waste impoundments. These requirements are considered relevant and appropriate at the Site and will be attained by the selected remedy.

Federal storm water regulations establish requirements for controlling storm runoff. These requirements are considered relevant and appropriate for controlling runoff from mine waste piles and will be attained by the selected remedy.

Federal and State hazardous waste acts and regulations will be attained for any hazardous waste which may be generated as the result of treatment of the mine discharges. This waste would be disposed of in a Subtitle C (hazardous waste) landfill or treated to render the waste "non-characteristic" and then disposed in a Subtitle D (solid waste) landfill.

State air quality regulations to control fugitive dust during remedial action are considered applicable at the Site, and the selected remedy will employ engineering controls to attain this requirement.

10.2.4 "To Be Considered" Requirements

The Colorado Division of Wildlife has established species-specific toxicity data for rainbow, brown and brook trout. This data has been used to evaluate the effectiveness of each of the remedial action alternatives. The selected alternative was, in part, chosen because it provides the highest level of protection of trout when compared to the other alternatives developed for the Site.

10.3 COST EFFECTIVENESS

The selected remedy is cost effective in mitigating the risks posed to human health from contaminated ground water and mine waste piles at the Site. The selected remedy is also cost effective in mitigating the risk to aquatic life from discharging mine tunnels. As discussed in detail in Section 9.0, the selected remedy was developed by retaining the most effective components of each alternative developed for the Site, and eliminating those components which provided little to no additional human health or environmental benefit. The cost of the selected remedy is lower than all other alternatives, except no action, and provides the same level of ARARs compliance and protection of human health and the environment.

10.4 UTILIZATION OF PERMANENT SOLUTIONS AND ALTERNATIVE TREATMENT TECHNOLOGIES TO THE MAXIMUM EXTENT PRACTICABLE AND PREFERENCE FOR TREATMENT AS A PRINCIPAL ELEMENT

The selected remedy represents the maximum extent to which permanent solutions and treatment technologies can be utilized in a cost effective manner at the Site. The selected remedy utilizes both conventional (active) and innovative (passive) technologies for treatment of mine discharges, and satisfies the statutory preference for treatment at Superfund sites. It is acknowledged that active treatment is more costly than passive treatment. However, as mentioned earlier in this document, the long-term effectiveness and reliability of active treatment and greater ease of implementation, provided the best balance of the nine evaluation criteria when considering the large volume of

contamination (flow) which will be treated in the area of the Argo Tunnel.

Recontouring of mine waste piles alone is not considered to be effective in reducing human health and environmental risks due to exposure of generally higher metals concentrations at depth in the mine waste piles. Consequently, recontouring and capping is the selected remedy where capping is technically feasible. On-site consolidation of the mine waste piles is considered to be slightly more effective in mitigating human health and environmental impacts than recontouring and capping. However, due to longer implementation time and the fact that it costs at least four times more than the other alternative, capping in place is considered to provide the best combination of balancing factors. Monitoring and institutional controls will be implemented at the capped mine waste piles to maintain a high degree of effectiveness, which will serve to minimize the difference in overall effectiveness between on-site consolidation and capping in place.

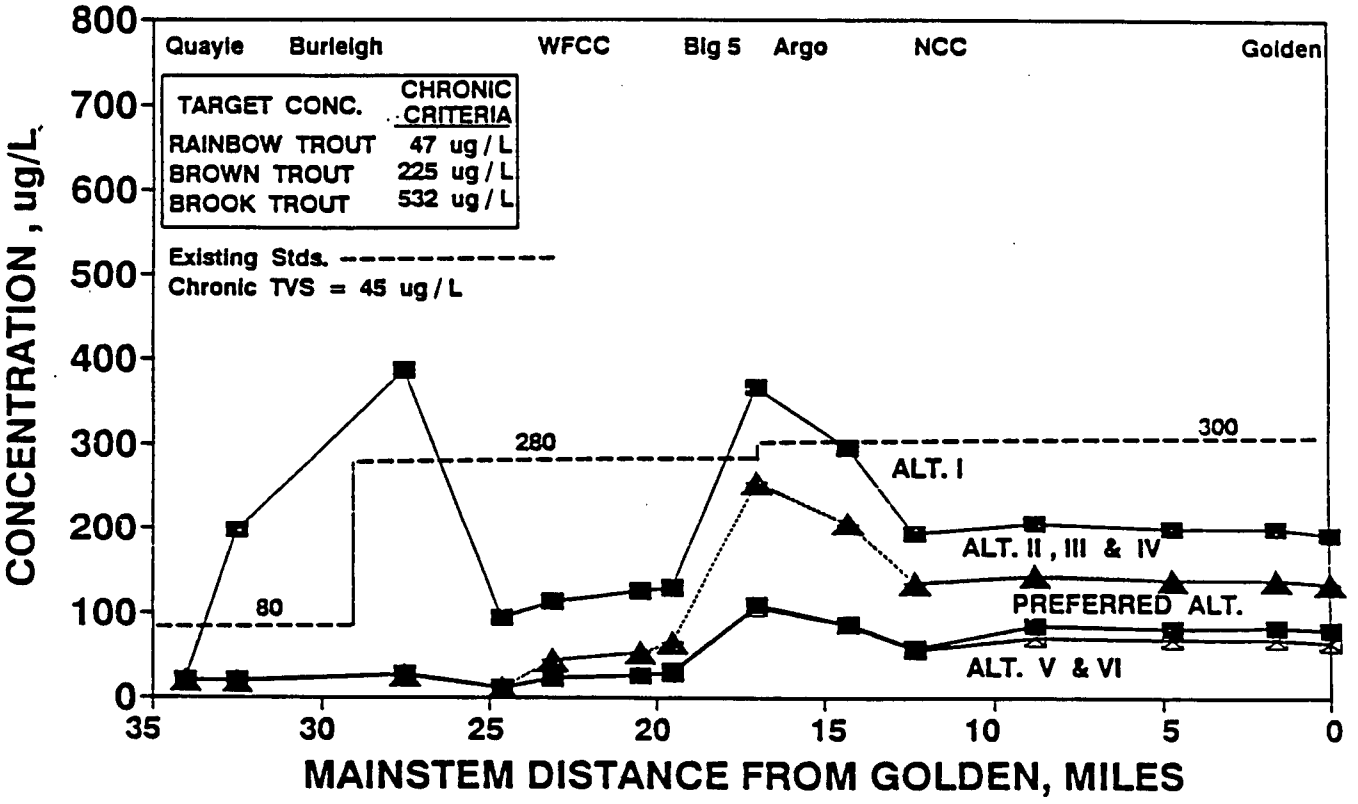
APPENDIX A

Graphics of Modeling Results

Key to Abbreviations

Cu - Copper
Fe - Iron
Mn - Manganese
Zn - Zinc
ALT - Alternative
MI - Miles
NCC - North Clear Creek
WFCC - West Clear Creek
WASP - Water Quality Simulation Program, Version 4, Computer Model

CLEAR CREEK FEASIBILITY STUDY
WASP4 LOWFLOW SIMULATION - DISSOLVED ZN



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ALT. V — ALT. VI — PREFERRED ALT.

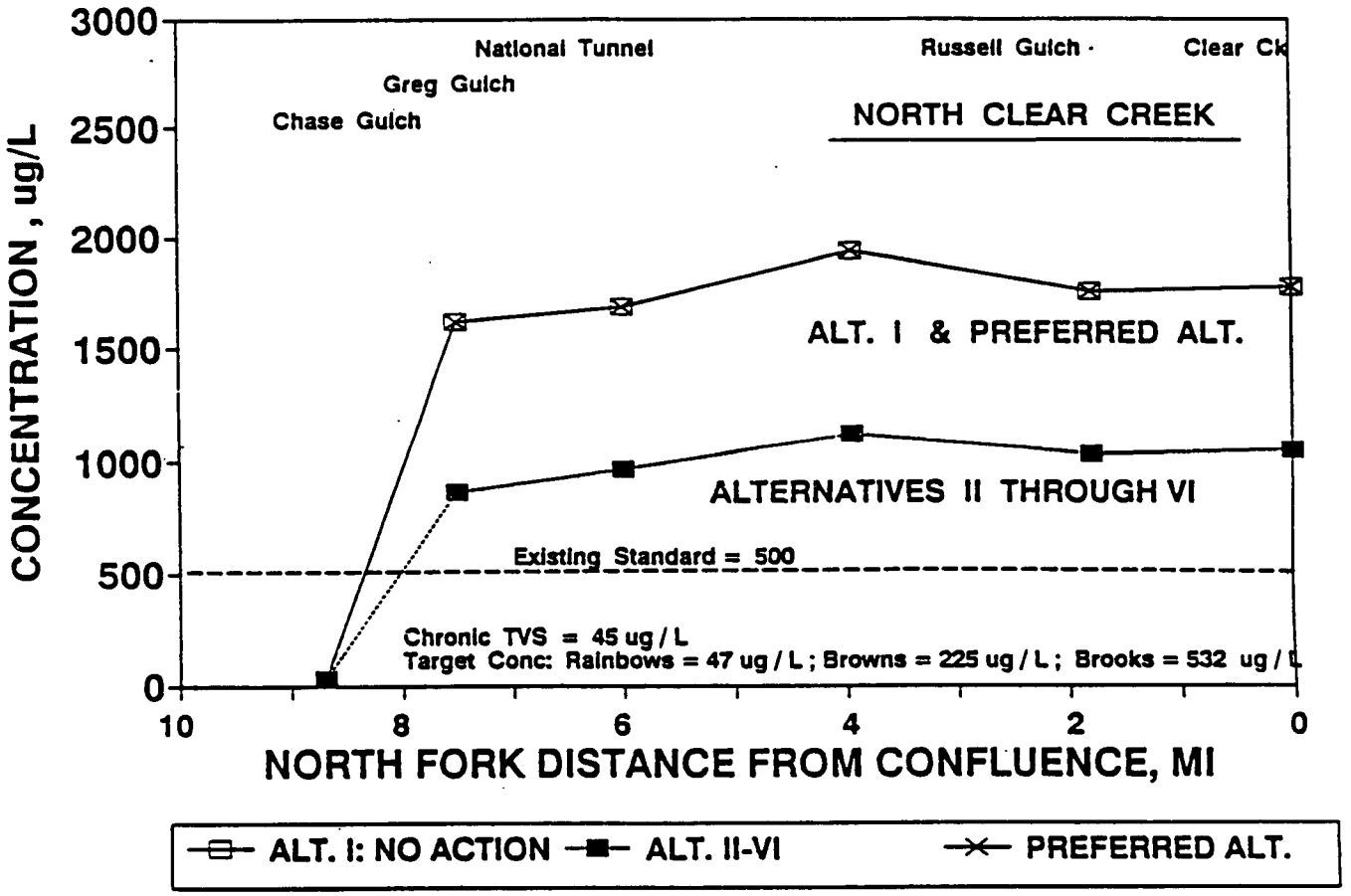
NOTES:

Chronic TVS = Aquatic Life Protection Criteria Based on Table Value Standards Presented in the Basic Standards and Methodologies for Surface Water, Section 3.1.0 August 17, 1989. TVSs are for dissolved metals except for Mn and Fe.

Target Concentrations: Based on the lower range of Toxicity Tiering for Rainbow / Cutthroat, Brown and Brook Trout. Values are Dissolved Metals for Acclimated Fish and Represent levels to Sustain a Naturally Reproducing Population.

Existing Standards: Colorado Department of Health - Water Quality Control Division, Classification and Numeric Standards, South Platte River Basin, Feb. 5, 1990, Total Recoverable.

CLEAR CREEK FEASIBILITY STUDY
WASP4 LOWFLOW SIMULATION - DISSOLVED ZN



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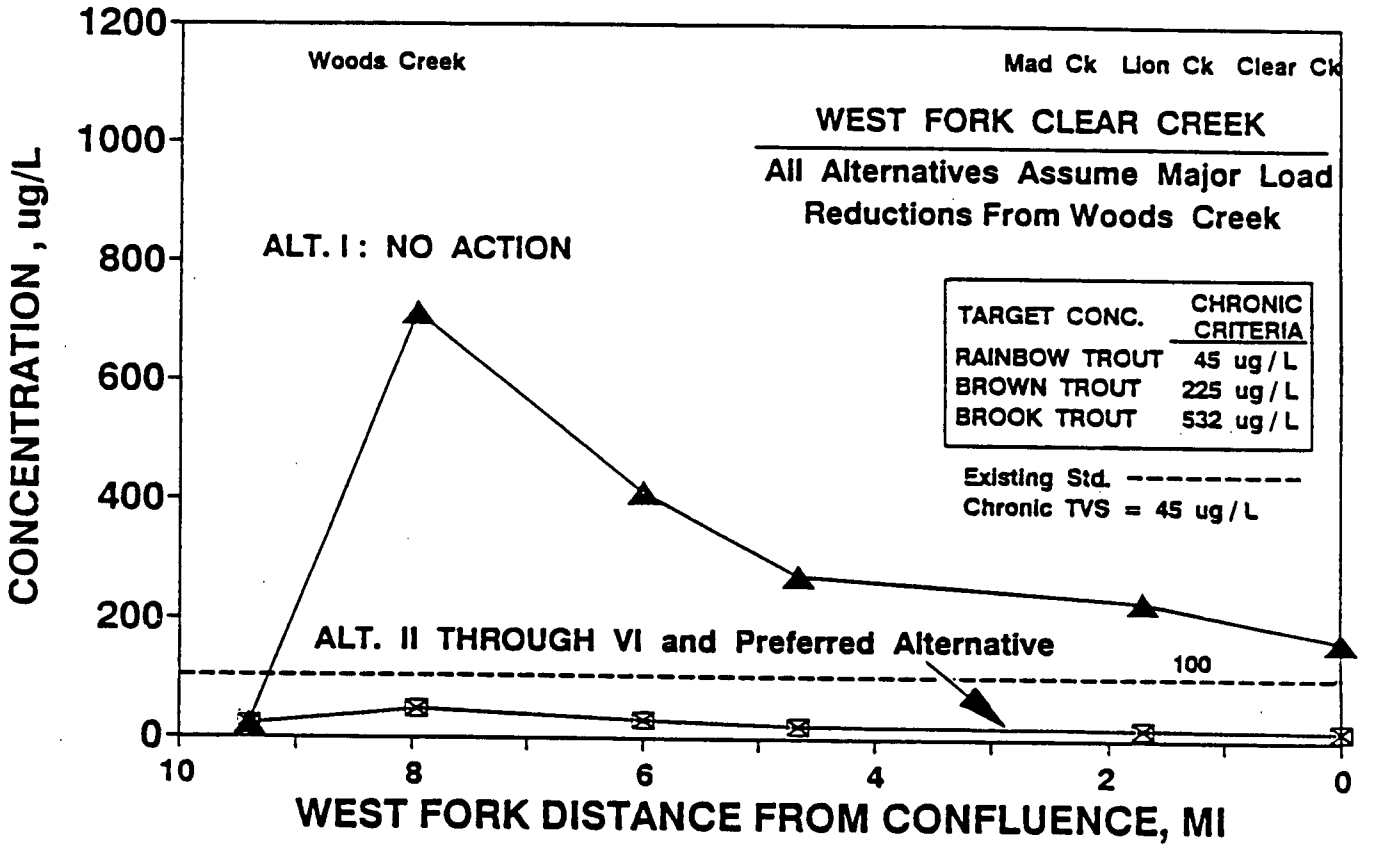

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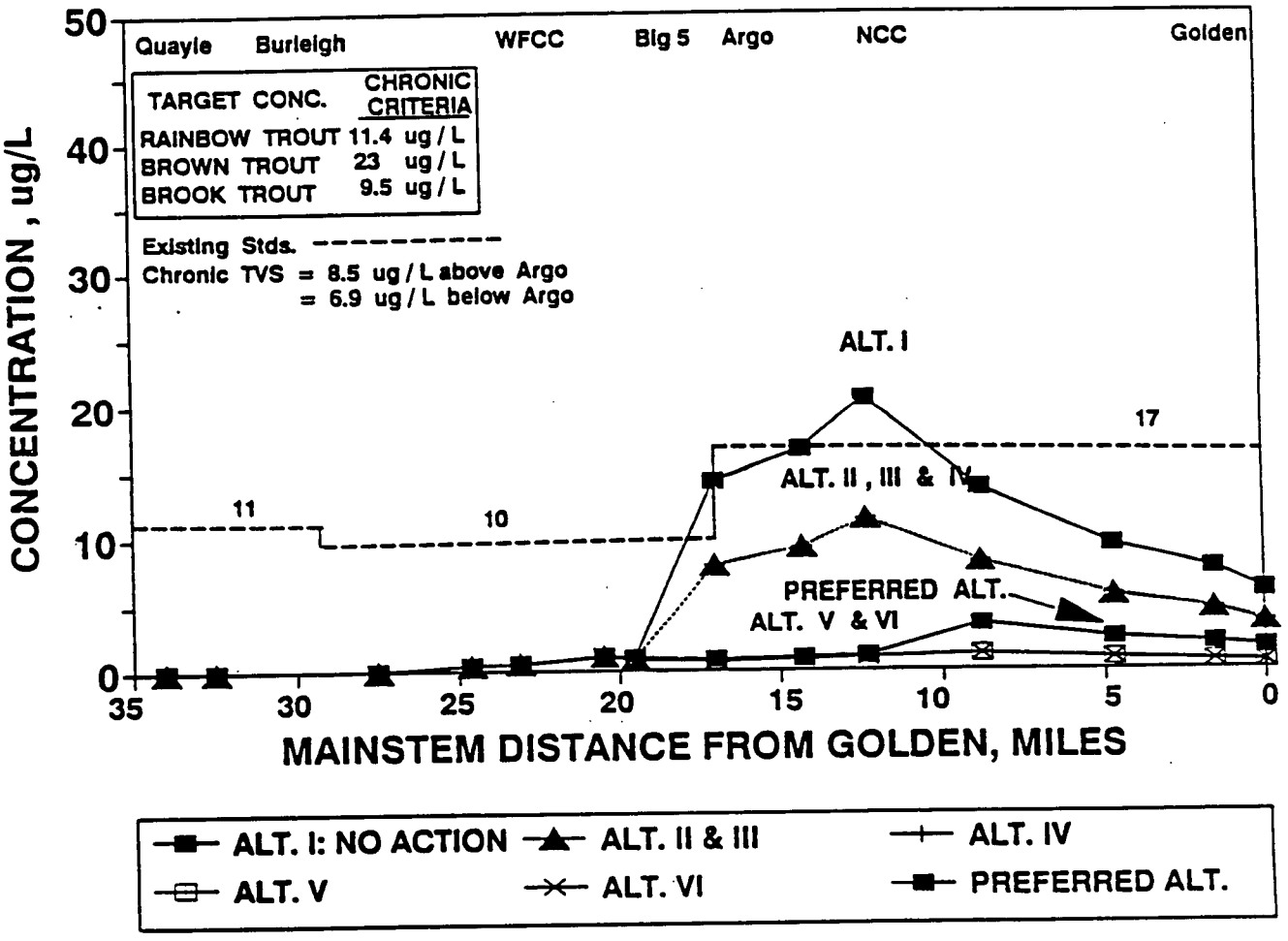
CLEAR CREEK FEASIBILITY STUDY
WASP4 LOWFLOW SIMULATION - DISSOLVED CU



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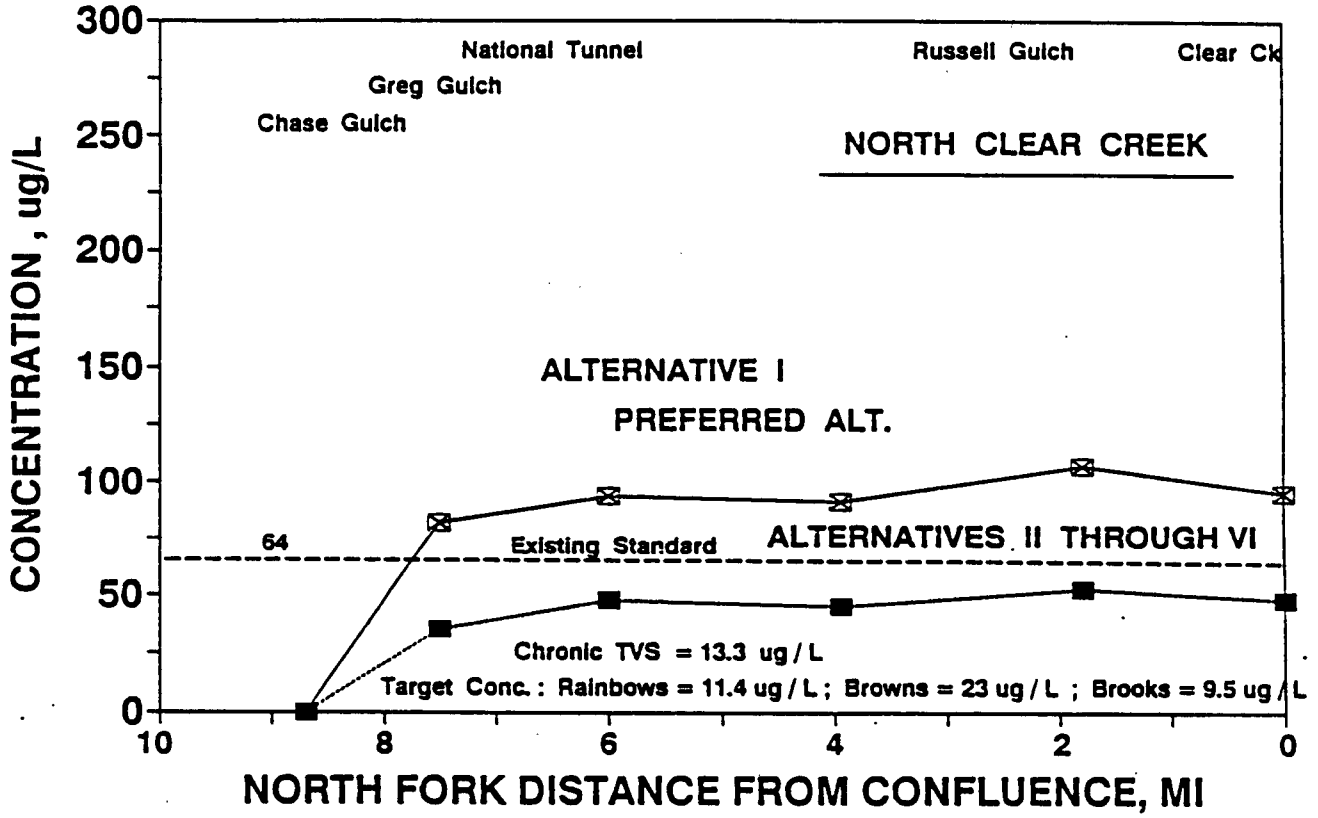
Existing Standards: Colorado Department of Health - Water Quality Control Division, Classification and Numeric Standards, South Platte River Basin, Feb. 5, 1990, Total Recoverable.

CLEAR CREEK FEASIBILITY STUDY
WASP4 LOWFLOW SIMULATION - DISSOLVED CU



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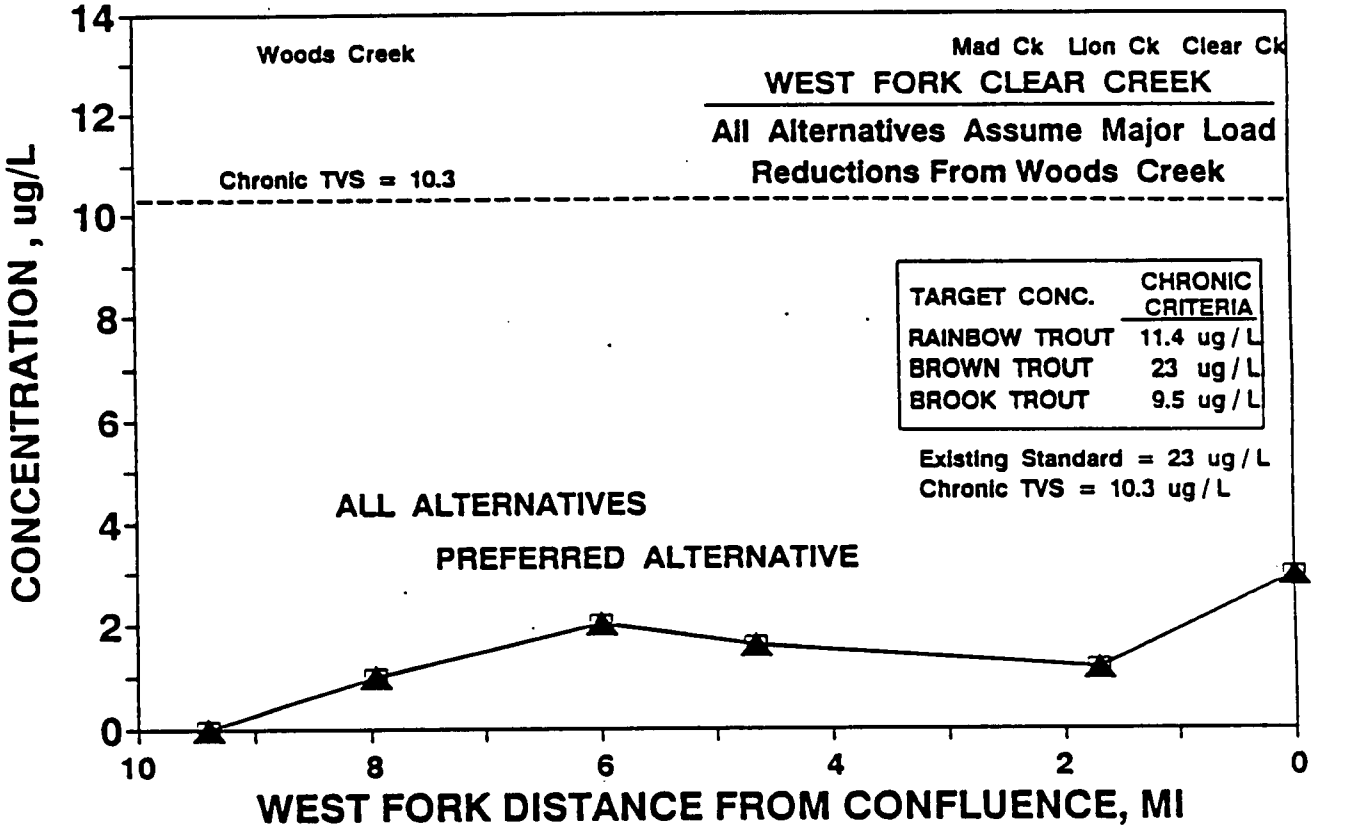
Existing Standards: Colorado Department of Health - Water Quality Control Division, Classification and Numeric Standards, South Platte River Basin, Feb. 5, 1990, Total Recoverable.

CLEAR CREEK FEASIBILITY STUDY
WASP4 LOWFLOW SIMULATION - DISSOLVED CU



ALT. I: NO ACTION — ALT. II THROUGH VI — PREFERRED ALT.

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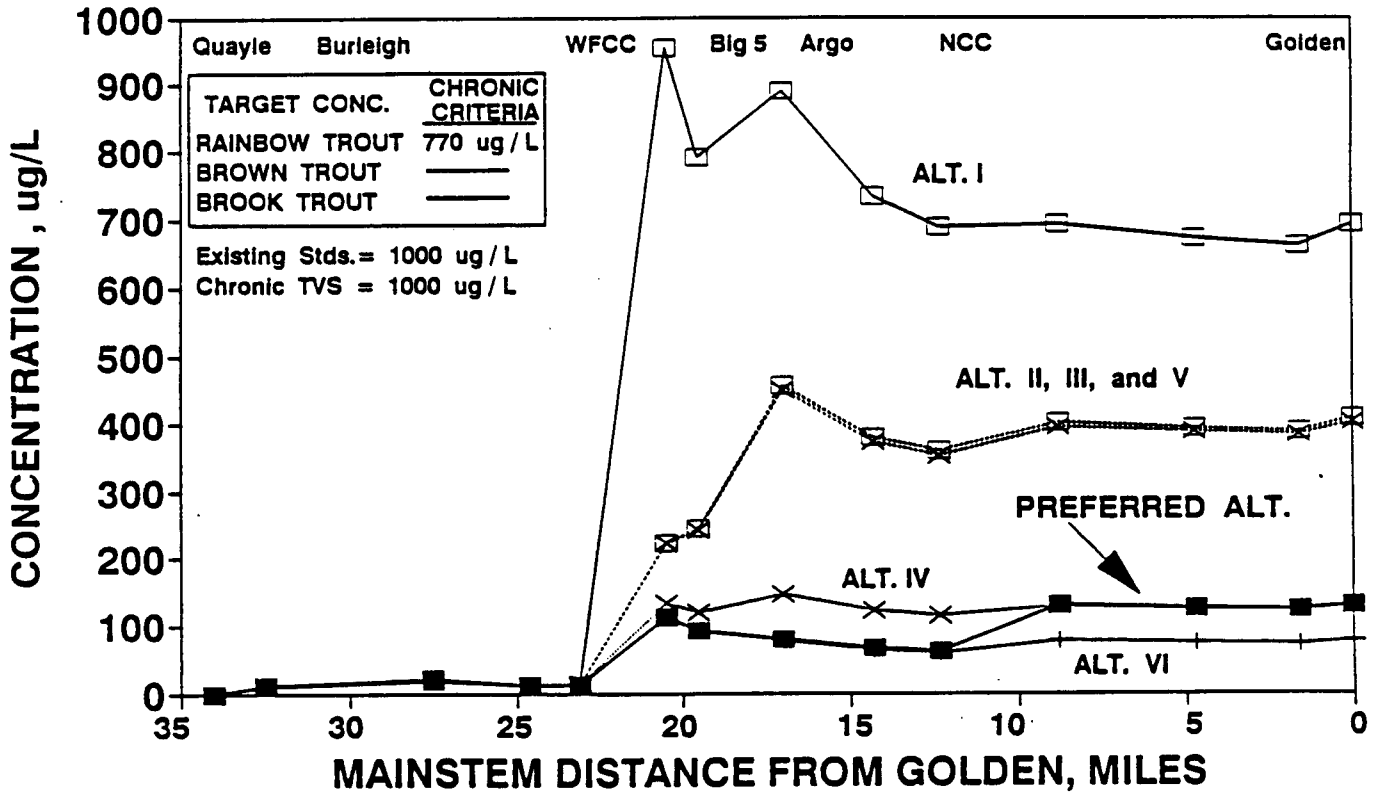
Existing Standards: Colorado Department of Health - Water Quality Control Division, Classification and Numeric Standards, South Platte River Basin, Feb. 5, 1990, Total Recoverable.

CLEAR CREEK FEASIBILITY STUDY
WASP4 LOWFLOW SIMULATION - TOTAL MN



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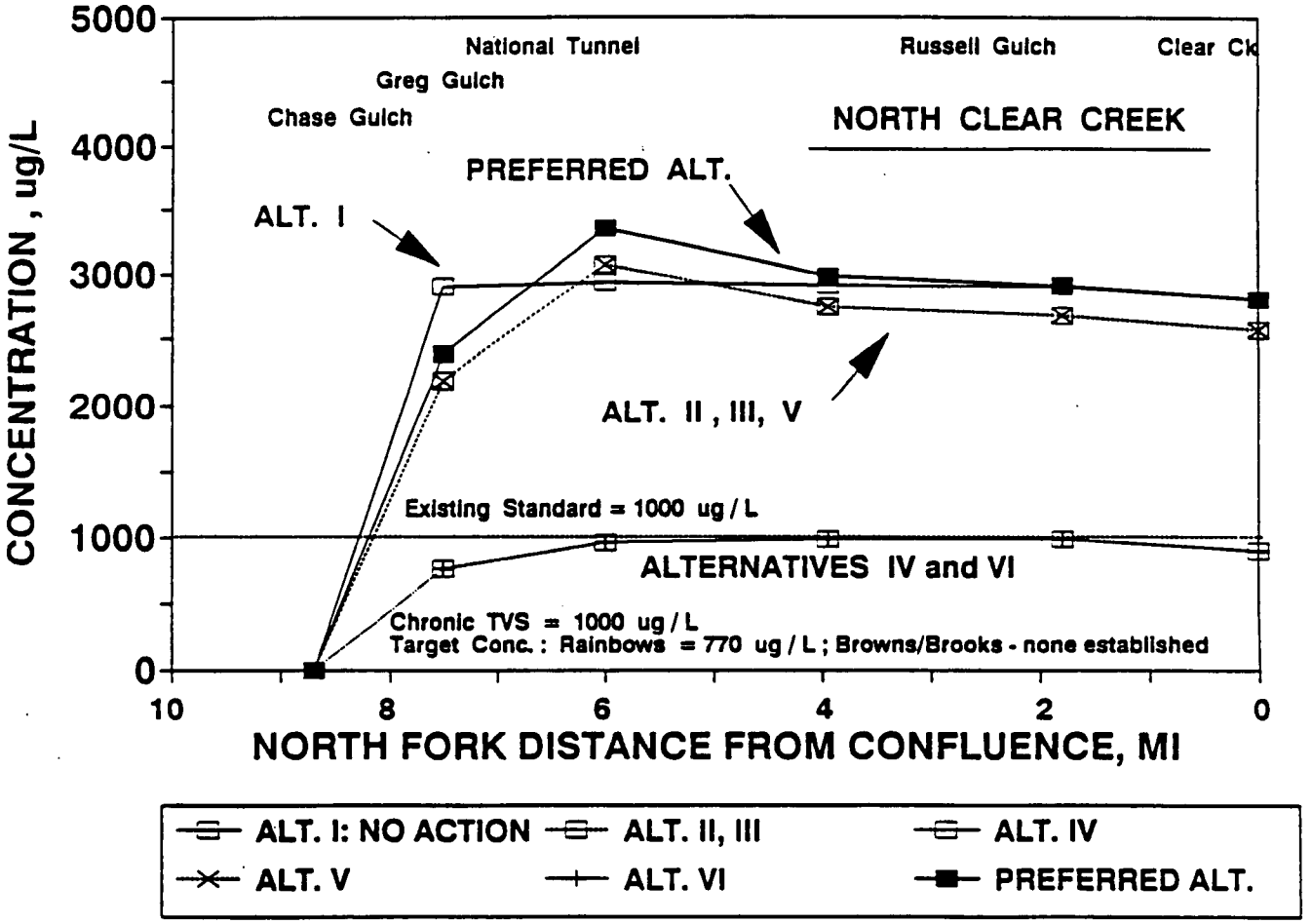
Existing Standards: Colorado Department of Health - Water Quality Control Division, Classification and Numeric Standards, South Platte River Basin, Feb. 5, 1990, Total Recoverable.

CLEAR CREEK FEASIBILITY STUDY
WASP4 LOWFLOW SIMULATION - TOTAL MN



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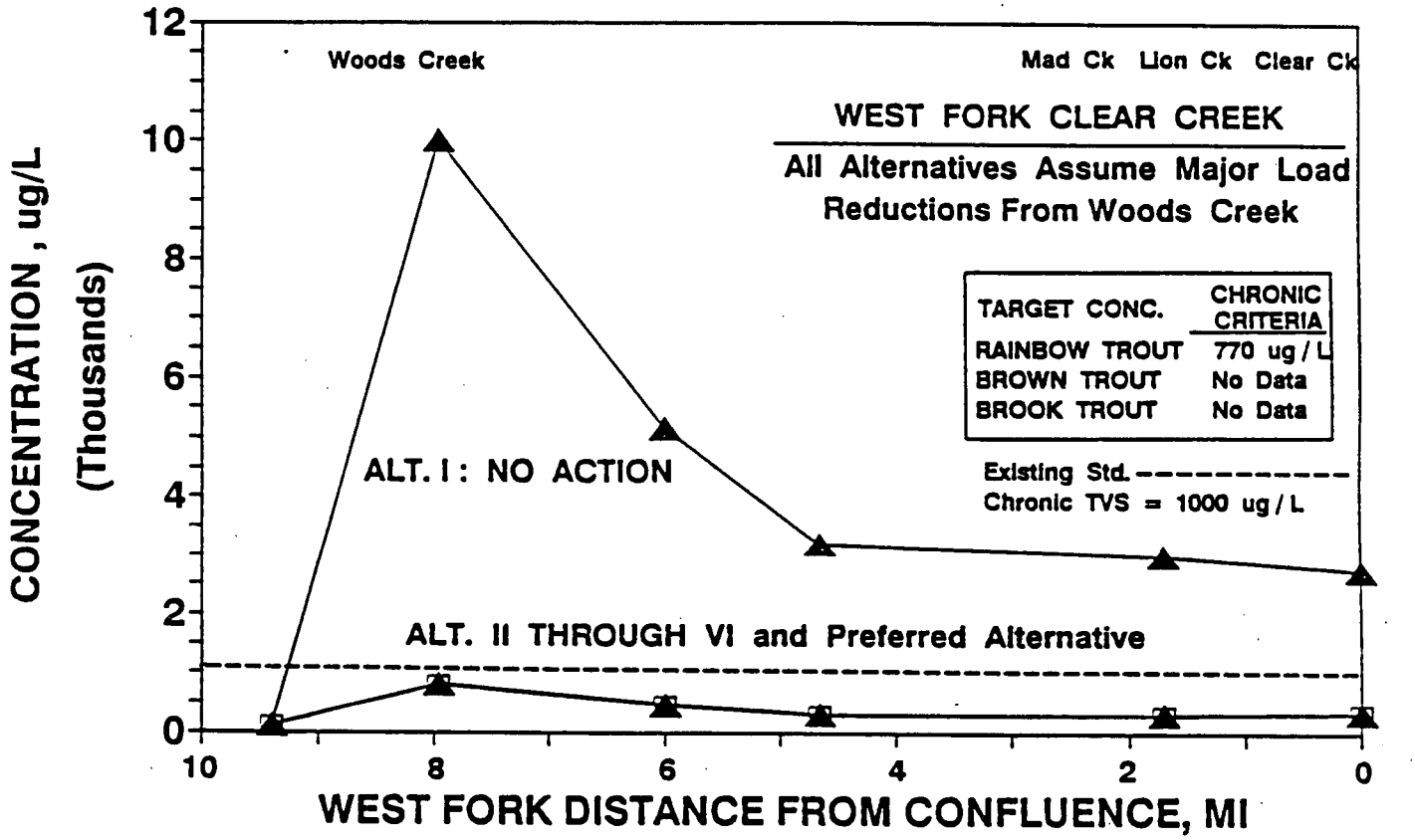
Existing Standards: Colorado Department of Health - Water Quality Control Division, Classification and Numeric Standards, South Platte River Basin, Feb. 5, 1990, Total Recoverable.

CLEAR CREEK FEASIBILITY STUDY
WASP4 LOWFLOW SIMULATION - TOTAL MN



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Existing Standards: Colorado Department of Health - Water Quality Control Division, Classification and Numeric Standards, South Platte River Basin, Feb. 5, 1990, Total Recoverable.

APPENDIX B

Federal and State of Colorado Applicable or Relevant and Appropriate Requirements

The stream segments numbers referenced in the following tables are based on State of Colorado designations for the Clear Creek basin. A narrative description of the specific segment numbers is presented below.

Segment 1	Mainstem of Clear Creek, including all tributaries, lakes and reservoirs, from the source to the Interstate 70 bridge above Silverplume.
Segment 2	Mainstem of Clear Creek, including all of the tributaries, lakes and reservoirs, from the Interstate 70 bridge above Silverplume to the Argo Tunnel discharge, except for the specific listings in Segments 3 through 9.
Segment 3	Mainstem of South Clear Creek, including all tributaries, lakes and reservoirs, from the source to the confluence with Clear Creek, except for the specific listing in 3b.
Segment 3b	Mainstem of Leavenworth Creek from source to confluence with South Clear Creek.
Segment 4	Mainstem of West Clear Creek from the source to the confluence with Woods Creek.
Segment 5	Mainstem of West Clear Creek from the confluence with Woods Creek to the confluence with Clear Creek.
Segment 6	All tributaries to West Clear Creek, including all lakes and reservoirs, from the source to the confluence with Clear Creek, except for the specific listings in Segments 7 and 8.
Segment 7	Mainstem of Woods Creek from the outlet of Upper Urad Reservoir to the confluence with West Clear Creek.
Segment 8	Mainstem of Lion Creek from the source to the confluence with West Clear Creek.
Segment 9	Mainstem to the Fall River, including all tributaries, lakes and reservoirs, from the source to the confluence with Clear Creek.
Segment 10	Mainstem of Chicago Creek, including all tributaries, lakes and reservoirs, from the source to the confluence with Clear Creek.

Segment 11	Mainstem of Clear Creek from the Argo Tunnel discharge to the Farmers Highline Canal diversion in Golden, Colorado.
Segment 12	All tributaries to Clear Creek, including all lakes and reservoirs, from the Argo Tunnel discharge to the Farmers Highline Canal diversion in Golden, Colorado, except for specific listings in Segment 13.
Segment 13	Mainstem of North Clear Creek, including all tributaries, lakes and reservoirs, from the source to the confluence with Clear Creek.

TABLE 1.1-1

STREAM CLASSIFICATIONS FOR CLEAR CREEK BASIN SEGMENTS 1-13

	Segment Number													
	1	2	3a	3b	4	5	6	7	8	9	10	11	12	13
Recreational Classification														
Class 1			X	X	X		X			X	X			
Class 2	X	X				X		X	X			X	X	X
Aquatic Life Classification														
Class 1 Cold	X	X	X		X	X	X			X	X	X		
Warm														
Class 2 Cold				X				X	X				X	X
Warm														
Use Classification														
Domestic Water Supply	X		X	X	X		X			X	X	X	X	
Agricultural Supply	X	X	X	X	X	X	X			X	X	X	X	X

Recreational classification:

Class 1 = Primary contact recreation (e.g. swimming)

Class 2 = Secondary contact recreation, those not in Class 1

Aquatic Life Classification:

Class 1 = Cold/warm stream segments capable of sustaining cold/warm water biota where physical habitat, water flows, and water quality conditions do not impair biota. Applies to segments with correctable water quality.

Class 2 = Cold/warm stream segments not capable of sustaining cold/warm water biota where physical habitat, water flows, or uncorrectable water quality conditions impair biota.

Use Classification:

Domestic water supply = suitable for potable water supplies after standard water treatment

Agricultural water supply = suitable for irrigation of crops or watering livestock.

TABLE 2.2-1

CLEAR CREEK SITE
POTENTIAL FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate?	Comments/Justification for Elimination from Further Consideration
FEDERAL				
• SAFE DRINKING WATER ACT	42 USC § 300G			
National Primary Drinking Water Standards	40 CFR Part 141	Establishes health based standards for public water systems (MCLs).	No/Yes	Applicable at free flowing outlet of public water supply system, relevant and appropriate for surface water designated for drinking water use and for ground water which is a current or potential drinking water supply. Defer to state regulations because delegated program.
• CLEAN WATER ACT	33 USC § 1251-1376			
Water Quality Criteria	40 CFR Part 131 Quality Criteria for Water 1986	Sets criteria for water quality based on toxicity to aquatic organisms and human health.	No/Yes	State standards have been adopted. This is a delegated program. Defer to state Table Value Standards (TVS).
Ore Mining and Dressing Point Source	40 CFR Part 440	Establishes effluent limitations on certain mining and milling operations New source performance standards.	No/Yes	Relevant and appropriate for inactive mine sites.
• SOLID WASTE DISPOSAL ACT (Resource Conservation and Recovery Act)	42 USC §§ 6901-6987			

TABLE 2.2-1 (continued)

CLEAR CREEK SITE
POTENTIAL FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate?	Comments/Justification for Elimination from Further Consideration
• SUBTITLE C	Sec. 3001-3020			
Identification and Listing of Hazardous Waste	40 CFR Part 261	Defines those solid wastes which are subject to regulation as hazardous waste.	No/Yes	
Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities	40 CFR Part 264	Defines minimal national requirements for treatment, storage, and disposal of hazardous waste.	No/Yes	Relevant and appropriate. Defer to state standards.
• CLEAN AIR ACT	442 USC §§ 7401-7642			
National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50	Establishes standards for ambient air quality to protect human health and welfare.	No/Yes	Lead is a contaminant of concern at the site. Lead standard is relevant and appropriate.
National Emission Standards for Hazardous Air Pollutants	40 CFR Part 61	Sets emission standards for designated hazardous pollutants	No/No	Requirements are promulgated for emissions of particular air pollutants from specific sources. Will be reconsidered as a potential action-specific ARAR.

TABLE 2.2-1 (continued)

CLEAR CREEK SITE
POTENTIAL FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate?	Comments/Justification for Elimination from Further Consideration
STATE OF COLORADO				
• COLORADO SAFE DRINKING WATER AUTHORITIES	CRS 24-4-104 to -105 CRS 25-1-101, -107, -109, -114, 114.1			
Primary Drinking Water	5 CCR 1003-1	Establishes standards for public water systems (MCLs).	No/Yes	Applicable at free flowing outlet of public water supply system, relevant and appropriate for surface water designated for drinking water use and for ground water which is a current or potential drinking water supply. Defer to state regulations because delegated program.
• COLORADO WATER QUALITY CONTROL ACT	CRS 25-8-101 to -703			
Basic Standards for Ground Water	5CCR 1002-8, Section 3.11.0	Establishes a system for classifying ground water and adopting water quality standards to protect existing and potential beneficial uses.	No/Yes	Clear Creek site aquifers have not been classified. Organic statewide standards have been adopted but organics are not chemicals of concern at the site.

TABLE 2.2-1 (continued)

CLEAR CREEK SITE
POTENTIAL FEDERAL AND STATE CHEMICAL-SPECIFIC ARARs

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate?	Comments/Justification for Elimination from Further Consideration
Basic Standards and Methodologies for Surface Water	5 CCR 1002-8 Section 3.1.0	Establishes basic standards, antidegradation standard, system for classifying state waters.	Yes/No	Applicable to any discharge to state waters, e.g., mine adit discharges.
Classifications and Numeric Standards, South Platte River Basin, et al.	5 CCR 1002-8, Section 3.8.0	Used in conjunction with Basic Standards and Methodologies (Sec. 3.1.0).	Yes/No	Applicable for classified surface water stream segments.
• COLORADO HAZARDOUS WASTE ACT	CRS 25-15-101 to-313			
Rules and Regulations Pertaining to Hazardous Waste	6 CCR 1007-3, Parts 260, 261, 262.11	Defines hazardous waste, requires waste characterization.	No/Yes	
• COLORADO AIR QUALITY CONTROL ACT	CRS 25-7-101 to-512			
Ambient Air Quality Standards	5 CCR 1001-2 to-1001-14	Sets ambient standards for TSP, SO_2, oxidants, CO, NO_2, Pb.	Yes/No	Only an ARAR if current site conditions or remedial activities are a major source of emissions.
Regulation No. 3	5 CCR 1001-5	Restricts exeedance in any attainment area of any National Ambient Air Quality Standards (NAAQS).	Yes/No	The site is located within an attainment area.

TABLE 2.2-2 (cont.)

CHEMICAL-SPECIFIC LEGALLY APPLICABLE REQUIREMENTS FOR CHEMICALS OF CONCERN

C. State of Colorado Water Quality Standards for Clear Creek Stream Segments

SEG-MENT	DESCRIPTOR	PH-MIN (SU)	PH-MAX (SU)	AS (UG/L)	CD (UG/L)	CR(tri) (UG/L)	CR(hex) (UG/L)	CU (UG/L)	PB (UG/L)	FE D (UG/L)	FE T (UG/L)	MN D (UG/L)	MN T (UG/L)	NI (UG/L)	AG (UG/L)	ZN (UG/L)
1	CC MNSTEM, SOURCE TO I-70 BRDG ABV SLVPL	6.5	9.0	50	0.4	50	25	11.0	8.0	300	1000	50	1000	50.0	0.100	80
2	CC MNSTEM, BRDG ABV SLVPLM TO ARGO TUNNL	6.5	9.0	50	2.0	100	25	10.0	5.0	---	1000	---	1000	50.0	0.100	280
3	S. CC TO CONFLUENCE WITH CC	6.5	9.0	50	0.4	50	25	5.0	4.0	300	1000	50	1000	50.0	0.100	90
5	MNSTEM W.CC, CONF W\WOODS TO CONF W\CC	6.5	9.0	50	3.0	100	25	23.0	25.0	---	1000	---	1100	100.0	0.100	100
6	ALL TRIBS TO W.CC EXCEPT ITEMS 7&8	6.5	9.0	150	2.0	50	33	1.8	1.7	---	1000	---	1000	18.0	0.002	45
7	WOODS CREEK MAIN	6.5	9.0	50	14.0	100	25	23.0	25.0	---	1000	---	9400	100.0	0.100	740
8	LION CREEK MAIN	3.0	9.0	---	---	---	---	---	---	---	---	---	---	---	---	---
9	FALL RIVER MNSTEM TO CONFLUENCE W\CC	6.5	9.0	150	2.0	50	33	1.8	1.7	---	1000	---	---	18.0	0.002	45
10	CHI.CREEK MNSTEM TO CONFLUENCE W\CC	6.5	9.0	50	0.4	50	25	6.0	4.0	300	1000	50	1000	50.0	0.100	110
11	CC MNSTEM FROM ARGO TO GLDN GAUGING STA.	6.5	9.0	150	3.0	50	123	17.0	1.6	---	1000	---	1000	59.0	0.030	300
12	TRIBS IN SECTION 10	6.5	9.0	50	10.0	50	50	1000.0	50.0	300	---	50	---	---	50.000	5000
13	N.CC FROM SOURCE TO CONFL. W\CC	6.5	9.0	50	0.4	100	25	64.0	45.0	---	5400	---	1000	50.0	0.100	. 500

Note: No stream standards are available for aluminum and fluoride.

a) Colorado Department of Health - Water Quality Control Division
Classification and Numeric Standards, South Platte River Basin, Laramie River Basin, Republican River Basin, Smokey Hill River Basin.
Amended:Feb 5,1990 (Effective March 30 1990): All existing water quality standards are total recoverable metals with the exception of TVSs as noted below.

b) Cd (14.0 ug/L), Mn T (9400 ug/L), and Zn (740 ug/L) are temporary modifications on Woods Creek mainstem; underlying standards for Woods Creek are Cd, 0.2 ug/L, Mn, I100 ug/L, and Zn, 100 ug/L.

c) Table value standards (TVSs) are promulgated for all metals in Segments 6,9, and for all metals in Segment 11 except Cd (3.0 ug/L), Cu (17.0 ug/L) and Zn (300 ug/L). TVSs are dissolved metals except for Fe and Mn which are total recoverable and ar based on low flow TVSs are based on low flow hardness sampled in the Phase II RI sampling, September 1989 (CDM 1990).

d) All numeric and TVS standards presented here are legally applicable.

TABLE 2.2-2 (cont.)

CHEMICAL-SPECIFIC RELEVANT AND APPROPRIATE REQUIREMENTS FOR CHEMICALS OF CONCERN

D. State of Colorado Water Quality Criteria During Low Flow for Clear Creek Stream Segments

SEG-MENT	DESCRIPTOR	PH-MIN (SU)	PH-MAX (SU)	AL (UG/L)	AS (UG/L)	CD (UG/L)	CR(tri) (UG/L)	CR(hex) (UG/L)	CU (UG/L)	PB (UG/L)	FE D (UG/L)	FE T (UG/L)	MN D (UG/L)	MN T (UG/L)	NI (UG/L)	AG (UG/L)	ZN (UG/L)
AQUATIC LIFE CHRONIC TABLE VALUE STANDARDS																	
1	CC MNSTEM, SOURCE TO I-70 BRDG ABV SLVPL	6.5	9.0	150	150	0.8	151	11	8.5	2.3	---	1000	---	1000	71.3	0.038	45
2	CC MNSTEM, BRDG ABV SLVPLM TO ARGO TUNNL	6.5	9.0	150	150	0.8	151	11	8.5	2.3	---	1000	---	1000	7.3	0.038	45
3	S. CC TO CONFLUENCE WITH CC	6.5	9.0	150	150	0.6	112	11	6.2	1.3	---	1000	---	1000	53.9	0.021	45
5	MNSTEM W.CC, CONF W\WOODS TO CONF W\CC	6.5	9.0	150	150	1.0	181	11	10.3	3.1	---	1000	---	1000	84.5	0.057	45
6	ALL TRIBS TO W.CC EXCEPT ITEMS 7&8	6.5	9.0	150	150	0.2	34	11	1.8	0.2	---	1000	---	1000	17.7	0.002	45
7	WOODS CREEK MAIN	6.5	9.0	150	150	1.6	296	11	17.2	7.2	---	1000	---	1000	133.4	0.160	45
8	LION CREEK MAIN	3.0	9.0	150	150	2.6	483	11	28.6	16.9	---	1000	---	1000	209.8	0.445	87
9	FALL RIVER MNSTEM TO CONFLUENCE W\CC	6.5	9.0	150	150	0.2	35	11	1.9	0.2	---	1000	---	1000	18.4	0.002	45
10	CHI.CREEK MNSTEM TO CONFLUENCE W\CC	6.5	9.0	150	150	0.4	69	11	3.7	0.6	---	1000	---	1000	34.3	0.007	45
11	CC MNSTEM FROM ARGO TO GLDN GAUGING STA.	6.5	9.0	150	150	0.7	123	11	6.9	1.6	---	1000	---	1000	59.0	0.025	45
12	TRIBS IN SECTION 10	6.5	9.0	150	150	0.7	123	11	6.9	1.6	---	1000	---	1000	59.0	0.025	45
13	N.CC FROM SOURCE TO CONFL. W\CC	6.5	9.0	150	150	1.3	232	11	13.3	4.7	---	1000	---	1000	106.3	0.095	45
AQUATIC LIFE ACUTE TABLE VALUE STANDARDS																	
1	CC MNSTEM, SOURCE TO I-70 BRDG ABV SLVPL	6.5	9.0	950	360	2.5	1266	16	12.2	51.4	---	---	---	---	687.9	1.050	80
2	CC MNSTEM, BRDG ABV SLVPLM TO ARGO TUNNL	6.5	9.0	950	360	2.5	1266	16	12.2	51.4	---	---	---	---	687.9	1.050	80
3	S. CC TO CONFLUENCE WITH CC	6.5	9.0	950	360	1.7	936	16	8.6	28.3	---	---	---	---	519.6	0.553	59
5	MNSTEM W.CC, CONF W\WOODS TO CONF W\CC	6.5	9.0	950	360	3.3	1520	16	15.1	73.7	---	---	---	---	815.1	1.530	95
6	ALL TRIBS TO W.CC EXCEPT ITEMS 7&8	6.5	9.0	950	360	0.3	283	16	2.2	2.7	---	---	---	---	171.1	0.045	18
7	WOODS CREEK MAIN	6.5	9.0	950	360	6.4	2486	16	26.5	194.5	---	---	---	---	1286.7	4.310	155
8	LION CREEK MAIN	3.0	9.0	950	360	12.6	4050	16	46.4	509.2	---	---	---	---	2023.9	1.202	251
9	FALL RIVER MNSTEM TO CONFLUENCE W\CC	6.5	9.0	950	360	0.3	293	16	2.3	2.9	---	---	---	---	177.0	0.048	19
10	CHI.CREEK MNSTEM TO CONFLUENCE W\CC	6.5	9.0	950	360	0.9	576	16	5.0	10.9	---	---	---	---	331.3	0.200	37
11	CC MNSTEM FROM ARGO TO GLDN GAUGING STA.	6.5	9.0	950	360	1.9	1032	16	9.7	34.4	---	---	---	---	569.2	0.680	65
12	TRIBS IN SECTION 10	6.5	9.0	950	360	1.9	1032	16	9.7	34.4	---	---	---	---	569.2	0.680	65
13	N.CC FROM SOURCE TO CONFL. W\CC	6.5	9.0	950	360	4.6	1947	16	20.0	120.1	---	---	---	---	1025.6	2.580	122

Note: No Table Value Standards available for fluoride.

a) Taken from existing Table Value Standards (Appendix 41), reported from Basic Standards and Methodologies for Surface Water, Section 3.1.0(August 17,1989)

b) TVSs are not adopted for all stream segments: Criteria are Relevant and Appropriate where not adopted: see Table 2.2-2 for segments where TVSs have been promulgated and are applicable ARARs.

c) TVSs based on low flow hardness value sampled in Phase II RI, September 1989 (CDM 1990).

d) TVSs are dissolved metals except for Fe and Mn which are total recoverable.

TABLE 2.2-2 (cont.)

CHEMICAL-SPECIFIC RELEVANT AND APPROPRIATE REQUIREMENTS FOR CHEMICALS OF CONCERN

E. State of Colorado Water Quality Criteria During High Flow for Clear Creek Stream Segments

SEG-MENT	DESCRIPTOR	PH-MIN (SU)	PH-MAX (SU)	AL (UG/L)	AS (UG/L)	CD (UG/L)	CR(tri) (UG/L)	CR(hex) (UG/L)	CU (UG/L)	PB (UG/L)	FE D (UG/L)	FE T (UG/L)	MN D (UG/L)	MN T (UG/L)	NI (UG/L)	AG (UG/L)	ZN (UG/L)
AQUATIC LIFE CHRONIC TABLE VALUE STANDARDS																	
1	CC MNSTEM, SOURCE TO I-70 BRDG ABV SLVPL	6.5	9.0	150	150	0.5	86	11	4.7	0.8	---	1000	---	1000	42.1	0.012	45
2	CC MNSTEM, BRDG ABV SLVPLM TO ARGO TUNNL	6.5	9.0	150	150	0.5	86	11	4.7	0.8	---	1000	---	1000	42.1	0.012	45
3	S. CC TO CONFLUENCE WITH CC	6.5	9.0	150	150	0.5	86	11	4.7	0.8	---	1000	---	1000	42.0	0.012	45
5	MNSTEM W.CC, CONF W\WOODS TO CONF W\CC	6.5	9.0	150	150	0.5	86	11	4.7	0.8	---	1000	---	1000	42.0	0.012	45
6	ALL TRIBS TO W.CC EXCEPT ITEMS 7&8	6.5	9.0	150	150	0.2	42	11	2.2	0.2	---	1000	---	1000	21.8	0.003	45
7	WOODS CREEK MAIN	6.5	9.0	150	150	0.7	132	11	7.4	1.8	---	1000	---	1000	63.2	0.029	45
8	LION CREEK MAIN	3.0	9.0	150	150	0.9	164	11	9.3	2.6	---	1000	---	1000	77.1	0.046	45
9	FALL RIVER MNSTEM TO CONFLUENCE W\CC	6.5	9.0	150	150	0.2	42	11	2.2	0.2	---	1000	---	1000	21.8	0.003	45
10	CHI.CREEK MNSTEM TO CONFLUENCE W\CC	6.5	9.0	150	150	0.5	86	11	4.7	0.8	---	1000	---	1000	42.0	0.012	45
11	CC MNSTEM FROM ARGO TO GLDN GAUGING STA.	6.5	9.0	150	150	0.5	86	11	4.7	0.8	---	1000	---	1000	42.0	0.012	45
12	TRIBS IN SECTION 10	6.5	9.0	150	150	0.5	86	11	4.7	0.8	---	1000	---	1000	42.0	0.012	45
13	N.CC FROM SOURCE TO CONFL. W\CC	6.5	9.0	150	150	0.5	86	11	4.7	0.8	---	1000	---	1000	42.0	0.012	45
AQUATIC LIFE ACUTE TABLE VALUE STANDARDS																	
1	CC MNSTEM, SOURCE TO I-70 BRDG ABV SLVPL	6.5	9.0	950	360	1.2	718	16	6.4	16.8	---	---	---	---	406.2	0.320	91
2	CC MNSTEM, BRDG ABV SLVPLM TO ARGO TUNNL	6.5	9.0	950	360	1.2	718	16	6.4	16.8	---	---	---	---	406.2	0.320	91
3	S. CC TO CONFLUENCE WITH CC	6.5	9.0	950	360	1.2	718	16	6.4	16.8	---	---	---	---	406.2	0.320	91
5	MNSTEM W.CC, CONF W\WOODS TO CONF W\CC	6.5	9.0	950	360	1.2	718	16	6.4	16.8	---	---	---	---	406.2	0.320	91
6	ALL TRIBS TO W.CC EXCEPT ITEMS 7&8	6.5	9.0	950	360	0.4	353	16	2.8	4.2	---	---	---	---	210.0	0.071	23
7	WOODS CREEK MAIN	6.5	9.0	950	360	2.1	1111	16	10.5	39.8	---	---	---	---	609.0	0.800	70
8	LION CREEK MAIN	3.0	9.0	950	360	2.9	1377	16	13.5	60.8	---	---	---	---	744.0	1.240	87
9	FALL RIVER MNSTEM TO CONFLUENCE W\CC	6.5	9.0	950	360	0.4	353	16	2.8	4.2	---	---	---	---	210.0	0.071	23
10	CHI.CREEK MNSTEM TO CONFLUENCE W\CC	6.5	9.0	950	360	1.2	718	16	6.4	16.8	---	---	---	---	406.0	0.320	91
11	CC MNSTEM FROM ARGO TO GLDN GAUGING STA.	6.5	9.0	950	360	1.2	718	16	6.4	16.8	---	---	---	---	406.0	0.320	91
12	TRIBS IN SECTION 10	6.5	9.0	950	360	1.2	718	16	6.4	16.8	---	---	---	---	406.0	0.320	91
13	N.CC FROM SOURCE TO CONFL. W\CC	6.5	9.0	950	360	1.2	718	16	6.4	16.8	---	---	---	---	406.0	0.320	91

Note: No table value standards available for fluoride.

a) Taken from existing Table Value Standards (Appendix 4I), reprinted from Basic Standards and Methodologies for Surface Water, Section 3.1.0 (August 17, 1989)

b) TVSs based on high flow hardness sampled in the Phase II RI in June 1989 (COM 1990).

c) TVSs are not adopted for all segments: Criteria are Relevant and Appropriate where not adopted: See Table 2.2-2C for segments where TVSs are promulgated and are applicable ARARs.

d) TVSs are dissolved metals except for Fe and Mn which are total recoverable.

TABLE 2.2-2

CHEMICAL-SPECIFIC ARARs AND TBCs FOR CHEMICALS OF CONCERN (COCs)

A. Drinking Water (μg/L)[a]					
	Federal Primary Standards	Colorado Primary Standards	RCRA Ground Water Maximums	Colorado Ground Water Standards[c]	Federal Maximum Contaminant Level Goals[b,f]
Ag	50	50	50	50	-
As	50	50	50	50	0
Be	1	-[g]	-	-	0[P]
Cd	10(5)[1]	10	10	10	5
Cr	100	50	50	50	100
Cu	-(1,300)[2]	-	-	-	1,300[P]
Fl	4,000	4,000	-	-	4,000
Mn	-	-	-	-	-
Ni	100	-	-	-	100
Pb	50(15)[2]	50	50	50	0[P]
Zn	-	-	-	-	-

[a]All values are total values, unless otherwise noted
[b]Safe Drinking Water Act: Drinking Water Regulations, April 1991
[c]Colorado Primary Drinking Water Regulation Part I of Title 25, CRS 1973
[d]40 CFR Part 264.94, July 1990.
[e]Dissolved values
[f]MCLGs above zero are relevant and appropriate
[g]"-" non established
[P]Proposed
[1]The Federal Primary Standard for Cadmium is relevant and appropriate and is currently 10 μg/L. In July 1992 the standard for cadmium will become 5 μg/L. The 5 μg/L concentration is a "to be considered" (TBC) concentration until July 1992.
[2]The concentrations of 1300 μg/L copper and 15 μg/L lead are TBCs.

TABLE 2.2-2 (cont.)

CHEMICAL-SPECIFIC ARARs FOR CHEMICALS OF CONCERN (COCs)

B. Federal Ambient Water Quality Criteria for Protection of Aquatic Life[a]

Chemical	µg/L	
	Acute[b]	Chronic[c]
As III	360[d]	190[d]
Cd	3.9[c,d]	1.1[c,d]
Cr III	1,700[c,d]	210[c,d]
Cr VI	16[d]	11[d]
Cu	18[c,d]	12[c,d]
Pb	82[c,d]	3.2[c,d]
Ni	1,800[c,e]	96[c,e]
Ag	4.1[c,e]	0.12[e]
Zn	320[c,e]	47[e]
Fe	-	1,000
pH	6.5-9.0	6.5-9.0

Note: No AQWC listed for aluminum and fluoride; criteria for manganese is for marine molluses only.

[a] Relevant and Appropriate Standards; Defer to State Table Value Standards (TVS).
[b] One-hour maximum.
[c] 4-day maximum. Values are hardness dependent; hardness of 100 mg $CaCO_3$/L assumed.
[d] Acid-soluble value.
[e] Total recoverable value.

TABLE 2.2-3

NATIONAL AMBIENT AIR QUALITY STANDARDS[a]
(NAAQS)

Criteria Pollutant	Primary Standards	Averaging Time
Carbon Monoxide	9 ppm 35 ppm	8-hour[b] 1-hour[b]
Lead	1.5 $\mu g/m^3$	Quarterly average
Nitrogen dioxide	0.053 ppm	Annual (arithmetic mean)
Particular Matter (PM_{10})	50 $\mu g/m^3$ 150 $\mu g/m^3$	Annual (arithmetic mean)[c] 24-hour[d]
Ozone	0.12 ppm	1-hour[e]
Sulfur oxides	0.03 ppm 0.14 ppm	Annual (arithmetic mean) 24-hour[b] 3-hour[b]

[a] Federal requirements have become State requirements in Colorado by means of the State Implementation Plan (SIP) approval process established under the CAA.

[b] Not to be exceeded more than once per year.

[c] The standard is attained where the expected annual arithmetic mean concentration, as determined in accordance with 52 Federal Register 24667, July 1, 1987, is less than or equal to 50 $\mu g/m^3$.

[d] The standard is attained when the expected number of days per calendar year with a 24-average concentration above 150 $\mu g/m^3$ is equal to or less than 1.

[e] The standard is attained when the expected number of days per calendar year with maximum hourly average concentrations above 0.12 ppm is equal to or less than 1.

TABLE 2.2-4

CLEAR CREEK SITE
POTENTIAL FEDERAL AND STATE LOCATION-SPECIFIC ARARs

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate?	Comments/Justification for Elimination from Further Consideration
FEDERAL				
FISH AND WILDLIFE COORDINATION ACT	16 USC §§ 661-666, 40 CFR Part 6.302(g)	Requires consultation when a Federal agency proposes or authorizes any modification of any stream to provide protection of fish and wildlife resources.	Yes/No	
ENDANGERED SPECIES ACT	16 USC §§ 1531-1543, 50 CFR Part-402, 40 CFR Part 6.302(h)	Requires that Federal agencies insure that any action by the agency is not likely to jeopardize endangered species or adversely modify their habitat.	Yes/No	Federally endangered Greenback trout has been identified within the site.
RIVERS AND HARBORS ACT	33 USC § 540	Prohibits unauthorized obstruction or alteration of any navigable water of the U.S.	Yes/No	
EXECUTIVE ORDER ON FLOODPLAIN MANAGEMENT	Executive Order 11988 40 CFR § 6.302(b) and Appendix A	Requires evaluation of potential effects of action on floodplains.	Yes/No	
EXECUTIVE ORDER ON PROTECTION OF WETLANDS	Executive Order 11990, 40 CFR § 6.302(a) and Appendix A	Prohibits discharge of dredged or fill material into wetlands or navigable waters of the U.S. without permit. Preserves and enhances wetlands.		

TABLE 2.2-4 (continued)

CLEAR CREEK SITE
POTENTIAL FEDERAL AND STATE LOCATION-SPECIFIC ARARs

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate?	Comments/Justification for Elimination from Further Consideration
CLEAN WATER ACT	Section 404 40 CFR 230 33 CFR 320-330	Prohibits discharge of dredged or fill material into wetlands or navigable waters of the U.S. without permit. Preserves and enhances wetlands.	Yes/No	
ARCHAEOLOGICAL AND HISTORIC PRESERVATION ACT	16 USC § 469 40 CFR 6.301(c)	Establishes procedures to provide for preservation of historical and archaeological data that might be destroyed through alteration of terrain as the result of a Federal or Federally licensed construction activity.	Yes/No	There are historic features in the vicinity of the site.
NATIONAL HISTORIC PRESERVATION ACT	16 USC § 470 40 CFR § 6.301(b) 36 CFR Part 800	Requires Federal agencies to consider effects on historic places.	Yes/No	There are historic places within the vicinity of the site.
HISTORIC SITES, BUILDINGS AND ANTIQUITIES ACT	16 USC § 461-467	Requires Federal agencies to consider effects on natural landmarks.	Yes/No	There are natural landmarks in the vicinity of the site.

TABLE 2.2-4 (continued)

CLEAR CREEK SITE
POTENTIAL FEDERAL AND STATE LOCATION-SPECIFIC ARARs

Standard, Requirement Criteria, or Limitation	Citation	Description	Applicable/ Relevant and Appropriate?	Comments/Justification for Elimination from Further Consideration
STATE OF COLORADO				
WILDLIFE, NONGAME, ENDANGERED, AND THREATENED SPECIES	CRS 33-2-101 to-108	Provides for regulation of nongame wildlife and threatened and endangered species.	Yes/No	
HISTORIC PLACES REGISTER	CRS 24-80.1-101 to-108	Establishes requirements protecting properties of historical significance.	Yes/No	There are historic places in the vicinity of the site.
HISTORICAL, PREHISTORICAL, AND ARCHAEOLOGICAL RESOURCES ACT	CRS 24-80-401 to-410	Regulates historical, prehistorical, and archaeological resources.	Yes/No	There are historical resources in the vicinity of the site.
COLORADO STATE HISTORICAL SOCIETY	CRS 25-80-201 to-211	Requires preservation of historic character for sites within state or federal historic preservation areas.	Yes/No	There are historic sites in the vicinity of the site.

TABLE 2.2-5

CLEAR CREEK SITE
POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs

Standard, Requirement Criteria, or Limitation	Citation	Description	Alternatives That May Trigger ARAR		Comments/Justification for Elimination from Further Consideration
			Tailings	Water	
FEDERAL					
•CLEAN AIR ACT	42 USC § 7401				
National Primary and Secondary Ambient Air quality Standards	40 CFR Part 50	Establishes standards for ambient air quality to protect human health.	2,3,5,6, s.a.	None	No remedial alternatives are expected to be a major source of emissions. Some of the tailing/waste rock alternatives may require monitoring to demonstrate that NAAQS are not exceeded.
National Emission Standards for Hazardous Air Pollutants	40 CFR Part 61	Sets emission standards for designated hazardous pollutants.	None	None	Source types for which standards are promulgated are not expected to part of any remedial alternative. Arsenic standard may be a TBC for some tailings/waste rock alternatives.
•CLEAN WATER ACT	33 USC § 1251-1376				
Dredge and Fill Requirements	Section 404 40 CFR 230 33 40 CFR 320-330	Prohibits discharge of dredged or fill material into wetlands or navigable waters of the U.S. without permit. Preserves and enhances wetlands.	All except no action		All alternatives, except no action, may result in activities in the vicinity of wetlands.

TABLE 2.2-5 (continued)

CLEAR CREEK SITE
POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs

Standard, Requirement Criteria, or Limitation	Citation	Description	Alternatives That May Trigger ARAR		Comments/Justification for Elimination from Further Consideration
			Tailings	Water	
Ore Mining and Dressing Point Source	40 CFR Part 440	Establishes effluent limitations on certain mining and milling operations.	3	None	Relevant and appropriate for reprocessing alternatives.
The National Pollutant Discharge Elimination System (NPDES)	40 CFR Part 122	Requires permits for the discharge of pollutants from any point source into waters of the U.S.	3	2,3,4,5, s.a.	
NPDES - Stormwater Discharges	40 CFR Part 122.26	Establishes permitting processes and discharge regulations for storm water.	1,2,3,4,5, s.a.	None	Relevant and appropriate for alternatives where mine material comes into contact with stormwater or snowmelt.
•DOT HAZARDOUS MATERIALS TRANSPORTATION ACT	49 USC § 1801; 49 CFR Parts 107, 171-177	Regulates transportation of hazardous materials.	3,6	2A, s.a.	
•SOLID WASTE DISPOSAL ACT (Resource Conservation and Recovery Act)	42 USC § 6901-6987				
SUBTITLE C	40 CFR 264.258(b) (Waste Piles) 40	Regulates placement of a cap over RCRA hazardous waste.	3	2,3,4,5, s.a.	If reprocessing or passive treatment results in production of a RCRA hazardous waste.

TABLE 2.2-5 (continued)

CLEAR CREEK SITE
POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs

Standard, Requirement Criteria, or Limitation	Citation	Description	Alternatives That May Trigger ARAR		Comments/Justification for Elimination from Further Consideration
			Tailings	Water	
	40 CFR 264.310(a) (Landfills)	Regulates closure/consolidation of land units with RCRA hazardous waste.	3	2,3,4,5 s.a.	If reprocessing or passive treatment results in production of a RCRA hazardous waste.
	40 CFR Part 263	Establishes standards which apply to persons transporting hazardous waste within the U.S.	3	2,3,4,5, s.a.	If reprocessing or passive treatment results in production and transportation of RCRA hazardous waste.
SUBTITLE D	Section 4001-4010 40 CFR Part 241	Guidelines for the land disposal of non-hazardous solid waste.	3,4,5,6,7, s.a.	2B,3,4,5, s.a.	
STATE OF COLORADO					
•AIR QUALITY CONTROL ACT	CRS 2507-101 TO-512				
Ambient Air Quality Standards	5 CCR 1001-14	Sets ambient standards for TSP, SO_2, oxidants, CO, NO_2, Pb.	2,3,5,6	None	If remedial activities are a major source of emissions.
Regulation No. 1	5 CCR 1001-3 Reg. 1, Sec. III D	Minimize fugitive particulate omission control plant.	2,3,5,6	None	Non-specific sources including construction activities, storage and handling operation, haul roads and tracks.

TABLE 2.2-5 (continued)

CLEAR CREEK SITE
POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs

Standard, Requirement Criteria, or Limitation	Citation	Description	Alternatives That May Trigger ARAR		Comments/Justification for Elimination from Further Consideration
			Tailings	Water	
Regulation No. 3	5 CCR 1001-5 Reg. 3, Sec. IVD	Restricts exceedance in any attainment area of any NAAQS and requires an Air Pollution Emission Notice.			
Regulation No. 8	5 CCR 1001-10	Sets forth emission control requirements for hazardous air pollutants, including beryllium, mercury, and lead	3	None	
•COLORADO WATER QUALITY CONTROL ACT	CRS 25-8-101-TO-703 5CCR 1002-8,3.1.14 5CCR 1002-3,10.1.3	Regulates discharges to surface waters.	None	2,3,4,5, s.a.	
•HAZARDOUS WASTE ACT	CRS 25-15-101 TO-313				
Rules and Regulations Pertaining to Hazardous Waste	6 CCR 1007-3, Parts 260, 261, 262.11	Defines hazardous waste, requires waste characterization	3	2,3,4,5, s.a.	Only an ARAR if reprocessing or passive treatment results in production of a hazardous waste.

TABLE 2.2-5 (continued)

CLEAR CREEK SITE
POTENTIAL FEDERAL AND STATE ACTION-SPECIFIC ARARs

Standard, Requirement Criteria, or Limitation	Citation	Description	Alternatives That May Trigger ARAR		Comments/Justification for Elimination from Further Consideration
			Tailings	Water	
•SOLID WASTES DISPOSAL SITES AND FACILITIES ACT	CRS 30-20-101 to-118	Solid waste regulations. Establishes broad siting criteria and site evaluation procedures for individual storage and disposal units. Requires consideration of local land uses.	3,4,5,6, s.a.	2,3,4,5, s.a.	Only an ARAR if reprocessing or passive treatment results in production of a hazardous waste.
Solid Waste Regulations, Capping	6CCR 1007-2 Secs. 2.4.1, 2.4.2, 2.4.5, 2.4.6, 4.2.6	Final cover required to establish vegetative erosion protection and waste isolation for operation of solid waste facility. Submit closure plan and notify the Colorado Department of Health.	3,4,5,6, s.a.	2,3,4,5, s.a.	
Solid Waste Regulations, Surface Water Control	6 CCR 1007-2 Section 2.1.4	Provide drainage to prevent ponding, erosion, water, and air pollution	3,4,5,6, s.a.	2,3,4,5, s.a.	
Solid Waste Regulations	6 CCR 1007-2 Secs. 1.1, 1.2, 1.3.2, 2.1.1	Siting must maximize wind protection and minimize upstream drainage. No disposal in 100 year floodplain or into or below surface water or ground water.	3,4,5,6, s.a.	2,3,4,5, s.a.	

s.a. - Selected Alternative