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PUBLIC REVIEW DRAFT
Gladstone Interim Water Treatment Plant Engineering Evaluation/Cost Analysis (EE/CA)

U.S. Army Corps of Engineers
Omaha District

Bonita Peak Mining District Superfund Site
San Juan County, Colorado

November 2016

CDM Smith

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List of Acronyms and Abbreviations

Ag	silver
Al	aluminum
AMD	acid mine drainage
ARAR	applicable or relevant and appropriate requirement
ARD	acid rock drainage
As	arsenic
Au	gold
Be	beryllium
BERA	baseline ecological risk assessment
BLM	U.S. Bureau of Land Management
BPMD	Bonita Peak Mining District
Ca(OH)2	hydrated lime
Cd	cadmium
CDM Smith	CDM Federal Programs Corporation
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfs	cubic feet per second
COPEC	contaminants of potential ecological concern
Cu	copper
cy	cubic yards
Deere & Ault	Deere & Ault Consultants, Inc.
EE/CA	engineering evaluation/cost analysis
EPA	U.S. Environmental Protection Agency
Fe	iron
FS	feasibility study
gpm	gallons per minute
g/t	grams per ton
HDPE	high-density polyethylene
IWTP	interim water treatment plant
lb/day	pound per day
MDL	method detection limit
mg/L	milligrams per liter
µg/L	micrograms per liter
MIW	mine influenced water
Mn	manganese
NAVD88	North American Vertical Datum of 1988
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
NTCRA	non-time critical removal action
Pb	lead
PPE	personal protective equipment
PRSC	post-removal site controls

RA	removal action alternative
RAO	removal action objective
RFP	request for proposal
RI	remedial investigation
s.u.	standard units
TBC	to be considered
TCLP	toxicity characteristic leaching procedure
TechLaw	TechLaw, Inc.
TSS	total suspended solids
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
URS	URS Operating Services
WTP	water treatment plant
cy/year	cubic yards per year
Zn	zinc

Executive Summary

Introduction and Purpose

The listing of the Bonita Peak Mining District (BPMD) Site on the National Priorities List (NPL), or Superfund, became effective on October 11, 2016. The Gold King Mine, for which the U.S. Environmental Protection Agency (EPA) currently operates an interim water treatment plant (IWTP) to treat adit discharge, is included in the BPMD Site. A January 2016 Action Memorandum (EPA 2016b) for the emergency removal action, under which the Gladstone IWTP was constructed and is being operated, anticipated that the treatment plant would be operated through November 2016. The purpose of this engineering evaluation/cost analysis (EE/CA) and the subsequent Action Memorandum is intended to transition the Gladstone IWTP from the "emergency removal action" to a non-time critical removal action (NTCRA) response that is an interim action for the BPMD Site.

The EE/CA identifies preliminary removal action objectives (RAOs) of the NTCRA. The results of the EE/CA, along with EPA's response decision, will be summarized in an Action Memorandum after review and response to public comments on the EE/CA. Section 300.415 (b)(4)(i) of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) requires completion of an EE/CA for all NTCRAs. This EE/CA was developed by CDM Federal Programs Corporation (CDM Smith) for the U.S. Army Corps of Engineers (USACE) Omaha District on behalf of EPA Region 8 as part of Task Order No. DK02 under USACE Contract No. W912DQ-15-D-3013. The EE/CA was prepared in accordance with the NCP and the *Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA* (EPA 1993). In addition, the cost estimates for each removal action alternative were developed in accordance with *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA 2000).

Site Background

This EE/CA is considering RAOs for the NTCRA area that encompasses the Gold King Mine adit and the Gladstone IWTP. The NTCRA area is located about 9 miles north of Silverton, Colorado in the BPMD Superfund Site. Much of the area near Silverton, within the Upper Animas River watershed, historically was mined for gold and silver. The Gold King Mine was primarily a gold mine and operated until the 1920s. After the closure of the mine, multiple portals to other abandoned mines, near the NTCRA area, were closed with bulkheads. These actions led to increased flow from the Level 7 portal (Gold King Mine adit) of the Gold King Mine. On August 5, 2015, there was a release of 3 million gallons of mine influenced water (MIW) from the Gold King Mine adit. The MIW first entered the North Fork of Cement Creek, then the main stem of Cement Creek, then the Animas River.

After the release, EPA initiated an emergency removal action. As part of this action, the IWTP was installed near the old townsite of Gladstone. The Gladstone IWTP was operational by October 2015 and removes metals through a lime neutralization, flocculation, and precipitation process. Effluent from the Gladstone IWTP passes through geotextile filter bags before discharging to Cement Creek. Sludge from the process is managed on site in a sludge drying area.

Site Description

The NTCRA area is located within the Upper Animas River watershed and the Cement Creek watershed. The Gold King Mine adit is located about halfway up the North Fork of Cement Creek from the confluence with the mainstem Cement Creek, and the Gladstone IWTP is located near the confluence of the South Fork and the mainstem of Cement Creek (Figure 2-1). Elevations in the area range from approximately 10,500 feet North American Vertical Datum of 1988 (NAVD88) at the Gladstone IWTP to 11,440 feet NAVD88 at the Gold King Mine adit on the North Fork of Cement Creek.

Determination of Removal Action Scope

The scope of the EE/CA is limited to the MIW discharge from the Gold King Mine adit, and the goal of the NTCRA is to minimize the release of contaminants of potential ecological concern (COPECs) from this discharge to Cement Creek. This action is considered an interim action because it is expected that the remedial action for the Bonita Peak Mining District site will ultimately address the Gold King Mine adit discharge and other sources of MIW to Cement Creek. The surface water COPECs for Cement Creek, determined in a baseline ecological risk assessment, include total aluminum, dissolved beryllium, dissolved cadmium, dissolved copper, total iron, dissolved lead, dissolved manganese, dissolved silver, dissolved zinc, and pH.

The following RAO has been developed for the NTCRA area:

- Reduce the mass of surface water COPECs and total suspended solids (TSS) in MIW after discharge from the Gold King Mine adit.

Identification and Description of Removal Action Alternatives

Because of the limited purpose and scope of this EE/CA, only suspension of water treatment through a no action alternative and continued treatment through the currently installed and operating Gladstone IWTP alternative are being reviewed and analyzed to address MIW discharging from the Gold King Mine adit. The alternatives are:

- Alternative RA1: Continue Operation of the Existing Gladstone IWTP to Treat Gold King Mine Adit MIW Discharge
- Alternative RA2: Suspend Operation of the Existing Gladstone IWTP to Treat Gold King Mine Adit MIW Discharge

A brief description of each removal action alternative is presented in the following subsections. The scope of each alternative includes both near-term activities as well as post-removal site control (PRSC) for a period of 5 years. For either alternative, the subsequent Action Memorandum will discuss PRSC responsibilities (EPA 2009).

Alternative RA1

Alternative RA1 entails utilizing the existing Gladstone IWTP and associated MIW collection and conveyance infrastructure (built or modified during the emergency removal action) to continue treatment of the MIW discharging from the Gold King Mine adit to Cement Creek under the authority of an NTCRA as an interim action for the Bonita Peak Mining District Site. Because of the

limited purpose and scope of this EE/CA, significant improvements to or expansion of the Gladstone IWTP or to the Gold King Mine adit MIW collection and conveyance system are not being analyzed. Under this alternative, treatment of Gold King Mine adit MIW and PRSC would continue year-round.

PRSCs in Alternative RA1 include the following:

- Bi-weekly monitoring of MIW influent and effluent
- Periodic snow removal and delivery of hydrated lime ($Ca(OH)_2$) and polymer flocculant
- Management of sludge, as it densifies in geotextile filter bags and dries in the sludge drying area(s), and interim sludge management areas. Management of geotextile filter bags, including stacking of bags, would be performed as necessary to densify treatment sludge and maximize usable storage space at the sludge drying area(s).
- Inspection and maintenance of the adit discharge collection sump, equalization pond, and pipelines that connect the treatment infrastructure

Alternative RA2

Alternative RA2 entails suspension of treatment operations at the existing Gladstone IWTP, pending evaluation of broader potential water treatment needs. Under this alternative, water treatment of Gold King Mine adit MIW would be suspended. Discharge from the stabilized adit of the Gold King Mine would be routed around the mine dump and allowed to discharge into the North Fork of Cement Creek untreated, as was occurring prior to construction of the IWTP.

Under this alternative, the plant would not be dismantled, which would allow for potential restart of the treatment in the future. Maintenance required to shut down the plant would involve winterization, discontinuation of electrical services, and discontinuing delivery of $Ca(OH)_2$ and polymer flocculant. MIW from the Gold King Mine adit would be rerouted to the North Fork of Cement Creek to avoid degradation of the treatment infrastructure. Sludge buildup in the equalization ponds would be removed and placed to dry in the sludge drying area.

Detailed Analysis and Comparative Analysis of Removal Action Alternatives

These removal action alternatives are evaluated and compared using the criteria specified in EPA's *Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA* (EPA 1993). This EE/CA evaluates the two removal action alternatives against the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost, as well their sub-criteria. The results of the detailed analysis for each removal action alternative are presented in Exhibit ES-1 to allow a comparative analysis of the alternatives and identify the key tradeoffs between them as presented in the EE/CA.

Recommended Removal Action Alternative

Taking into consideration the evaluation criteria presented in this EE/CA, the recommended removal action alternative for the Gladstone IWTP is Alternative RA1: Continue Operation of Existing Gladstone IWTP to Treat Gold King Mine Adit MIW Discharge. Alternative RA1 includes utilizing the existing IWTP and associated infrastructure (built or modified during the emergency removal action) to continue treatment of the MIW from the Gold King Mine adit.

This alternative addresses the MIW discharge to Cement Creek and thus achieves the RAO. This alternative also has higher long-term effectiveness and permanence than Alternative RA2 and has reduction of toxicity and mobility of the COPECs through treatment unlike Alternative RA2. Short-term effectiveness and implementability issues are not significantly different between the two alternatives.

Alternative RA2 does not meet the RAO. While implementability of Alternative RA2 may be slightly higher than for Alternative RA1, it has lower long-term effectiveness and permanence as compared to Alternative RA1 and does not involve treatment.

The difference between costs for the two removal alternatives is significant. However, Alternative RA1 achieves acceptable overall protection of human health and the environment and compliance with applicable or relevant and appropriate requirements (ARARs) to the extent practicable, whereas Alternative RA2 does not achieves acceptable overall protection of human health and the environment and compliance with chemical-specific ARARs. In addition, the overall effectiveness based on “long-term effectiveness and permanence” and “reduction of toxicity, mobility, or volume through treatment” criteria is higher for Alternative RA1 than for Alternative RA2, and there is relatively little difference in ratings for the other criteria (Exhibit ES-1). Thus, the overall protectiveness of Alternative RA1 was determined to be proportional to its costs hence cost-effective, i.e., it represents a reasonable value for the money to be spent.

Exhibit ES-1. Summary of Comparative Analysis for Removal Action Alternatives

Removal Action Alternative	Description	Effectiveness					Implementability					Cost	
		Overall Protection of Human Health and the Environment	Compliance with ARARs	Long Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume through Treatment	Short Term Effectiveness	Technical Feasibility	Administrative Feasibility	Availability of Services and Materials	State (Support Agency) Acceptance	Community Acceptance	Present Value Cost (Dollars)	
RA1	Continue Operation of Existing Gladstone IWTP to Treat Gold King Mine Adit MIW Discharge	+	+	❸	❹	❸	❸	❸	❸	NE	NE	$$$$$	$7,326,000
RA2	Suspend Operation of Existing Gladstone IWTP to Treat Gold King Mine Adit MIW Discharge	–	–	❷	❶	❸	❸	❹	❹	NE	NE	$	$126,000

Notes:

1. The numerical designations for the qualitative ratings system used in this table are not used to quantitatively assess removal action alternatives (for instance, individual rankings for an alternative are not additive).
2. Detailed cost spreadsheets (cost summaries, present value analyses, and cost worksheets) for each alternative are presented in Appendix E.

Legend for Qualitative Ratings System:

Effectiveness and Implementability

For First Two Criteria

–	Unacceptable
+	Acceptable

For Rest of the Criteria

❶	None
❷	Low
❸	Low to Moderate
❹	Moderate
❺	Moderate to High
❻	High
NE	Not Evaluated

Cost

Present Value Cost in Dollars

❶	None
$	Low ($0 through $500K)
$$	Low to Moderate ($500K through $1M)
$$$	Moderate ($1M through $1.5M)
$$$$	Moderate to High ($1.5M through $2M)
$$$$$	High (Greater than $2M)

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Section 1
Introduction

This engineering evaluation/cost analysis (EE/CA) report for the Gladstone Interim Water Treatment Plant (IWTP) in the Bonita Peak Mining District (BPMD) Superfund Site was prepared by CDM Federal Programs Corporation (CDM Smith) for the U.S. Army Corps of Engineers (USACE) Omaha District on behalf of the U.S. Environmental Protection Agency (EPA) Region 8 as part of Task Order No. DK02 under USACE Contract No. W912DQ-15-D-3013.

The EE/CA was prepared in accordance with the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and the *Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA* (EPA 1993). In addition, the cost estimates for each removal action alternative were developed in accordance with *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA 2000).

1.1 Purpose

This EE/CA was prepared to support the selection of an alternative for the implementation of a non-time-critical removal action (NTCRA) for the Gladstone IWTP. For purposes of this EE/CA, the **NTCRA area** is limited to the following:

- **The Discharge From The Gold King Mine Adit And The Gladstone IWTP –** Refers to the previously installed water treatment plant (WTP) and infrastructure (e.g., ponds, pipelines) from the Gold King Mine adit to the treated effluent discharge to Cement Creek

The listing of the BPMD Site on the National Priorities List became effective on October 11, 2016. The Gold King Mine, for which EPA currently operates an interim water treatment plant (IWTP) to treat adit discharge, is included in the National Priorities List (NPL), or Superfund, Site. A January 2016 Action Memorandum (EPA 2016b.) for the emergency removal action under which the Gladstone IWTP was constructed and is being operated anticipated that the treatment plant would be operated through November 2016. The purpose of this EE/CA and the subsequent Action Memorandum is intended to transition the Gladstone IWTP from the "emergency removal action" to a non-time critical removal response that is an interim action for the Bonita Peak Mining District site.

The purpose of the EE/CA is to document the environmental review and removal action selection process and provide a framework for evaluating and selecting alternative technologies. The EE/CA identifies preliminary removal action objectives (RAOs) of the NTCRA and analyzes the effectiveness, implementability, and cost of removal action alternatives that may be used to satisfy the RAOs. The results of the EE/CA, along with EPA's response decision, will be summarized in an Action Memorandum after review and response to public comments on the EE/CA. Section 300.415 (b)(4)(i) of the NCP requires completion of an EE/CA for all NTCRAs. The results of the EE/CA, along with EPA's response decision, will be summarized in an Action Memorandum after review and response to public comments on the EE/CA.

1.2 EE/CA Organization

The EE/CA is organized as follows:

1. Summarize site characterization and present the nature and extent of contamination associated with the NTCRA (presented in Section 2).
2. Identify a removal action boundary for the NTCRA considered in this EE/CA and provide rationale (presented in Section 2).
3. Present the removal scope, schedule, and RAOs for the NTCRA (presented in Section 3).
4. Identify removal action alternatives that may be used to satisfy the RAO and evaluate the effectiveness, implementability, and cost (presented in Section 4).
5. Conduct a comparative analysis of removal action alternatives to each other with respect to effectiveness, implementability, and cost (presented in Section 5).
6. Recommend the removal action alternative that best meets the evaluation criteria (presented in Section 6).

Section 2
Site Characterization

The first part of this section presents an overview of the physical characteristics of the NTCRA area (the proposed removal action boundary) and previous removal actions completed within this area. The second part focuses on the contaminant source and transport within the NTCRA area.

2.1 Site Description and Background

Physical characteristics of the NTCRA area are presented in this section, including site location, background, topography, site features, climate, surface water, geology, hydrogeology, and ecology. Figure 2-1 shows the general vicinity of the Gold King Mine adit and Gladstone IWTP in relation to the BPMD Superfund Site, and Figure 2-2 shows more detail within the NTRCA area, which is the focus of this EE/CA.

2.1.1 Site Location

The Gold King Mine adit is approximately 9 miles north of the town of Silverton, CO off of Colorado State Highway 110 (Figure 2-1). The Gold King Mine adit has a latitude of 37.8945 N and longitude of 107.6384 W. It is located in the southeast quarter of Section 16, Township 42 North, Range 7 West on the U.S. Geological Survey (USGS) Ironton 7.5-Minute Topographic Quadrangle (USGS 2013).

The Gold King Mine adit is located along the North Fork of Cement Creek. The Cement Creek watershed originates in the San Juan Mountains in San Juan County, CO, and is a tributary to the Upper Animas River. Cement Creek is approximately 8 miles long, flowing from north to south before the confluence with the Animas River at Silverton, CO (Herron et al. 1998). The Animas River flows south from Silverton to Durango, CO, crosses into New Mexico, and joins the San Juan River in Farmington, NM.

2.1.2 Site Background

The Gold King Mine is one of numerous underground mining operations in the BPMD Superfund Site upstream of Silverton, CO. Olaf Nelson, a local miner, discovered the Gold King Mine in the late 1880s. Operation at the Gold King Mine began in the late 1880s and operated on and off until the early 1920s. During operation, the Gold King Mine produced over 700,000 tons of gold (Au) and silver (Ag) ore (EPA 2016a).

At the end of mining operations, the Gold King Mine and many other inactive or abandoned mines in the mining district continued to discharge mine influenced water (MIW) from adits into streams. The focus of this EE/CA is on managing and treating MIW discharge from the Gold King Mine adit. Previous response action activities conducted at the Gold King Mine adit are described below:

- 2014 and 2015: EPA investigations were performed around the Gold King Mine adit. (EPA 2016c).

- August 2015: While EPA was conducting work around the Gold King Mine adit, 3 million gallons of MIW was unexpectedly released from the mine. Upon the release, concentrated MIW discharged into the North Fork of Cement Creek, below the mine, and ultimately into the Animas River (EPA 2016c). EPA immediately began implementation of an emergency removal action to address the release.
- October 2015: As part of the emergency removal action to the Gold King Mine adit release, the Gladstone IWTP was constructed to treat discharge from the Gold King Mine adit (EPA 2016c).
- April 2016: The BPMD Site was proposed for addition to the NPL (EPA 2016d).
- June 2016: Steps were taken to stabilize the Gold King Mine adit (EPA 2016c).
- September 2016: The BPMD Site was listed on the NPL and the listing became effective on October 11, 2016 (EPA 2016d).

2.1.3 Site Topography

The Gold King mine adit and Gladstone IWTP are located in an area of rugged, steep topography within the San Juan Mountains in southwestern Colorado. Elevations in the area range from approximately 10,500 feet North American Vertical Datum of 1988 (NAVD88) at the Gladstone IWTP to approximately 11,440 feet NAVD88 at the Gold King Mine adit on the North Fork of Cement Creek. The location of the Gladstone IWTP is on relatively flat terrain just above the confluence of the South Fork and mainstem of Cement Creek.

2.1.4 Site Features

Watersheds within the San Juan Mountains, which include the Upper Animas River watershed and the Gold King Mine adit, contain some 400 abandoned or inactive mines, where large- to small-scale mining operations occurred (EPA 2016a). The focus of this EE/CA is solely the removal action operations at the Gold King Mine adit and the Gladstone IWTP, which is currently treating the MIW discharging from the Gold King Mine adit under an emergency removal action.

2.1.4.1 Gold King Mine Adit

Ore extraction at the Gold King Mine took place on seven levels. The initial entry point was at Level 1, at an elevation of approximately 12,160 feet. Exploration continued in a downward direction to Level 7. The Level 7 portal (Gold King Mine adit), at the elevation of approximately 11,440 feet, is the location of the MIW release in August 2015 and where discharge continues. Note, the vertical reference datum for these elevations is unknown.

MIW discharging from the Gold King Mine adit contains elevated concentrations of aluminum (Al), arsenic (As), cadmium, (Cd), copper (Cu), iron (Fe), manganese (Mn), and zinc (Zn). A sump was installed near the portal to collect the MIW in a pipe where it is gravity fed to the Gladstone IWTP.

2.1.4.2 Gladstone IWTP

The Gladstone IWTP utilizes a lime neutralization and precipitation process to treat MIW from the Gold King Mine adit. It is located at the old townsite of Gladstone, at an elevation of 10,500 feet (vertical reference datum unknown), about 1 mile southwest of Gold King Mine adit (Figure 2-2).

In response to the uncontrolled release of MIW water from the Gold King Mine adit in August 2015, the IWTP was designed and constructed by the contractor Alexco in 21 days after receiving notice to proceed from EPA. The Gladstone IWTP began operating in October 2015. Additional details on the IWTP processes are provided in Section 4.3 and in Appendix A. Metals removal efficiency in the Gladstone IWTP is discussed in detail in Section 4.3.2.

2.1.5 Climate

The location of the site has an alpine climate with snowy, cold winters and cool summers. The greatest amount of snowfall is between the months of November and April, with an average snowfall of 12 feet per year (EPA 2016b). Precipitation was evaluated by long-term precipitation data collected from the National Oceanic and Atmospheric Administration (NOAA) weather station at Silverton, CO, which is in close proximity to the NTCRA area. The weather station has a latitude of 37.809 N and a longitude of 107.663 W. In 2015, the Silverton station recorded annual precipitation of approximately 26 inches (NOAA 2016). In this alpine climate region, the minimum and maximum mean temperatures for January and July are 8°F/24°F and 36°F/72°F, respectfully (Chapman et al. 2006).

2.1.6 Surface Water

The Animas River watershed extends from the mountainous terrain above Silverton, CO, south into the San Juan River in Northern New Mexico (URS Operating Services [URS] 2012). The three major tributaries that flow into the Animas River at Silverton include Cement Creek, Mineral Creek, and the Upper Animas River. Cement Creek and the Upper Animas River below Silverton are briefly described as they are the receiving waters for the Gold King Mine adit MIW discharge.

2.1.6.1 Cement Creek

The Cement Creek watershed area is 20.1 square miles (12,864 acres) (USGS 2016a). Cement Creek occurs within the northern portion of the Animas River watershed. The Gold King Mine adit is located about halfway up the North Fork of Cement Creek from the confluence with the mainstem Cement Creek. The Gladstone IWTP is located near the confluence of the South Fork and the mainstem of Cement Creek.

The Cement Creek USGS stream gauge closest to the site is located at Silverton, CO (station 09358550), located near the confluence of Cement Creek and the Animas River, at elevation 9,386 feet NAVD88. The stream gauge location is shown on Figure 2-1. Daily stream discharge values have been recorded and averaged since 1991. The highest daily discharge occurs in early June, with an average flow of 166 cubic feet per second (cfs). The lowest daily discharges occur throughout January and February, with average flows of 12 to13 cfs. (USGS 2016a).

2.1.6.2 Upper Animas River below Silverton

Cement Creek enters the Upper Animas River on the east side of Silverton, CO. About 1 mile downstream from that confluence, Mineral Creek enters the Upper Animas River, south of town. USGS gauging station 09358000 is located about 0.7 miles downstream from the confluence of Mineral Creek and the Upper Animas River, at elevation 9,205 feet NAVD88 (USGS 2016b). The watershed area of the Upper Animas River measured from this station is 146 square miles (93,440 acres) (USGS 2016b). The stream gauge location is shown on Figure 2-1.

Daily flow rates have been recorded and averaged from 1991 through 2016. Over this 25-year period, the highest flows have occurred in early June, with an average flow rate of 1,260 cfs. Low flows have historically occurred in January and February, with an average flow rate of 59 cfs (USGS 2016b).

2.1.7 Geology

The geology of NTCRA area is relevant to the assessment of the hydrogeological framework and understanding of potential source materials. Therefore, this section focuses on the description of the bedrock geology and ore mineralization. Other aspects of the site geology were described by Burbank and Luedke (Burbank and Luedke 1969) and Free et al. (Free et al. 1989).

2.1.7.1 Stratigraphy

The Gold King Mine is located in the northern region of the collapsed, tertiary-aged Silverton caldera within the Silverton Volcanic Group (Free et al. 1989, Herron et al. 2000). Three main volcanic units compose the caldera fill (Free et al. 1989).

- The Eureka Tuff is the lowest formation in the Silverton Volcanic Group and is a lithic rhyolitic ashflow tuff.
- The Burns Formation is fairly uniform and most commonly composed of rhyodacite, ridged quartz-latic flows, and flow breccias and tuffs (Burbank and Luedke 1969, Free et al. 1989).
- The Henson Formation is the uppermost formation in the Silverton Volcanic Group, primarily andestitic pyroclastites. An irregular fracture system formed in this member, characterized by layers of volcanic breccias, lapillite, and tuffite.

The mine is located within the Burns Formation, which can be divided into upper and lower members. The lower member is characterized by rhyolitic flows, amphibole, and biotite. Approximately 25 feet of silicic material separates the two members and is primarily welded pumice-rich and pebble-rich tuff. Either side of the tuff layer contacts the adjacent member sharply and does not conform to volcanic flows. The upper member is characterized by pyroxene andesite, porphyritic lava flows, and a dense aphanitic mass (Burbank and Luedke 1969, Free et al. 1989). Faulting and volcanic intrusions created contorted layering in the Burns Formation. The Gold King Mine underground workings intersect the Bonita fault zone. From the entrance, the Gold King Mine Level 7 tunnel passes through the upper member, the tuff layer, the lower member, and back to the upper member. The Burns Formation experienced post-depositional tectonic strain, which created space for hydrothermal mineralization (Free et al. 1989).

2.1.7.2 Mineralization

Research conducted by Bernhard Free et al. is the main source of mineralization information for the Gold King Mine. Their research shows that mineralization near the NTCRA area occurred in two main phases 23 and 11 million years ago (Free et al. 1989). Base metal mineralization occurred first, during recurring volcanic activity near a quartz-monzonite stock, in the southern caldera region. Gold (Au) was mineralized epithermally from heat generated by movement of the Red Mountain porphyry stock, which is located in the north-central caldera region. It is hypothesized that meteoric hydrothermal solutions from the Red Mountain Stock funneled

through the open fracture system, causing several Au-concentrating alterations. In the BPMD, Au was concentrated in lodes, which are ore veins in fissures and between layers of rock.

Two of these lodes, the Gold King and Davis, are parallel and steeply inclined, extending about 0.7 miles from the Level 7 portal up to Level 1, which is just above the historic Sampson Adit (Free et al. 1989). Ore from these lodes was primarily banded quartz and pyrite, with sporadic galena, sphalerite, chalcopyrite, and unidentified Ag minerals (Burbank and Luedke 1969). The Au and Ag content within this ore was up to 3,016 grams per ton (g/t) and 1,088 g/t, respectively. Ore removed through the early 1900s produced about 14.65 g/t Au and 74.32 g/t Ag as well as minimal amounts of lead (Pb) and Cu (Free et al. 1989). The remaining ore is estimated to have a grade of 10.9 g/t Au and 90 g/t Ag, with 1,459 tons of ore reserve (Free et al. 1989).

The highest grade ore was present in the mid to upper part of the Burns Formation. The jasperoidal veins in the Henson formation, above the Burns Formation, were not as mineralized. The boundary between the two formations marks a transition zone between ore-containing rock below and the barren country rock above. Within the Burns Formation, argillic alterations contain the highest percentage of Au ore, whereas the acid-sulfate alterations contain low Au values (Free et al. 1989).

2.1.8 Site Hydrogeology

Years of mining and the installation of bulkheads has significantly influenced groundwater elevations within the BPMD Superfund Site. Historically, groundwater flowed along fractures and faults, with minimal leakage through bedrock, likely due to low primary permeability. With the advent of underground mining, bedrock groundwater that once followed natural fractures instead followed the new path of least resistance, the networks of tunnels in the underground mine workings. Thus, drainage and haulage tunnels form preferential flow paths for bedrock groundwater, leading to MIW formation when water and air interact with these mineralized source areas within the tunnels.

It has been hypothesized that groundwater naturally moved from the Sunnyside Basin toward Cement Creek, generally northeast to southwest (Simon Hydro-Search 1993). Field observations before the installation of the bulkheads documented a greater occurrence of natural springs along the east side of Cement Creek than along Eureka Gulch (Simon Hydro-Search 1993).

Permeability in the bedrock generally decreases with depth, as the overburden pressure increases, forming a near-surface aquifer within interconnected fractures and joints (Stover 2007). Additionally, permeability is greater within the welded tuffs such as the layer dividing the upper and lower members of the Burns Formation (Simon Hydro-Search 1993). Major fractures (secondary permeability) are one of the main conduits for groundwater flow between the mine workings.

Bulkheads at many of the mine portals were used to regulate water levels during the operation of the Sunnyside mine through 1991. Between 1997 and 2004, bulkheads were installed to stop the uncontrolled flow of water from the mines, including three locations on the American Tunnel (drainage tunnel from the Sunnyside mine), the Mogul mine, and multiple locations throughout the Sunnyside mine. The bulkheads modified the bedrock hydrogeology and resulted in changes in water flowing from adits. A bulkhead was installed at the Red and Bonita Mine in 2015, but the

valve was left open due to uncertainty about how it would affect groundwater elevations and discharging adits.

A groundwater elevation map was created in 2016 by Deere & Ault Consultants, Inc. (Deere & Ault), using three data points: a 2001 depth reading from the Sunnyside Mine pool, a 2002 measurement of pressure behind the Bulkhead 2 on the American Tunnel, and a constant flow rate (~550 gallons per minute [gpm]) from the Gold King Mine adit, which suggests a groundwater connection rather than a surface drainage (Deere & Ault 2016). This figure is reproduced herein as Figure 2-3. This figure shows the static water elevation is at least 11,500 feet (vertical reference datum unknown), just higher than the Gold King Mine adit.

2.1.9 Human Health and Ecological Risks

2.1.9.1 Human Health Risk

As of October 2016, a human health risk assessment for the BPMD Superfund Site or Gladstone IWTP NTCRA area has not been conducted.

2.1.9.2 Terrestrial Ecology

The NTCRA area is located in the Volcanic Subalpine Forests ecoregion of Colorado (Chapmen et al. 2006). This area is characterized by high elevation, steep-sloped, glaciated mountains and high-gradient perennial streams. In this zone, the vegetation is dominated by subalpine firs, Englemann spruce, whortleberry, kinnikinnick, snowberry, sedges, mountain brome, and forbs. The Gold King Mine adit is about 600 feet below the treeline. However, areas disturbed by mining activities have sparse vegetative cover (URS 2012). The primary soil orders found in the NTCRA area are Inceptisols, Alifsols, and Mollisols.

In a wetland and sensitive species survey conducted by URS in 2011, the fauna in the area around the Gold King Mine adit and Gladstone IWTP were identified. Mammalian species found included American elk, mule deer, Golden-mantled ground squirrels, Colorado chipmunks, American pika, and the yellow-bellied marmot. Bird species observed in late-summer included Cooper's hawk, spotted sandpiper, golden eagle, red-tailed hawk, Cassin's finch, Yellow-rumped warbler, junco, Lincoln and White-crowned sparrows, gray jay, and the American robin. None of these species are considered threatened or endangered by the federal Endangered Species Act or Colorado Parks & Wildlife (URS 2012).

2.1.9.3 Aquatic Ecology

In a 1997 USGS benthic macroinvertebrate survey, water quality at the mouth of Cement Creek was deemed "impaired," ranking 74.1 out of 100 on the impairment scale (Church et al. 2007). A study in 2002 found that the number of aquatic taxa in the Animas River decreases significantly after the confluence with Cement Creek (Church et al. 2007). The presence of ferricrete (iron oxy-hydroxide precipitates), which creates a solid layer along the creek bed, may contribute to the lack of habitat for macroinvertebrates. In a 2013 EPA study, no fish were found for approximately 2 miles downstream of Cement Creek in the Animas River (EPA 2016b).

2.1.9.4 Ecological Risk Assessment

EPA funded a baseline ecological risk assessment (BERA) that was conducted from 2009 to 2014 and published in April 2015 (TechLaw, Inc. [TechLaw] 2015). The following information is summarized from that report, which focused in part on the risks associated with exposure to surface water and sediment for aquatic and wildlife receptors in the mainstem of Cement Creek.

The contaminants of potential ecological concern (COPECs) in the surface water in the mainstem of Cement Creek include pH, total Al, dissolved beryllium (Be), dissolved Cd, dissolved Cu, total Fe, dissolved Pb, dissolved Mn, dissolved Ag and dissolved Zn (TechLaw 2015). The chronic benchmarks for Al and Fe are based on the total metals due to the potential formation of iron and aluminum oxy-hydroxide precipitates; therefore, those COPECs are for total Al and total Fe. The sediment COPECs in Cement Creek include As, Be, Cu, Pb, Ag, and Zn.

It was found that the benthic macroinvertebrate population in the mainstem of Cement Creek was impaired due to poor surface water and sediment quality as well as lack of habitat for macroinvertebrates. Furthermore, the water chemistry in Cement Creek is highly toxic and acutely lethal to fish, primarily due to low pH and high Al concentrations but also elevated Cd, Cu, and Zn. The 6-year study found that the water quality in Cement Creek would cause lethal stress to fish and would be acutely toxic to juvenile rainbow trout. It is worth noting that the pre-mining, natural state of Cement Creek may not have supported benthic macroinvertebrates nor fish due to the naturally occurring low pH and high metals concentrations (TechLaw 2015).

Analysis of the hazard quotients suggested that the sediment posed moderate risk and that the surface water posed high risk to the benthic macroinvertebrate population.

The fate and transport of contaminants and exposure pathways for wildlife receptors were not investigated for Cement Creek since the communities of fish and aquatic invertebrates in the creek were minimal or non-existent.

2.1.10 Surrounding Land Use and Population

The Gold King Mine and Gladstone IWTP are approximately 9 miles north of Silverton, CO. The population in 2015 in the community of Silverton was estimated to be 637 (U.S. Census Bureau 2016). Historically, mining was the main industry in the area; therefore, there are many inactive and abandoned mines within the Cement Creek watershed. Tourism (including skiing and recreation) and construction are now the most common industries. (datausa.com 2016, city-data.com 2016). There is a ski area north of Silverton, which is south of the NTCRA Site. The ski area is limited to a single lift and small parking lot.

The land east of Cement Creek, near the Gladstone IWTP, is divided into several private mining claims, with a small parcel of land adjacent to the IWTP managed by the U.S. Bureau of Land Management (BLM). Much of the land west of Cement Creek is managed by the BLM and is interspersed with a few private mining claims.

2.2 Previous Response Actions

In summer 2015, EPA was conducting work around the Gold King Mine adit. The uncontrolled release of MIW from the Gold King Mine adit occurred during this work.

Following the release, EPA initiated emergency removal actions under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Section 104 and requested an exemption from 12-month and $2 million limits to address appropriate response actions.

Initial emergency removal actions at the NTCRA area included:

- Installation of the Gladstone IWTP in the former townsite of Gladstone, with a treatment capacity of 1,200 gpm (EPA 2016c)
- Construction of a series of equalization ponds to ensure consistent influent flow rates into the IWTP (EPA 2016c)
- Stabilization of the Gold King Mine adit portal entrance with shotcrete and steel reinforcement structures (EPA 2016b)
- Improvement of access road to the Gold King Mine adit portal (EPA 2016b)

The response activities, beyond what are described in the text above, and associated activity costs, as of July 15, 2016, are shown in Exhibit 2-1 (EPA 2016c).

Exhibit 2-1. Costs in Response to Incident

Emergency Response Activities	Costs
Mine Stabilization and Mitigation of Mine Drainage	$7,312,175
Sampling, Data Management, and Analysis	$7,573,594
Agency Personnel	$4,958,735
Interim Water Treatment Plant	$2,675,162
Alternative Water and Animal Feed	$1,698,553
Reimbursement of State, Tribal, and Local Response Costs	$1,622,224
Other (e.g., Protective Clothing, Supplies, and Materials)	$757,771
Total	$26,598,214
Funds Provided for State and Tribal Water Quality Information	
State and Tribal Monitoring Grants	$2,270,900
Real Time Monitoring	$600,000
Public Education and Outreach	$100,000
Total	$2,970,900

Adapted from EPA's "One Year After the Gold King Mine Incident; A Retrospective of EPA's Efforts To Restore and Protect Impacted Communities" (EPA 2016c).

2.3 Source, Nature, and Extent of Contamination

The Gold King Mine adit is one of many mines in the BPMD Superfund Site discharging MIW and affecting surface water. The scope of this EE/CA is limited to evaluation of the NTCRA area, and so the discussion is focused on this mine and facility. The discussion further focuses on the surface water COPECs identified in the 2015 BERA, as discussed in Section 2.1.9.

As part of the upcoming CERCLA remedial investigation (RI) and feasibility study (FS) process, the nature and extent of the other contaminant sources in the Animas River watershed and appropriate remedial alternatives will be subject to future evaluations that are wider in scope than the areas evaluated in this EE/CA.

2.3.1 Contaminant Fate and Transport

The source of contamination evaluated in this EE/CA is the discharging MIW from the Gold King Mine adit. MIW is water that is contaminated or influenced by mining-related activities. It is a broad term that does not specify the source of the contamination (other than a mining activity) or the pH of the water. MIW can include both acid mine drainage (AMD) and acid rock drainage (ARD) or water that is not acidic. AMD is metal-bearing, acidic water discharged from underground mine workings through adits, tunnels, or shafts. ARD is a similar discharge of metal-bearing acidic water resulting from water seeping or flowing through and from acid-generating materials such as pyritic waste rock, tailings piles, or mineralized rock formations. Both of these terms provide more information about the source and nature of the water than does the term MIW. In this EE/CA, the impacted water is referred to as either "MIW" or "acidic MIW."

Acidic MIW forms when water and oxygen interact with sulfide-rich mine wastes, host rocks, or vein rocks. Sulfuric acid forms and can dissolve additional metals into the MIW. This MIW can discharge through adit portals or via seeps and springs in the groundwater and enter surface water. The Gold King Mine adit is one of many mines discharging MIW to local surface waters.

In the BPMD Superfund Site, the surface waters in the main stems of Cement Creek, Mineral Creek, and the Upper Animas River carry high loads of total and dissolved metals and high acidity into the Animas River in the vicinity of Silverton even though substantial dilution with cleaner water occurs. Aquatic life in the affected waterways is exposed to the elevated levels of COPECs. In Cement Creek, current metal levels are high enough and pH levels low enough to cause Cement Creek to be essentially devoid of aquatic life.

2.3.2 Gold King Mine Adit Water Quality and Discharge

This section summarizes the flow rate and water quality information for untreated MIW discharging from the Gold King Mine adit after the release in August 2015. The samples of untreated MIW were collected at the influent of the Gladstone IWTP and not at the adit because of the ongoing construction and portal rehabilitation activities. The data are currently the closest samples representative of water quality discharging from the Gold King Mine adit.

Flow rates, influent water quality, and treated effluent water quality data are presented in Table 2-1. Figures 2-4 through 2-14 show dissolved and total metals concentrations as well as pH and flow for the influent and effluent to the IWTP. Exhibit 2-2 summarizes the influent data (i.e., untreated Gold King Mine adit discharge) for the Cement Creek COPECs. The untreated Gold King

Mine adit discharge exhibits a low pH and contains elevated concentrations of heavy metals, Fe and Al, including elevated concentrations of most of the surface water COPECs.

Exhibit 2-2. Influent COPEC Concentrations and Flow Rate of MIW from The Gold King Mine Adit

COPECs and Flow Rate	Units	Values		
		Min	Max	Average
Flow Rate	gpm	300	961	540
Aluminum, Total	µg/L	13,000	75,000	26,957
Beryllium, Dissolved	µg/L	2.5	9.3	6.0
Cadmium, Dissolved	µg/L	35	170	66
Copper, Dissolved	µg/L	1,900	11,000	4,904
Iron, Total	µg/L	49,000	340,000	118,087
Lead, Dissolved	µg/L	0.3	35	12
Manganese, Dissolved	µg/L	1.2	30,000	23,391
pH	s.u.	3.3	3.4	3.3
Silver, Dissolved	µg/L	0.1	2.0	0.2
Zinc, Dissolved	µg/L	11,000	45,000	19,609

Note: Statistics of data from 10/19/2015 to 7/22/2016. For the statistical calculations, n=26 for flow; n=23 for Al, Be, Cd, Cu, Fe, Pb, Mn, Ag, and Zn; and n=3 for pH.
s.u. = standard units; µg/L = micrograms per liter

The maximum flow rate of 961 gpm occurred in April 2016 after personnel intentionally shut down inflow into the IWTP for several hours for maintenance, which allowed the equalization ponds to fill. The high flow rate represents a brief, rapid emptying of the equalization ponds for treatment and not flow from the adit. The highest concentrations of Al, Cd, Cu, Fe, Ag, and Zn occurred in June and July and do not appear to correspond with any flow rate trends. For all COPECs except for Ag, the lowest concentrations were observed in March and April. No trend was observed for Ag because the concentrations observed in October through April were not detected above the laboratory method detection limit (MDL).

2.3.3 Gladstone IWTP Effluent Water Quality and Discharge

This section summarizes the flow rate and water quality information for the treated Gladstone IWTP effluent. The flow rate into and out of the IWTP is the same. Further information on the Gladstone IWTP process and treatment effectiveness is provided in Section 4.3.

Exhibit 2-3. Gladstone IWTP Effluent Flow Rate and COPEC Concentrations

COPECs and Flow Rate	Units	Statistic		
		Minimum	Maximum	Average
Flow	gpm	300	961	540
Aluminum, Total	µg/L	170	12,000	3,094
Beryllium, Dissolved	µg/L	0.2	1.8	0.2
Cadmium, Dissolved	µg/L	0.2	44	5.7
Copper, Dissolved	µg/L	1.4	680	50
Iron, Total	µg/L	270	50,000	10,576

Exhibit 2-3. Gladstone IWTP Effluent Flow Rate and COPEC Concentrations (continued)

COPECs and Flow Rate	Units	Statistic		
		Minimum	Maximum	Average
Lead, Dissolved	µg/L	0.1	1.5	0.2
Manganese, Dissolved	µg/L	18	25,000	12,545
pH	s.u.	6.8	9.4	8.4
Silver, Dissolved	µg/L	0.1	0.1	0.1
Zinc, Dissolved	µg/L	26	11,000	645

Note: Statistics of data from 10/19/2015 to 7/22/2016. For the statistical calculations, n=25 for Al and Fe; n=23 for Be, Cd, Cu, Pb, Mn, Ag, pH, and Zn; and n=26 for flow.

COPEC concentrations in the treated effluent generally have decreased since the beginning of operations. All maximum concentrations reported in Exhibit 2-3 occurred before 2016, with the exception of dissolved Pb, which peaked in February 2016. The maximum concentrations of treated effluent do not correspond with the maximum concentrations of the untreated MIW influent. This suggests that the higher effluent concentrations occurred during the first few months when the operation of the IWTP was being adjusted and are not necessarily dependent on influent concentrations.

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Section 3

Removal Action Scope, Goals, and Objectives

3.1 Statutory Limits on Removal Actions

Section 104(c)(1) of CERCLA requires that Superfund–financed removal actions not continue after $2 million has been obligated for the response action or 12 months has elapsed from the date of the initial response to a release or threatened release of hazardous substances. A removal action may qualify for exemption from the $2 million/12-month statutory limits; the conditions for an exemption include one or more of the following:

- Continued response actions are immediately required to prevent, limit, or mitigate an emergency; there is an immediate risk to public health or welfare or the environment; and such assistance will not otherwise be provided on a timely basis.
- Continued response action is otherwise appropriate and consistent with the remedial action to be taken.

As discussed in Section 2.2, emergency removal action work commenced in August 2015; therefore, emergency removal actions have been ongoing for approximately 1 year, 2 months. Expenditures from the commencement of emergency removal action work to July 15, 2016 as indicated in Exhibit 2-1 have been approximately $26.6 million. The exemption listed in the first bullet was invoked to continue above the statutory limits for cost and duration.

For this EE/CA and subsequent Action Memorandum decision document, the exemption from the $2 million/12-month statutory limit is based on second bullet above, the continued response action is otherwise appropriate and consistent with the remedial action to be taken.

3.2 Determination of Removal Action Scope

The scope of the EE/CA is limited to the MIW discharge from the Gold King Mine adit, and the goal of the NTCRA is to minimize the release of COPECs from this discharge to Cement Creek. This action is considered an interim action because it is expected that the remedial action for the BPMD Superfund Site will ultimately address the Gold King Mine adit discharge and other sources of MIW to Cement Creek. The surface water COPECs for Cement Creek, determined in a BERA, include total aluminum, dissolved beryllium, dissolved cadmium, dissolved copper, total iron, dissolved lead, dissolved manganese, dissolved silver, dissolved zinc, and pH.

The following RAO has been developed for the NTCRA area:

- Reduce the mass of surface water COPECs and total suspended solids (TSS) in MIW after discharge from the Gold King Mine adit.

3.3 Determination of Tentative Removal Action Schedule

Through the emergency removal action work, the Gladstone IWTP is essentially complete and operational. Additional activities would need to be performed as part of the NTCRA to either continue or suspend IWTP operations. The remaining activities would need to be implemented during the 2017 construction season (during the summer months when the ground is clear of snow, presumed June 2017). The following is a tentative schedule of major removal action milestones:

Activity	Tentative Date
Draft EE/CA	November 2016
Public comment period	November through December 2016
Response to significant public comments	December 2016
Action Memorandum	December 2016
Removal action design/planning	January 2017 through June 2017
NTCRA implementation start	Upon Action Memorandum completion
NTCRA implementation completion	5 years – anticipated January 2022

The scope of each alternative includes both near-term activities as well as PRSC for a period of 5 years. For either alternative, the subsequent Action Memorandum will discuss PRSC responsibilities (EPA 2009).

3.4 Planned Remedial Activities

There are additional remedial activities currently being planned for the NTCRA area. EPA is currently reviewing other potential data needs to determine future RI activities at the BPMD Superfund Site. Some of these activities may be conducted within or in close proximity to the NTCRA area identified within this EE/CA.

Section 4

Identification and Analysis of Removal Action

4.1 Overview

This section describes and analyzes each removal action alternative identified and developed to address MIW discharging from the Gold King Mine adit.

The following removal action alternatives were identified for evaluation in this EE/CA:

- Removal Action Alternative (RA) 1: Continue Operation of Existing Gladstone IWTP for Gold King Mine Adit MIW Discharge
- RA2: Suspend Operation of Existing Gladstone IWTP for Gold King Mine Adit MIW Discharge

These removal action alternatives are evaluated and compared using the criteria specified in EPA's *Guidance on Conducting Non-Time-Critical Removal Actions under CERCLA* (EPA 1993). Evaluation criteria are used to compare removal action alternatives in the areas of effectiveness, implementability, and cost. The evaluation criteria and subcriteria are:

Effectiveness

- **Overall Protection of Human Health and the Environment –** This subcriterion evaluates how each alternative achieves adequate protection and describes how the alternative will reduce, control, or eliminate risks at the NTCRA area through the use of treatment, engineering, or institutional controls. This evaluation should identify any unacceptable short-term impacts.
- **Compliance with Applicable or Relevant and Appropriate Requirements (ARARs) and Other Criteria, Advisories, and Guidance –** This subcriterion evaluates how each alternative addresses/complies with ARARs of federal and state statutes as well as other criteria, advisories, and guidance that are typically identified as "to be considered" (TBC) information. A list of ARARs and TBCs are provided in Appendix B.
- **Long-Term Effectiveness and Permanence –** This subcriterion evaluates the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes in the NTCRA area. Magnitude of risk as well as adequacy and reliability of controls are specific factors evaluated.
- **Reduction in Toxicity, Mobility, or Volume of Waste –** This subcriterion evaluates EPA's policy of preference for treatment (i.e., for technologies that will permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances as their principal element).

- **Short-Term Effectiveness –** This subcriterion evaluates the effects of the alternative during implementation before the removal objectives have been met. Alternatives should also be evaluated with respect to their effects on human health and the environment following implementation. Protection of the community, protection of the workers, environmental impacts, and time until response objectives are achieved are specific factors evaluated.

Implementability

- **Technical Feasibility –** This subcriterion evaluates the ability of the technology to implement the remedy. The reliability of the technology is also of concern as technical problems associated with implementation may delay the schedule.

- **Administrative Feasibility –** This subcriterion evaluates those activities needed to coordinate with other offices and agencies. The administrative feasibility of each alternative should be evaluated, including the need for offsite permits, adherence to applicable non-environmental laws, and concerns of other regulatory agencies. Statutory limits as well as permits and waivers are specific factors evaluated.

- **Availability of Services and Materials –** This subcriterion determines if offsite treatment, storage and disposal capacity, equipment, personnel, services and materials, and other resources necessary to implement an alternative will be available in time to maintain the removal schedule. Availability of funds to meet post-removal site controls (PRSC) requirements is also a factor.

- **State (Support Agency) Acceptance –** This subcriterion evaluates the State of Colorado's (through the Colorado Department of Public Health and Environment [CDPHE]) anticipated response to and acceptance of a removal action alternative.

- **Community Acceptance –** This subcriterion evaluates the public's anticipated response to and acceptance of a removal action alternative.

Cost

- **Direct Capital Costs, Indirect Capital Costs, and Annual PRSC Costs –** This subcriterion evaluates the capital for materials, equipment and related items, and the annual PRSC cost. Cost estimates for each removal action alternative were developed in accordance with *A Guide to Developing and Documenting Cost Estimates during the Feasibility Study* (EPA 2000). As stated in this guidance, it is also pertinent to development of cost estimates for an EE/CA.

The last two subcriteria of implementability (State Acceptance and Community Acceptance) are not directly evaluated in this EE/CA. The agency acceptance and the community acceptance criteria are evaluated when the final decision on the proposed removal action is selected in conjunction with the preparation of the Action Memorandum. These two subcriteria are extremely significant; careful planning and consideration are required to gain adequate acceptance.

The descriptions and evaluation using the qualitative ratings system of each removal action alternative (RA1 and RA2) are presented in Sections 4.4, and 4.5, respectively. The qualitative rating categories are defined in Exhibit 5-1 in Section 5. The detailed rationale for the ratings is provided in Appendix C.

4.2 Assumptions Affecting Development of Removal Alternatives

Several primary assumptions affect the development of removal action alternatives evaluated in this EE/CA. These assumptions are driven by requirements of the RAOs and ARARs identified in Appendix B. These primary assumptions were taken into consideration during development of removal action alternatives and include the items listed in Exhibit 4-1:

Exhibit 4-1. Primary Assumptions

Primary Assumption	Rationale
The evaluation is limited to the existing IWTP and associated water treatment infrastructure for the Gold King Mine adit.	The scope of this EE/CA is to evaluate continuing or suspending water treatment operations and not expansion or modification of the existing IWTP and associated MIW collection and transfer infrastructure from the Gold King Mine adit that was installed during the emergency removal action. No other mine water discharges will be treated or otherwise accommodated as part of this evaluation. Evaluation of broader site water treatment needs (which include expansion or modification of the existing IWTP and/or MIW collection and transfer infrastructure) is expected to be addressed in a future CERCLA response action evaluation.
The basis of the RAO and subsequent evaluation focuses on surface water COPECs from the draft final BERA and TSS.	The basis of the RAO and subsequent evaluation is focused on surface water COPECs because there is an available draft BERA for the watershed (Techlaw 2015) indicating adverse ecological risks to aquatic receptors. TSS is included as a basis for the RAO because it is indicative of suspended minerals, which in an acidic aqueous environment can cause adverse impacts to aquatic receptors such as benthic macroinvertebrates through mineralogical coatings on their habitat.
The effectiveness evaluation is limited to an evaluation of "end of pipe" contaminant mass reductions rather than evaluations of contaminant mass reductions in Cement Creek.	Contaminant mass reduction through treatment is assumed to occur only through the IWTP process. If operations are suspended, adit discharge will return to surface water in the North Fork of Cement Creek untreated, and no contaminant mass reduction is assumed. State water quality standards for Cement Creek are used as a point of comparison for contaminant concentrations in treated effluent. However, the concentrations of COPECs attributable to natural or anthropogenic background or releases from mines other than the Gold King Mine adit have not been determined. Thus, the impacts of the treated or untreated MIW from the Gold King Mine adit to changing conditions in Cement Creek are not evaluated but rather changes that can be demonstrated at the point of entry into surface water of Cement Creek (i.e., "end of pipe" concentrations).
Evaluation of human health risks are excluded from EE/CA evaluation.	Human health risks are excluded from direct evaluation in this EE/CA because a human health risk assessment is not yet available for the site and human health risks are not known to exist above background conditions from exposure to surface water contamination in Cement Creek. However, for most of the mining-related metals of concern, the chemical-specific ARARs (i.e., state water quality standards) for protection of aquatic life are evaluated, which tend to be more stringent than those that are protective of human health.
Gladstone IWTP is evaluated in the EE/CA as currently configured.	The Gladstone IWTP, under current emergency removal actions, undergoes periodic modifications to increase effectiveness and reduce cost. The IWTP configuration described in the technical memorandum in Appendix A is the basis for EE/CA evaluation. This technical memorandum outlines the capabilities of the IWTP along with some of the unknown conditions from the Gold King Mine adit discharge that the IWTP may not be able to fully address as part of current operations and configuration.

Exhibit 4-1. Primary Assumptions (continued)

Primary Assumption	Rationale
Evaluation based on the existing operating and cost data from the Gladstone IWTP and the Gold King Mine adit discharge after the IWTP was installed.	Analytical data were provided by EPA on September 7, 2016 via email and represent data from October 19, 2016 through July 22, 2016. Data from other outside parties was not used. This cutoff date was used so that data presentation was not in continuous change in the EE/CA. The EE/CA evaluation is caveated that it can only evaluate the performance of the IWTP to date and that this is not intended to address all discharges that could emanate from the Gold King Mine adit in the future. The Gold King Mine adit discharges water from a dynamic groundwater system undergoing changes in flow rate and geochemistry and is only under physical control insofar as the mine portal has been stabilized. Drastic changes within the mine (collapses, sludge wasting, rapid inflows of groundwater) may happen, and the ability of the IWTP to address changing conditions is not evaluated in any detail, but the uncertainty will be discussed. Furthermore, the evaluation is based on an assumption that because existing data are used, performance and cost changes to the IWTP operations due to change in operator are not included in this evaluation.
Long-term disposal location for sludge is excluded from EE/CA evaluation.	Sludge volume generation from the Gladstone IWTP is estimated to be about 6,000 cubic yard (cy)/year. Sludge generation could change if modifications to the IWTP are made. There is sufficient capacity at the Gladstone IWTP under current generation rates to store approximately 1 year of sludge. Because the timeframe for the period of analysis is for 5 years, it is assumed that if IWTP operation continues, an additional interim management location for sludge would be identified by EPA and readied for use prior to mid-2017 so that sludge could be transported to this additional location for interim management. However, evaluation of long-term or permanent sludge disposal options is excluded from this EE/CA and is expected to be addressed in a future CERCLA response action evaluation, recognizing that sludge management and disposal may be a long-term BPMD site need.
Evaluation of state ARARs is limited to Colorado.	The site is located in Colorado, but the release of MIW impacted the Animas River, which flows out of Colorado into the San Juan River in New Mexico. Because the evaluation is only looking at point of entry into surface water in Cement Creek and is not looking at broader effects on surface water, downstream effects and effects across state boundaries are not evaluated. Therefore, the evaluation of state ARARs is strictly limited to Colorado. New Mexico ARARs are excluded as the EE/CA even though the New Mexico ARARs were identified in the first Action Memorandum for the Gold King Mine. As the CERCLA process moves forward, EPA may consider ARARs from downstream states and/or sovereign nations impacted by the MIW release.
Evaluations of alternatives that suspend IWTP operations assume mothballing rather than dismantling equipment (other than the lime silo) and does not include a restart of the IWTP.	The EE/CA evaluation assumes that due to uncertainty in future response actions needs at the BPMD Superfund Site, suspension of operations at the Gladstone IWTP would involve “mothballing” rather than dismantling the IWTP and associated water conveyance and treatment to allow future restart to quickly occur. However, a restart is not assumed within the 5-year period of analysis because the need to restart likely would not be required within the same period. The exception to the approach of mothballing equipment is the lime silo, which is a rented piece of equipment; the assumption is the lime silo would be removed and returned to the rental vendor. With suspension of treatment operations, the system will be taken offline and discharge from the Gold King Mine adit will be allowed to flow out of the portal through conveyance channels and into surface water as it was before initiation of the emergency removal action. To preserve the IWTP infrastructure, the acidic MIW from the Gold King Mine adit is assumed to no longer be routed down to the Gladstone area through the pipes and equalization ponds. Instead, MIW would be routed from the adit to the North Fork of Cement Creek untreated, as was occurring prior to construction of the Gladstone IWTP.

4.3 Existing Gladstone IWTP Components and Performance

4.3.1 Gladstone IWTP Components

The Gladstone IWTP was constructed in response to EPA's request for proposals (RFP) for a "fully automated water treatment facility" to treat AMD from the Gold King Mine adit. The plant was designed and substantially operational within 21 days of the notice to proceed from EPA. To summarize the components and capabilities of the Gladstone IWTP, a summary technical memorandum of the treatment plant components and capabilities is included with this EE/CA as Appendix A. Highlights of the treatment process and components described in the memorandum are described here and shown in the process diagram, Figure 4-1.

The Gladstone IWTP entails a single-stage, lime neutralization process to raise the pH of the MIW and precipitate and remove heavy metals, Fe and Al, as metal hydroxides. The key components to the chemical treatment process are the lime-neutralization reactor, flocculation basin, the inclined plate clarifiers, the geotextile filter bags, electrical power, and control system. The initial RFP specified an average of 600 gpm of MIW, with a range of 200 to 900 gpm, and a hydraulic spike of up to 1,200 gpm. The RFP requirements and Gladstone IWTP design capacities are provided in the technical memorandum in Appendix A.

Gold King Mine adit MIW is delivered by gravity from the adit discharge collection sump through a 4,000-foot long high-density polyethylene (HDPE) pipeline to settling equalization ponds at the upper Gladstone area and then is gravity drained into the Gladstone IWTP lime-neutralization reactor. Figure 2-2 shows a map of the NTCRA infrastructure. Hydrated lime (Ca(OH)2) is added as a slurry to the treatment reactor at a rate to achieve a target pH of between 7.5 and 9.0 in the flocculation basin immediately downstream of the reactor. Polymer flocculent is added to coagulate the metal hydroxide sludge particles in the slowly agitated flocculation basin to encourage particle coagulation. The flow enters an inclined plate clarifier (two clarifiers available) where particles impinge upon inclined plates to promote settling of the sludge and allow treated water to overflow and discharge to Cement Creek.

The sludge settles to a cone at the base of the clarifier where it is pumped to geotextile bags for filtration and sludge consolidation. Metals removal efficiency from this treatment process is shown on Tables 4-1 and 4-2. Water expressed through the filter bags ("bag filtrate") is of the same quality as the clarifier overflow. It can be pumped back to the treatment system or discharged directly to the creek; currently, the water is pumped back into the treatment system for ease of monitoring and because some sludge can make it through the bags at times. The filter bags gradually fill with sludge and when full can be taken offline to further decant and consolidate. Percentages of solids in the sludge range from approximately 10 to 15 percent. Higher percent solids are achieved by stacking the bags or allowing the sludge to experience freeze-thaw cycles. After consolidation, sludge can be moved to drying beds using conventional excavation equipment. However, space is limited at the Gladstone IWTP, with capacity limited to managing approximately 1 year of sludge.

Because the period of analysis for this EE/CA is assumed to be 5 years of IWTP operation, additional space for interim sludge management is needed. The presumption of the EE/CA is that sufficient interim storage capacity for sludge exists at the Gladstone IWTP through mid-2017 when capacity at the Gladstone IWTP will be exhausted. Before this time, an additional interim sludge management location would be identified so that transport of sludge to this interim management

location could begin in the 2017 construction season. A permanent sludge disposal location has not yet been determined but may be a component of the overall remedy for the BPMD site.

4.3.2 Gladstone IWTP Performance Summary

Exhibit 4-2 summarizes the loading data for the Cement Creek COPECs in both the untreated influent and the treated effluent (metals loading data are presented in Table 4-3, and statistics on the metals loading data are presented in Table 4-4).

Exhibit 4-2. COPEC Loads in MIW from the Gold King Mine Adit

Location	Influent	Effluent
COPEC	Average load (lb/day)	
Aluminum, Total	161	19
Beryllium, Dissolved	0.036	0.002
Cadmium, Dissolved	0.40	0.04
Copper, Dissolved	29	0.3
Iron, Total	708	67
Lead, Dissolved	0.068	0.001
Manganese, Dissolved	148	84
Silver, Dissolved	0.0011	0.0006
Zinc, Dissolved	119	4

Note: Statistics of data from 10/19/2015 to 7/22/2016. For the statistical calculations of the influent, n=23 for Al, Be, Cd, Cu, Fe, Pb, Mn, Ag, and Zn. For the statistical calculations of the effluent, n=25 for Al and Fe and n=23 for Be, Cd, Cu, Pb, Mn, Ag, pH, and Zn.
lb/day = pounds per day

The Gladstone IWTP has proven performance at decreasing COPEC concentrations from the MIW influent. Exhibit 4-3 presents the minimum, maximum, and average removal rates for the COPECS identified in Section 2.3.2. Removal rates were calculated from 7 months of data (October 19, 2015 through July 22, 2016). Of the nine COPECs, seven are removed at an efficiency of 85 percent or greater. Silver removal rates are much lower; however, the Ag influent concentrations were often detected below the laboratory MDL.

Exhibit 4-3. Percent Load Reduction between Gladstone IWTP MIW Influent and Effluent

COPEC	Percent Load Reduction		
	Minimum	Maximum	Average
Aluminum, Total	42.9%	98.7%	86.5%
Beryllium, Dissolved	94.0%	98.4%	97.0%
Cadmium, Dissolved	84.8%	99.7%	93.1%
Copper, Dissolved	96.1%	99.98%	99.7%
Iron, Total	50.6%	99.8%	89.6%
Lead, Dissolved	77.5%	99.8%	95.7%
Manganese, Dissolved	26.3%	99.94%	52.1%
Silver, Dissolved	0.0%	23.1%	11.5%
Zinc, Dissolved	96.2%	99.92%	99.0%

Note: In some cases, percent removal was not calculated, including when treated water was qualified by a U or UJ and had a greater concentration than the influent, when the influent was qualified with a U or UJ and had a greater concentration than the effluent, or when both influent and effluent were qualified by a U or UJ. For statistical calculations, n=23 for Al and total Fe; n=22 for Mn; n=21 for Be, Cd, Cu, Pb, and Zn; and n=2 for Ag. Values equal to or greater than 99.9 percent are shown to the hundredths place to distinguish the percentages from 100 percent.

The metals that are precipitated from the treatment process are concentrated in the sludge. A sludge sample was collected on April 12, 2016 to be analyzed for metals concentration. None of the concentrations in the sludge exceeded toxicity characteristic leaching protocol (TCLP) standards, which are used to determine whether a solid waste is characteristically hazardous due to toxicity. Therefore, the sludge is not considered characteristic hazardous waste due to toxicity from metals concentrations. Exhibit 4-4 compares the TCLP standards to the sludge sample. Validated sludge data from April and August are included in Appendix D.

Exhibit 4-4. TCLP Metals Standards and Gladstone IWTP Sludge Metals Concentration

Analyte	TCLP standard (mg/L)	Gladstone IWTP Sludge (mg/L)
Arsenic	5.0	0.03 U
Barium	100	0.05 U
Cadmium	1.0	0.31
Chromium	5.0	0.05 U
Lead	5.0	0.025 U
Mercury	0.2	0.02 U
Selenium	1.0	0.025 U
Silver	5.0	0.01 UJ

Notes: Data from 4/12/2016 sample; U - Analyte was analyzed for but not detected above the MDL, which is shown; UJ - Analyte was analyzed for but not detected above the MDL. The MDL is approximate and may be inaccurate or imprecise.
mg/L = milligrams per liter

4.4 Alternative RA1: Continue Operation of Existing Gladstone IWTP for Treat Gold King Mine Adit MIW Discharge

Alternative RA1 entails utilizing the existing Gladstone IWTP and associated MIW collection and conveyance infrastructure (built or modified during the emergency removal action) to continue treatment of the MIW from the Gold King Mine adit. No further significant improvements or expansions to the Gladstone IWTP or to the Gold King Mine adit and MIW collection and conveyance system would be done. Under this alternative, treatment of Gold King Mine adit MIW and PRSC would continue, as has been ongoing since the Gladstone IWTP was brought online in October 2015, using the IWTP components as discussed in Section 4.3 above and in Appendix A.

This alternative would produce treated effluent, which would be discharged to Cement Creek. The effluent flow will be slightly less than the influent flow due to the production of sludge from the treatment process. The sludge will contain a high percentage of water, therefore, removing a fraction of water from the effluent flow.

The general PRSC activities performed during the operation of the MIW collection and conveyance system include but are not limited to:

- Monitoring of the automated system for the IWTP, including physical checks at least weekly by an operator.
- Periodic snow removal in the vicinity of the Gladstone IWTP during winter to allow year-round MIW treatment.

- Periodic truck delivery of $Ca(OH)_2$ and polymer flocculant for operation of the IWTP. From Silverton, CO trucks would use State Highway 110 and State Road 10 for deliveries.
- Sludge generation would be managed by the use of geotextile filter bags, sludge drying area(s), and interim sludge management areas. Details on the sludge production and management are found in Section 4.3.1. Management of geotextile filter bags, including stacking of bags, would be performed as necessary to densify treatment sludge and maximize usable storage space at the sludge drying area(s).
- Inspection and maintenance of the adit discharge collection sump and equalization ponds are shown on Figure 4-1, including periodic removal of accumulated MIW sludge and replacement of liner material, as necessary.
- Inspection and maintenance of pipelines from the adit sump to the equalization ponds and from the equalization ponds to the IWTP.

For the purposes of this EE/CA, the following additional assumptions are included:

- It is assumed that bi-weekly monitoring of MIW influent and effluent would be conducted as part of PRSC.
- It is assumed that MIW treatment will continue through the winter months, as was done during the winter of 2015 through 2016. As discussed in Appendix A, to continue water treatment, sufficient lime must be stored on site during winter months due to snow and ice accumulation on the roadways. The design duration of lime storage on site is greater than 150 days between lime truckload deliveries. No deliveries of lime to the IWTP occurred between December 31, 2015 and May 6, 2016.
- Because space for sludge management is limited to 1 year of accumulation at the Gladstone IWTP, dried sludge would be transported to an additional interim sludge management area. For the purposes of the EE/CA cost estimate, it is assumed this annual sludge volume is hauled off every year to a location up to 12 miles away. The presumption of the EE/CA is that sufficient interim storage capacity for sludge exists at the Gladstone IWTP through mid-2017 when capacity at the Gladstone IWTP would be exhausted. Before this time, an additional interim sludge management location would be identified so that transport of sludge for interim management could begin in the 2017 construction season. Permanent disposition (i.e., disposal) of the sludge is not included as part of this EE/CA evaluation.

The assumptions of the removal action alternative scope above were used as the basis of evaluation in the EE/CA. However, the subsequent Action Memorandum would address PRSC responsibilities.

4.4.1 Effectiveness

4.4.1.1 Overall Protection of Human Health and the Environment

Evaluation of overall protection of human health and the environment for Alternative RA1 is provided in Table C-1 (Appendix C) using the evaluation criteria considerations. The overall rating on this criterion for Alternative RA1 is “acceptable.” **+**

4.4.1.2 Compliance with ARARs

Evaluation of compliance with ARARs for Alternative RA1 is provided in Table C-1 (Appendix C) using the evaluation criteria considerations. ARARs evaluated for this alternative are included in Appendix B. The overall rating on this criterion for Alternative RA1 is "acceptable." **+**

4.4.1.3 Long-Term Effectiveness and Permanence

Evaluation of long-term effectiveness and permanence for Alternative RA1 is provided in Table C-1 (Appendix C) using the evaluation criteria considerations. The overall rating on this criterion for Alternative RA1 is "moderate." ❸

4.4.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Evaluation of reduction of toxicity, mobility, or volume through treatment for Alternative RA1 is provided in Table C-1 (Appendix C) using the evaluation criteria considerations. The overall rating on this criterion for Alternative RA1 is "moderate to high." ❹

4.4.1.5 Short-Term Effectiveness

Evaluation of short-term effectiveness for Alternative RA1 is provided in Table C-1 (Appendix C) using the evaluation criteria considerations. The overall rating on this criterion for Alternative RA1 is "moderate." ❸

4.4.2 Implementability

4.4.2.1 Technical Feasibility

Evaluation of technical feasibility for Alternative RA1 is provided in Table C-2 (Appendix C) using the evaluation criteria considerations. The overall rating on this criterion for Alternative RA1 is "moderate." ❸

4.4.2.2 Administrative Feasibility

Evaluation of administrative feasibility for Alternative RA1 is provided in Table C-2 (Appendix C) using the evaluation criteria considerations. The overall rating on this criterion for Alternative RA1 is "moderate." ❸

4.4.2.3 Availability of Services and Materials

Evaluation of availability of services and materials for Alternative RA1 is provided in Table C-2 (Appendix C) using the evaluation criteria considerations. The overall rating on this criterion for Alternative RA1 is "moderate." ❸

4.4.2.4 State (Support Agency) Acceptance

Evaluation of state (support agency) acceptance for Alternative RA1 is not directly evaluated in this EE/CA; thus, the overall rating on this criterion for Alternative RA1 is "not evaluated." Please see Section 4.5 for a detailed explanation.

4.4.2.5 Community Acceptance

Evaluation of community acceptance for Alternative RA1 is not directly evaluated in this EE/CA; thus, the overall rating on this criterion for Alternative RA1 is "not evaluated." Please see Section 4.6 for a detailed explanation.

4.4.3 Cost

Evaluation of cost for Alternative RA1 is provided in Table C-3 (Appendix C) using the evaluation criteria considerations. Detailed cost estimates for this alternative are included in Appendix E. The overall rating on this criterion for Alternative RA1 is "high." $$$$$

4.5 Alternative RA2: Suspend Operation of Existing Gladstone IWTP to Treat Gold King Mine Adit MIW Discharge

Alternative RA2 entails suspension of treatment operations at the existing Gladstone IWTP, pending evaluation of broader potential water treatment needs. Under this alternative, water treatment of Gold King Mine adit MIW would be suspended. Discharge from the stabilized adit of the Gold King Mine would be routed around the mine dump and allowed to discharge into the North Fork of Cement Creek untreated, as was occurring prior to construction of the IWTP.

For the purposes of this EE/CA, the following activities performed during the suspension of operations of the MIW collection and conveyance system are assumed to include but are not limited to:

- Suspension of water treatment activities means that the IWTP would not be dismantled. It would be shut down to allow for a potential restart of treatment operations in the future. This would include expected shutdown activities such as winterization (draining of pipes and tanks), discontinuing electrical service and other utilities, securing of equipment, and consumption of remaining water treatment reagents that cannot be stored for the long term. For example, all $Ca(OH)_2$ lime stored on site should be consumed and not left in storage silos so it does not solidify. It is assumed that the decision to suspend water treatment operations would occur before large quantities of lime would be delivered; therefore, no chemicals would be left for consumption.

- To preserve the IWTP infrastructure, acidic MIW from the Gold King Mine adit would no longer be routed down to the Gladstone area through the pipes and equalization ponds. This would prevent damage to the pipelines due to freeze-thaw cycles, clogging with precipitates, or corrosion to valves. Instead, MIW would be routed from the adit to the North Fork of Cement Creek.

- Any solids accumulated in the equalization ponds would be removed and consolidated with the other IWTP sludge. Rainfall and snowmelt would accumulate and would be allowed to overflow to Cement Creek as necessary.

- It is assumed that the sludge generated at the IWTP would remain stored on site in the sludge drying area. However, evaluation of long-term or permanent sludge disposal options is excluded from this EE/CA and is expected to be addressed in a future CERCLA response action evaluation, recognizing that sludge management and disposal may be a long-term BPMD site need.

- It is assumed PRSC at the Gold King Mine adit would be limited and would not include any activities to enter the mine. It is assumed that the piping or channels used to divert the Gold King Mine adit discharge around the mine dump and to North Fork of Cement Creek

would be inspected quarterly to ensure these diversion features are not clogging and are continuing to function properly.

The assumptions of the removal action alternative scope above were used as the basis of evaluation in the EE/CA. However, the subsequent Action Memorandum would address PRSC responsibilities.

4.5.1 Effectiveness

4.5.1.1 Overall Protection of Human Health and the Environment

Evaluation of overall protection of human health and the environment for Alternative RA2 is provided in Table C-4 (Appendix C) using the evaluation criteria considerations. The overall rating on this criterion for Alternative RA2 is "unacceptable." **-**

4.5.1.2 Compliance with ARARs

Evaluation of compliance with ARARs for Alternative RA2 is provided in Table C-4 (Appendix C) using the evaluation criteria considerations. ARARs evaluated for this alternative are included in Appendix B. The overall rating on this criterion for Alternative RA2 is "unacceptable.".

4.5.1.3 Long-Term Effectiveness and Permanence

Evaluation of long-term effectiveness and permanence for Alternative RA2 is provided in Table C-4 (Appendix C) using the evaluation criteria considerations. The overall rating on this criterion for Alternative RA2 is "low to moderate." ❷

4.5.1.4 Reduction of Toxicity, Mobility, or Volume through Treatment

Evaluation of reduction of toxicity, mobility, or volume through treatment for Alternative RA2 is provided in Table C-4 (Appendix C) using the evaluation criteria considerations. The overall rating on this criterion for Alternative RA2 is "none." ❶

4.5.1.5 Short-Term Effectiveness

Evaluation of short-term effectiveness for Alternative RA2 is provided in Table C-4 (Appendix C) using the evaluation criteria considerations. The overall rating on this criterion for Alternative RA2 is "moderate." ❸

4.5.2 Implementability

4.5.2.1 Technical Feasibility

Evaluation of technical feasibility for Alternative RA2 is provided in Table C-5 (Appendix C) using the evaluation criteria considerations. The overall rating on this criterion for Alternative RA2 is "moderate." ❸

4.5.2.2 Administrative Feasibility

Evaluation of administrative feasibility for Alternative RA2 is provided in Table C-5 (Appendix C) using the evaluation criteria considerations. The overall rating on this criterion for Alternative RA2 is "moderate to high." ❹

4.5.2.3 Availability of Services and Materials

Evaluation of availability of services and materials for Alternative RA2 is provided in Table C-5 (Appendix C) using the evaluation criteria considerations. The overall rating on this criterion for Alternative RA2 is "moderate to high." ❹

4.5.2.4 State (Support Agency) Acceptance

Evaluation of state (support agency) acceptance for Alternative RA2 is not directly evaluated in this EE/CA; thus, the overall rating on this criterion for Alternative RA2 is "not evaluated." Please see Section 4.5 for a detailed explanation.

4.5.2.5 Community Acceptance

Evaluation of community acceptance for Alternative RA2 is not directly evaluated in this EE/CA; thus, the overall rating on this criterion for Alternative RA2 is "not evaluated." Please see Section 4.6 for a detailed explanation.

4.5.3 Cost

Evaluation of cost for Alternative RA2 is provided in Table C-6 (Appendix C) using the evaluation criteria considerations. Detailed cost estimates for this alternative are included in Appendix E. The overall rating on this criterion for Alternative RA2 is "low." $

4.6 State (Support Agency) Acceptance

The State of Colorado (through CDPHE) may have technical and administrative concerns. Assessment of the state acceptance will not be completed until comments on the EE/CA are submitted to EPA by CDPHE. CDPHE may review the alternatives, and its concerns will be considered in determining the recommended alternative in the final EE/CA and in the final selection of the removal action in the Action Memorandum. Thus, state acceptance is not considered in the detailed analysis of alternatives presented in the EE/CA.

4.7 Community Acceptance

Assessment of community acceptance will include responses to questions any interested person in the community may have regarding any component of the removal action alternatives presented in the final EE/CA. This assessment will be completed after EPA receives public comments on the final EE/CA during the public commenting period. Thus, community acceptance is not considered in the detailed analysis of alternatives presented in the EE/CA.

Section 5

Comparative Analysis of Removal Action Alternatives

This EE/CA evaluates the two removal action alternatives in Section 4 against the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost, as well their sub-criteria. The results of the detailed analysis for each removal action alternative are presented in Exhibit 5-1 to allow comparative analysis of the alternatives and identify the key trade-offs between them as presented in the EE/CA. Comparative analysis for the removal action alternatives using the evaluation criteria has been put into narrative form in the following subsections. Only significant comparative differences between alternatives are presented; the full set of rationale for the qualitative ratings is provided in Appendix C.

This EE/CA evaluates the two removal action alternatives in Section 4 against the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost as well their sub-criteria. The results of the detailed analysis for each removal action alternative are presented in Exhibit 5-1 to allow comparative analysis of the alternatives and identify the key trade-offs between them as presented in the EE/CA. Comparative analysis for the removal action alternatives using the evaluation criteria has been put into narrative form in the following subsections. Only significant comparative differences between alternatives are presented; the full set of rationale for the qualitative ratings is provided in Appendix C.

5.1 Overall Protection of Human Health and the Environment

Alternative RA1 was given an acceptable rating as it would address the RAO and would provide adequate protection for human health and the environment from the MIW discharge from the Gold King Mine adit. Current data indicate that the existing Gladstone IWTP removes a substantial percentage of the COPECs mass discharging from the Gold King Mine adit. TSS present or forming in the untreated Gold King Mine adit MIW is removed in the equalization basins and Gladstone IWTP process and prevented from entering surface water in Cement Creek, limiting the likelihood of an uncontrolled release of suspended solids. EPA recognizes that the mass of COPECs discharging from the Gold King Mine adit is only a portion of the total mass of COPECs transported in Cement Creek and that treatment of only this one source does not appreciatively improve water quality conditions in Cement Creek or the Animas River. Nonetheless, since the Gladstone IWTP is in place and available, continuing treatment of this one source does provide some benefit in the interim. EPA will be investigating and studying the other sources of untreated mine discharges and natural mineralization in the area that would still contribute to the mass of COPECs transported in Cement Creek and looking for other opportunities to address these sources (either as interim or final actions), irrespective of MIW treatment. Protection of human health and the environment is dependent on continued MIW treatment under designed capacities. Monitoring and regular PRSC of the IWTP system performance will ensure continued MIW treatment. There is uncertainty whether the RAO could be consistently met because of potential variability in flows and concentrations discharging from the Gold King Mine adit due to the limited period of data evaluated to date.

Alternative RA2 was given an unacceptable rating as it does not address the RAO and would not provide adequate protection for human health and the environment from the MIW discharge from the Gold King Mine adit. MIW from the Gold King Mine adit would no longer be treated at the Gladstone IWTP. Instead, MIW would be routed to the North Fork of Cement Creek as was done prior to the release. Untreated MIW would flow into Cement Creek, which will increase the mass of COPECs in Cement Creek to approximately pre-release levels. Because concentrations and flow rates discharging from the adit have been observed to vary since the release, water discharged from the Gold King Mine adit may be of worse quality than prior to the release, resulting in even higher mass of COPECs released to surface water and perhaps significantly worsening risks to aquatic receptors. Because MIW would not be routed for treatment, any TSS released, either chronically or in a sudden event, would not be controlled. There is potential for precipitates forming within the mine portal to build up and be released unexpectedly, which could adversely impact some aquatic receptors as benthic macroinvertebrates.

5.2 Compliance with ARARs

Alternative RA1 was given an acceptable rating under the assumption that all identified ARARs and TBCs will be met. Alternative RA2 was given an unacceptable rating because it may not be able to meet all identified chemical-specific ARARs.

For both RA1 and RA2, location- and action-specific ARARs would be addressed, to the extent practicable, during the removal action implementation. Treatment residuals (sludge) stored on site would need to be in compliance with action-specific ARARs such as the Colorado State Solid Waste Disposal Sites and Facilities Act and Implementing Regulations. Additional information concerning compliance with potential ARARs is provided in Appendix C.

5.3 Long-term Effectiveness and Permanence

Alternative RA1 was given a rating of "moderate." A reduction of exposure risk to human and ecological receptors from MIW would occur from collection, active treatment of MIW from the Gold King Mine adit, and discharge to Cement Creek. Average removal rates of COPECs ranged from as low as 11.5 percent for dissolved Ag, 52.1 percent for dissolved Mn, and the remaining seven COPECs were removed at an efficiency greater than 85 percent. Removal rates are shown in detail in Table 4-3 and summarized in Table 4-4. TSS present or forming in the untreated Gold King Mine adit MIW is removed in the equalization basins and Gladstone IWTP process and prevented from entering surface water, limiting the likelihood of an uncontrolled release of suspended solids as occurred in August 2015. Long-term effectiveness and permanence is dependent on continued MIW treatment under designed capacities, and PRSC activities would be required periodically to repair, monitor, and maintain the Gladstone IWTP for the 5-year period. Also, management of sludge generated from Gladstone IWTP would be required both at the current location and the new interim sludge management area. COPECs are currently sequestered within the treatment sludge. However, residual risks would potentially remain until the sludge is disposed of at a permanent location because exposing sludge to acidic conditions in the future could liberate the sequestered COPECs. Sludge disposition (i.e., disposal) is expected to be addressed in a future CERCLA response action evaluation, recognizing that sludge management and disposal may be a long-term BPMD site need. Until sludge is disposed of in a permanent location, the sludge drying area and interim sludge management area could be breached by high surface water flows, ice jams, or avalanches and could migrate to surface water and groundwater.

Alternative RA2 was given a rating of "low to moderate." After suspension of the Gladstone IWTP, untreated MIW would substantially contribute to metals mass loading of Cement Creek and the Animas River. For example, the average mass of COPECs removed in the Gladstone IWTP would cease, and mass loads entering Cement Creek would increase to 992 lb/day. Because concentrations and flow rates discharging from the adit have been observed to vary since the release, water discharged from the Gold King Mine adit may be of worse quality than prior to the release, resulting in even higher mass of COPECs released to surface water, perhaps significantly worsening risks to aquatic receptors. The Gladstone IWTP would not be in use to mitigate the effects of potentially higher mass loads of COPECs if they occur. Untreated MIW would once again flow into North Fork, which could increase exposure risk to human and ecological receptors. TSS present or forming in the untreated Gold King Mine adit portal could be released chronically or in a sudden, uncontrolled release. Unlike RA1, accumulation of sludge would stop, but previously generated sludge would still need to be disposed of properly. Until sludge is disposed of in a permanent location, the sludge drying area could be breached by high surface water flows, ice jams, or avalanches and could migrate to surface water and groundwater.

5.4 Reduction of Toxicity, Mobility, and Volume through Treatment

Alternative RA1 was given a rating of "moderate to high." The removal action is active treatment of MIW at the Gladstone IWTP. The lime neutralization process removes the COPECs from the water as solid metal hydroxides, and treated water flows to Cement Creek. The average load of COPECs mass removed is 992 lb/day. Each clarifier within the Gladstone IWTP is designed to remove 330 mg/L TSS per 900 gpm. Treatment results in a reduction of toxicity and mobility of the metal contaminants by transferring them from the aqueous and mobile phase to a more geochemically stable and less bioavailable solid phase. Metal treatment sludge is not as bioavailable due to the buffered conditions. However, the contaminants (metals) cannot be destroyed, only immobilized. Until sludge is disposed of in a permanent location, the sludge drying area and interim sludge management area could be breached by high surface water flows, ice jams, or avalanches. Treatment residuals are estimated at 6,000 cy sludge per year. This alternative would satisfy the statutory preference for treatment as a principal element of the removal action.

Under Alternative RA2, the suspension of the IWTP would stop treatment of the MIW. Thus, it would fail to provide a reduction of toxicity, mobility, or volume through treatment since treatment is not a component of this alternative. As with Alternative RA1, sludge would need to be disposed of in a permanent location. Until sludge is disposed of in a permanent location, the sludge drying area could be breached by high surface water flows, ice jams, or avalanches. This alternative would not satisfy the statutory preference for treatment as a principal element of the removal action. Thus, Alternative RA2 was given a rating of "none."

5.5 Short-Term Effectiveness

Because the Gladstone IWTP has been constructed and is operational, Alternative RA1 would only have minor impacts to the community and workers due to truck traffic related to transportation of treatment materials such as reagents. Short-term risks posed to the community during implementation of the alternative relate to trespassers within the areas of the Gold King Mine and the Gladstone IWTP. The road to the IWTP is also used to access the base of the Silverton

Mountain ski area (small resort for expert skiers); however, lime deliveries would be limited after the onset of winter, allowing for about 150 days of lime storage on site, lessening the likelihood of IWTP truck traffic interfering with skier traffic. In addition, after capacity at the existing sludge drying area is exhausted, there will be additional periodic truck traffic for transport of sludge to the new the interim sludge management area. While limited exposure to MIW and treatment plant reagents or residuals may occur while workers perform monitoring and PRSC, exposure risk would be mitigated through the use of personal protective equipment (PPE).

Alternative RA2 limits short-term risks to workers, the community, and the environment primarily through implementation of the suspension of the Gladstone IWTP. Work area restrictions (such as exclusion zones) would be implemented during suspension of the Gladstone IWTP to reduce short-term exposure risks to the community. There would be minor impacts to the community under this alternative as truck traffic would only be required temporarily as workers suspend the Gladstone IWTP. Short-term risks posed to the community during implementation of the alternative relate to trespassers within the areas of the Gold King Mine and the Gladstone IWTP. The road to the IWTP is also used to access the base of the Silverton Mountain ski area (small resort for expert skiers); however, truck traffic would only be required temporarily as workers suspend the Gladstone IWTP, lessening the likelihood of IWTP truck traffic interfering with skier traffic. Workers performing suspension of the Gladstone IWTP would potentially be exposed to MIW and treatment plant materials or residuals that poses unacceptable risks. Safety measures, such as the use of PPE, would protect workers during suspension of the Gladstone IWTP.

Under both alternatives, potential impacts could be from safety hazards during remedial implementation such as slips and falls, mechanical hazards, high altitude, and weather. Furthermore, management of sludge generated from the Gladstone IWTP during treatment would be required. Available area to manage the sludge is currently limited to the area adjacent to the Gladstone IWTP, and transport to an additional interim management area would be required under RA1. Under both alternatives, the sludge management area(s) are not intended to be the permanent disposal location(s) for treatment residuals.

Overall, Alternative RA1 and Alternative RA2 were given a rating of “moderate.”

5.6 Technical Feasibility

Alternative RA1 includes PRSC and monitoring of the existing Gladstone IWTP. While operation is feasible and lime neutralization is a proven, effective technology for removing metals from MIW, winter operations at the IWTP are challenging, making equipment and treatment material deliveries temporarily unavailable. Sufficient lime must be stored at the IWTP for continuous operation throughout the winter. Gladstone IWTP operations could be shut down due to inclement weather, which could affect highways for treatment material deliveries, cause power outages (which can be mitigated temporarily with onsite generators), or prevent personnel from accessing the plant. Future activities may be required under this removal action alternative because MIW will be a continuous problem at the site. The size of the influent storage ponds is geographically limited, leaving only a few hours filling time before the ponds are overtopped. There is limited area on site for sludge storage, and alternative RA1 would require identification and development of another interim sludge management area to continue IWTP operations.

Inspection and monitoring of the Gold King Mine adit, Gladstone IWTP, influent storage ponds, and sludge storage area are relatively straightforward and can be implemented using available materials, equipment, and labor resources. However, monitoring could become difficult during winter storm events.

Alternative RA2 would suspend operation of the existing Gladstone IWTP. To ensure Gladstone IWTP infrastructure is not damaged, the settling ponds and pipes should be drained, electrical service disconnected, and remaining lime on site should be consumed to prevent it from solidifying. Suspension of the Gladstone IWTP may be difficult, especially with regard to mothballing the pipes and equalization ponds. These would remain in-place and be exposed to weather conditions. Schedule delays may result from unexpected difficulties in mothballing Gladstone IWTP equipment. In addition, future activities may be required under this removal action alternative because MIW will be a continuous problem at the site. The ease of restart of the Gladstone IWTP may be impeded from equipment, which has not operated in some time or is damaged due to natural causes (weather). Similarly, inspection and monitoring of the Gold King Mine adit are straightforward but could be impeded during winter storm events.

Under both alternatives, disposal of treatment residuals (sludge) from the IWTP would require a permanent disposal location (excluded from evaluation in this EE/CA). Sludge disposition is expected to be addressed in a future CERCLA response action evaluation, recognizing that sludge management and disposal may be a long-term BPMD site need.

Overall, both Alternative RA1 and Alternative RA2 were given a rating of "moderate" for technical feasibility.

5.7 Administrative Feasibility

Both Alternatives RA1 and RA2 involve onsite PRSC although the degree of PRSC is greater for Alternative RA1. Both alternatives qualify for an exemption of the statutory limit of $2,000,000 and 12-month duration. Both alternatives would be performed within the boundary of the BPMD Superfund Site; thus, no offsite permits would be required. A Consent for Access is in place with a private property owner for siting of the Gladstone IWTP at the current location for both alternatives, however, these consents expire on December 31, 2016, and the owner has not indicated that he will approve an extension. An additional access agreement would be required for the additional interim sludge management location under RA1.

Because Alternative RA1 requires additional coordination and access from a second private property owner for interim sludge management, Alternative RA1 was given a rating of "moderate" for administrative feasibility. Alternative RA2 was given a rating of "moderate to high" for administrative feasibility.

5.8 Availability of Services and Materials

Alternative RA1 includes PRSC and monitoring of the existing Gladstone IWTP. While labor, equipment, materials, and technical specialists for monitoring and PRSC of the Gladstone IWTP are currently available and should continue to be available, winter operations at the IWTP are challenging and could limit availability of materials. Specifically, sufficient $Ca(OH)_2$ lime must be stored at the IWTP for continuous operation throughout the winter and requires transporting a

significant distance over mountain roads. Similarly, having continuous power service to the Gladstone IWTP during winter conditions could be problematic although backup power generation capabilities exist for short periods of time. Presence of operators could be limited by winter conditions as well. Thus, Alternative RA1 was given a rating of "moderate" for availability of services and materials.

Alternative RA2 requires availability of services and materials primarily for suspension of operations and mothballing of specific IWTP components. While the suspension of operations and related mothballing of equipment requires personnel familiar with the Gladstone IWTP, the activity is for a limited duration, and the personnel and equipment to perform this activity should be readily available. Thus, Alternative RA2 was given a rating of "moderate to high" for availability of services and materials.

5.9 State (Support Agency) Acceptance

The State of Colorado (through CDPHE) may have technical and administrative concerns. Assessment of the state acceptance will not be completed until comments on the EE/CA are submitted to EPA by CDPHE. CDPHE may review the alternatives, and their concerns will be considered in determining the recommended alternative in the final EE/CA and in the final selection of the removal action in the Action Memorandum. Thus, state acceptance is not considered in the detailed analysis of alternatives presented in the EE/CA.

5.10 Community Acceptance

Assessment of community acceptance will include responses to questions any interested person in the community may have regarding any component of the removal action alternatives presented in the final EE/CA. This assessment will be completed after EPA receives public comments on the final EE/CA during the public comment period. Thus, community acceptance is not considered in the detailed analysis of alternatives presented in the EE/CA.

5.11 Cost

Present value costs for both removal action alternatives were analyzed over a 5-year period of analysis.

The present value cost for Alternative RA1 was given a rating of "high." The present value cost for this alternative is approximately $7,326,000.

The present value cost for Alternative RA2 was given a rating of "low." The present value cost for this alternative is approximately $126,000.

Exhibit 5-1. Summary of Comparative Analysis for Removal Action Alternatives

Removal Action Alternative	Description	Effectiveness					Implementability					Cost	
		Overall Protection of Human Health and the Environment	Compliance with ARARs	Long Term Effectiveness and Permanence	Reduction of Toxicity, Mobility, or Volume through Treatment	Short Term Effectiveness	Technical Feasibility	Administrative Feasibility	Availability of Services and Materials	State (Support Agency) Acceptance	Community Acceptance	Present Value Cost (Dollars)	
RA1	Continue Operation of Existing Gladstone IWTP to Treat Gold King Mine Adit MIW Discharge	+	+	❸	❹	❸	❸	❸	❸	NE	NE	$$$$$	$7,326,000
RA2	Suspend Operation of Existing Gladstone IWTP to Treat Gold King Mine Adit MIW Discharge	—	—	❷	❶	❸	❸	❹	❹	NE	NE	$	$126,000

Notes

1. The numerical designations for the qualitative ratings system used in this table are not used to quantitatively assess removal action alternatives (for instance, individual rankings for an alternative are not additive).
2. Detailed cost spreadsheets (cost summaries, present value analyses, and cost worksheets) for each alternative are presented in Appendix E.

Legend for Qualitative Ratings System:

Effectiveness and Implementability

For First Two Criteria

—	Unacceptable
+	Acceptable

For Rest of the Criteria

❶	None
❷	Low
❸	Low to Moderate
❹	Moderate
❺	Moderate to High
❻	High
NE	Not Evaluated

Cost

Present Value Cost in Dollars

❶	None
$	Low ($0 through $500K)
$$	Low to Moderate ($500K through $1M)
$$$	Moderate ($1M through $1.5M)
$$$$	Moderate to High ($1.5M through $2M)
$$$$$	High (Greater than $2M)

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Section 6

Recommended Removal Action Alternative

Taking into consideration the evaluation criteria presented in this EE/CA, the recommended removal action alternative for the Gladstone IWTP is Alternative RA1: Continue Operation of Existing Gladstone IWTP to Treat Gold King Mine Adit MIW Discharge. Alternative RA1 includes utilizing the existing IWTP and associated infrastructure to continue treatment of the MIW from the Gold King Mine adit. Under Alternative RA1, no further significant improvements to the IWTP or to the adit portal and water collection and conveyance system would be done other than routine PRSC.

This alternative addresses the MIW discharge to Cement Creek, minimizes the mass of COPECs in the discharge, and meets the RAO. This alternative also has higher long-term effectiveness and permanence than Alternative RA2 and has reduction of toxicity and mobility of the COPECs through treatment unlike Alternative RA2. Short-term effectiveness and implementability issues are not significantly different between the two alternatives.

Alternative RA2 does not meet the RAO. While implementability of Alternative RA2 may be slightly higher than for Alternative RA1, it has lower long-term effectiveness and permanence as compared to Alternative RA1 and does not involve treatment.

The difference between costs for the two removal alternatives is significant. However, Alternative RA1 achieves acceptable overall protection of human health and the environment and compliance with ARARs to the extent practicable, whereas Alternative RA2 does not achieve acceptable overall protection of human health and the environment and compliance with chemical-specific ARARs. In addition, the overall effectiveness based on "long-term effectiveness and permanence" and "reduction of toxicity, mobility, or volume through treatment" criteria are higher for Alternative RA1 than for Alternative RA2, and there is relatively little difference in ratings for the other criteria (Exhibit 5-1).

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Section 7
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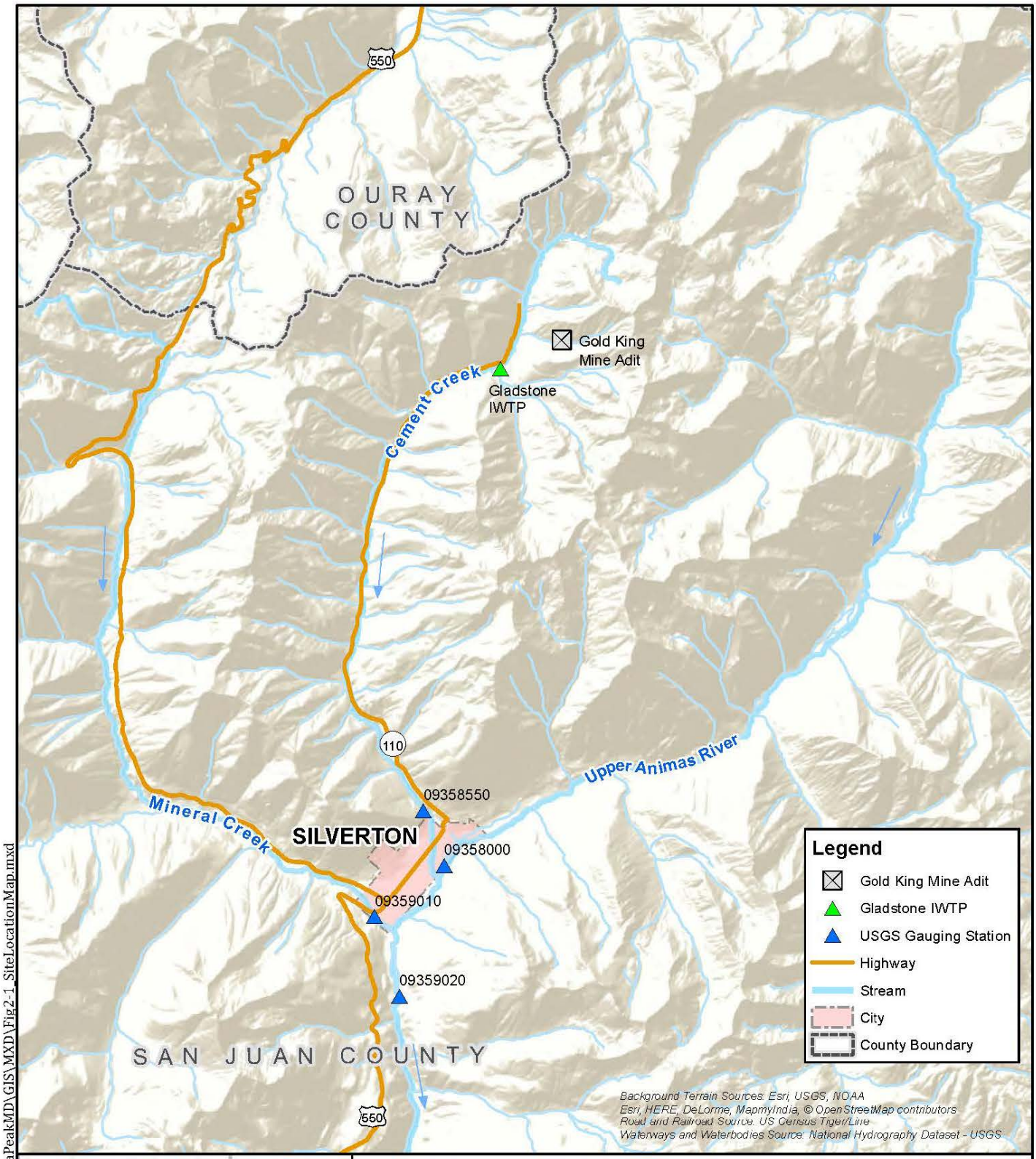
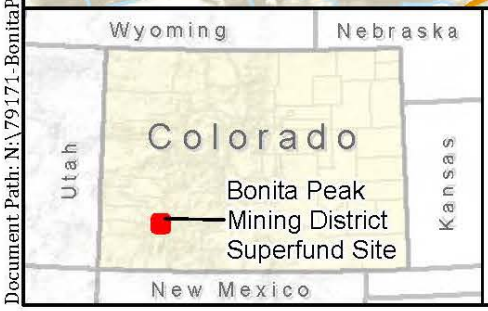
Figures -

Note: An independent data quality review for data used to create Figures 2-4 through 2-14 has not been completed by CDM Smith and is presented as provided by EPA.





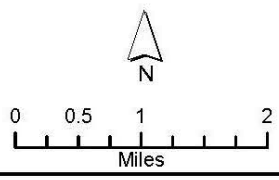


Figure 2-1
Site Location Map
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

CDM Smith

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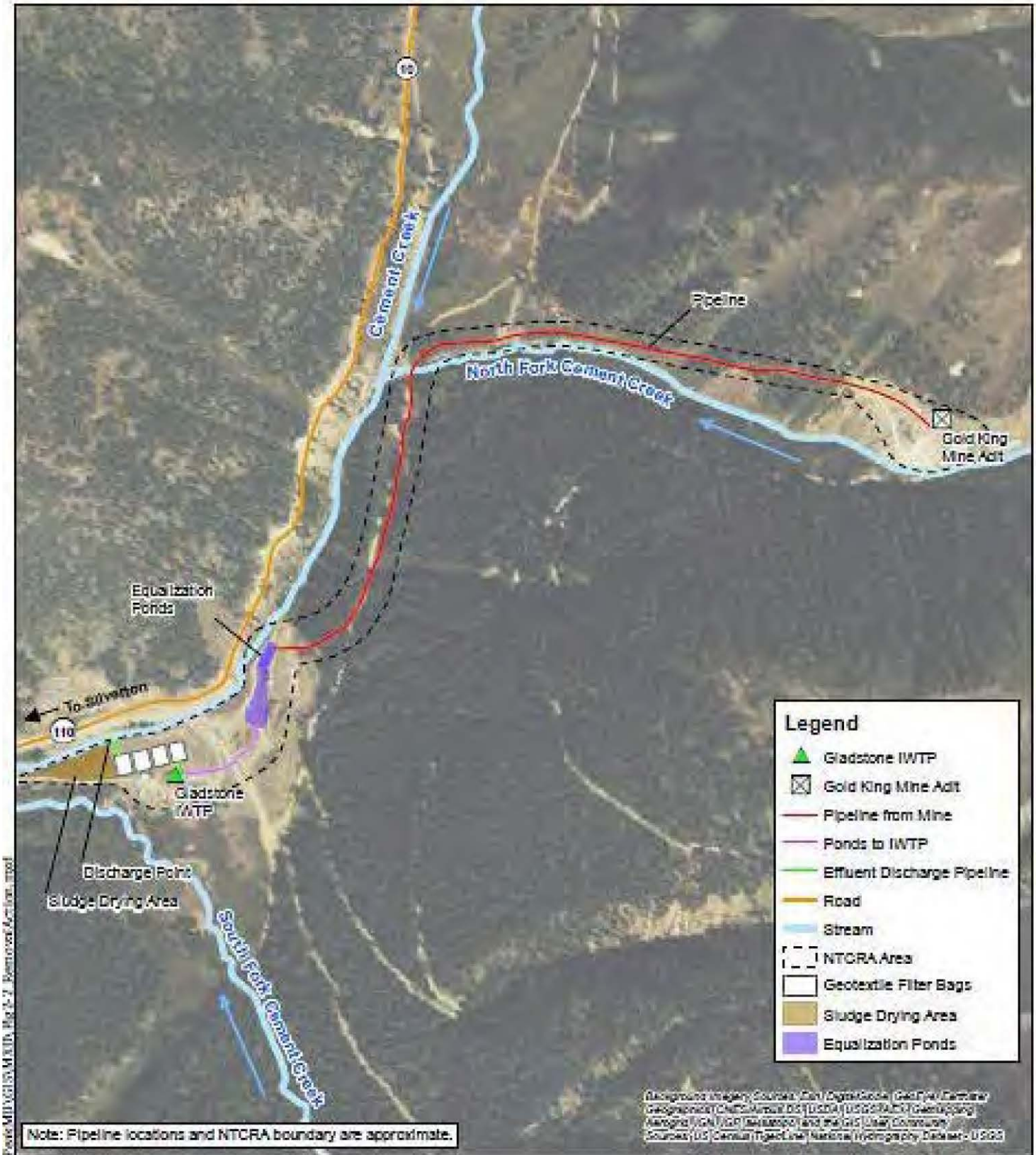
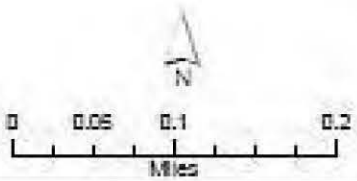


Figure 2-2
Non-Time-Critical Removal Action Infrastructure
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site



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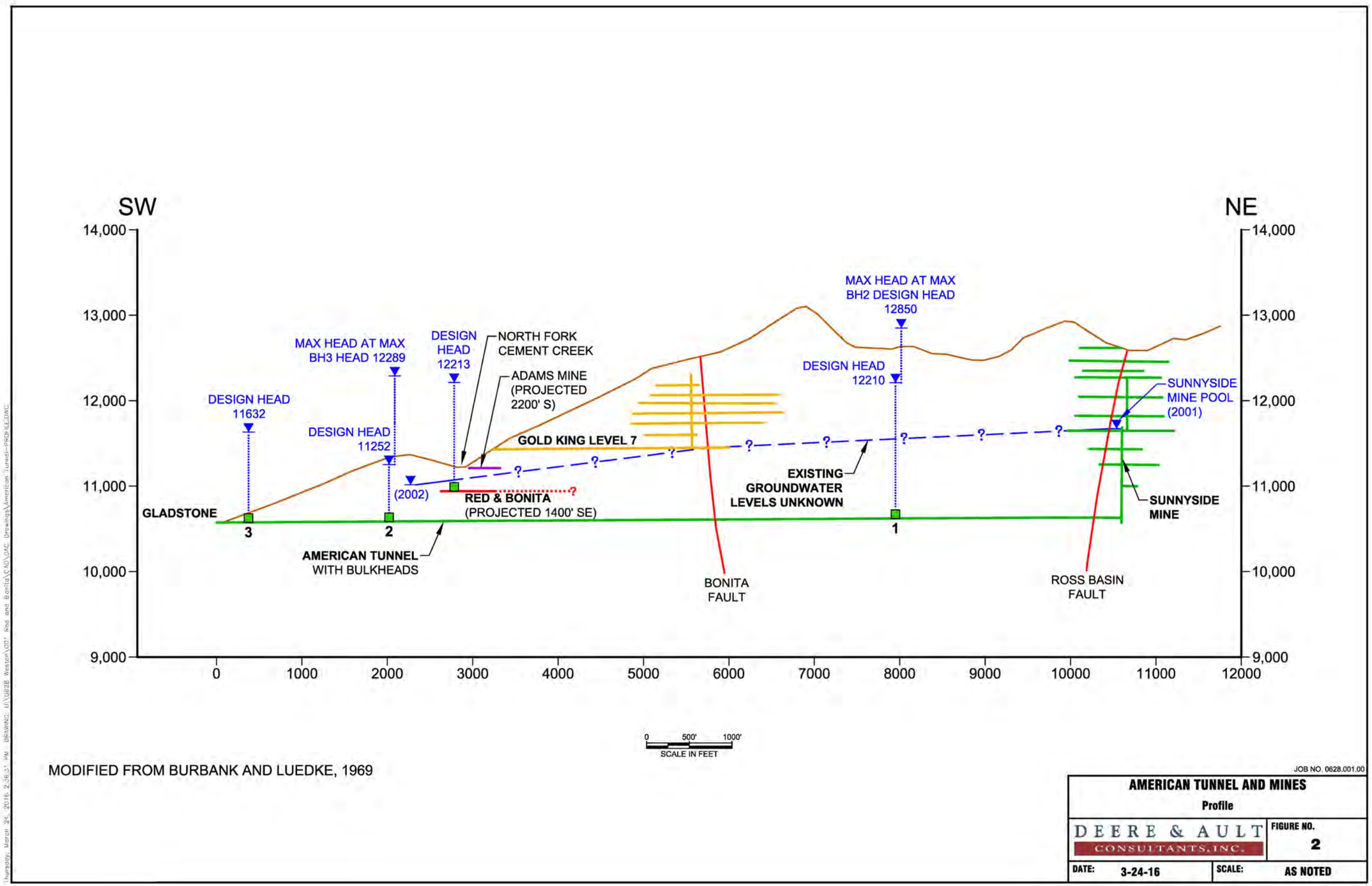

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Profile

DEERE & AULT CONSULTANTS, INC.

FIGURE NO. 2

DATE: 3-24-16

SCALE: AS NOTED

Adapted from Figure 2 from the March 2016 technical memorandum on the Red and Bonita Mine Bulkhead Closure Evaluation (Deere & Ault 2016)

Figure 2-3
Static Water Elevation near the NTCRA area
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

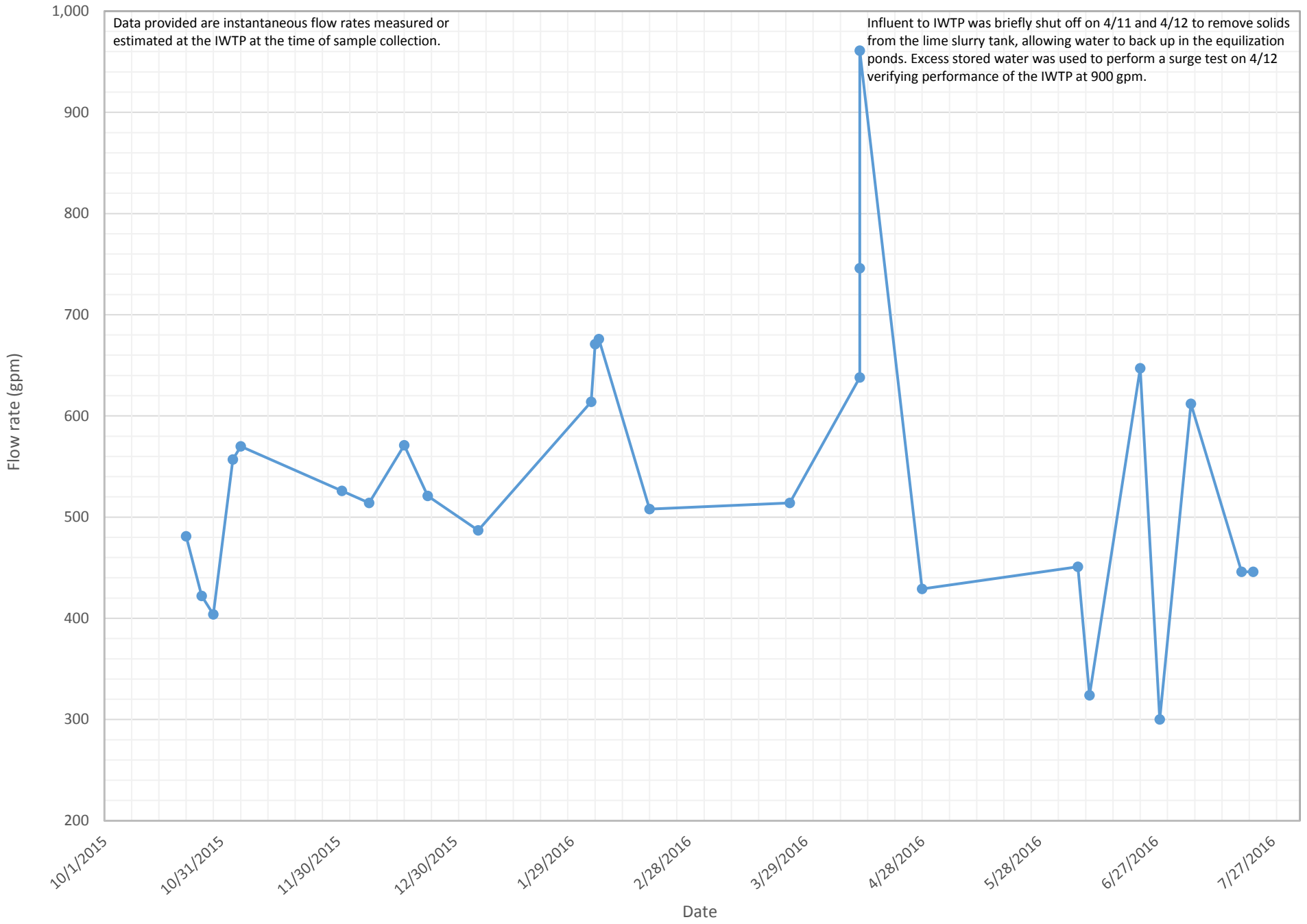

Figure 2-4
Treatment Flow Rate
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

CDM Smith

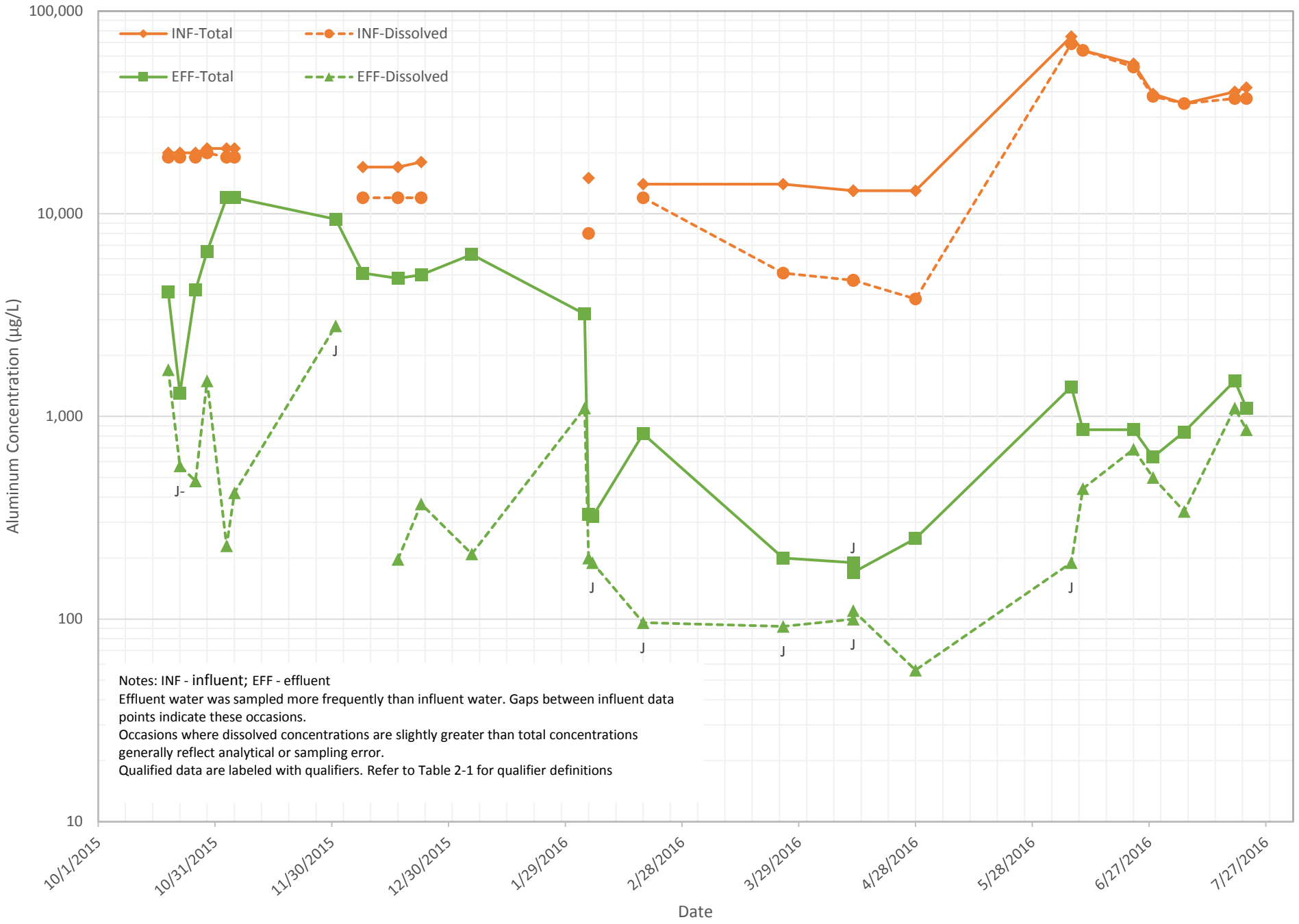

Figure 2-5
Total and Dissolved Aluminum: MIW Influent and Effluent Concentration
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

CDM Smith

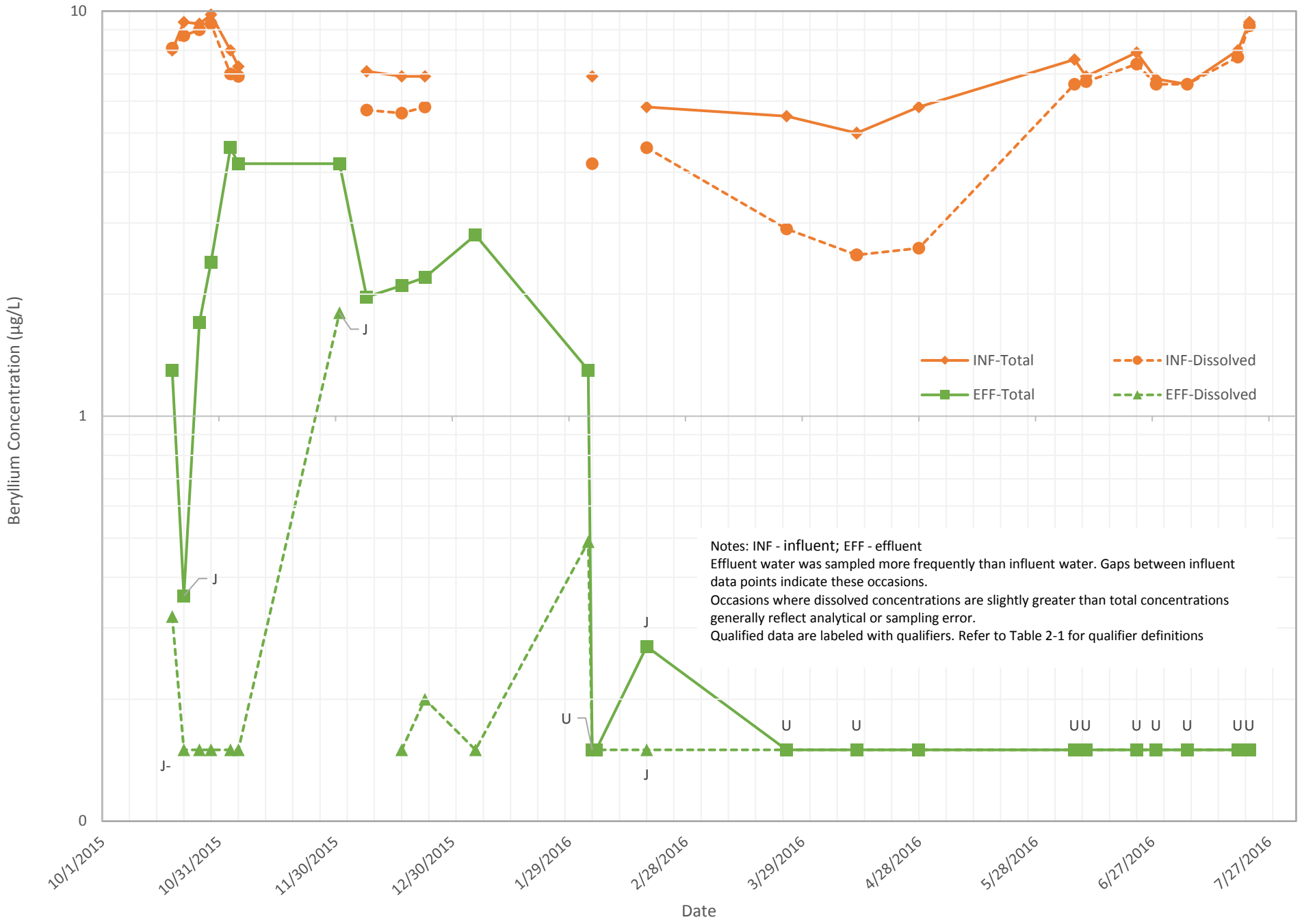

Figure 2-6
Total and Dissolved Beryllium: MIW Influent and Effluent Concentration
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

CDM Smith

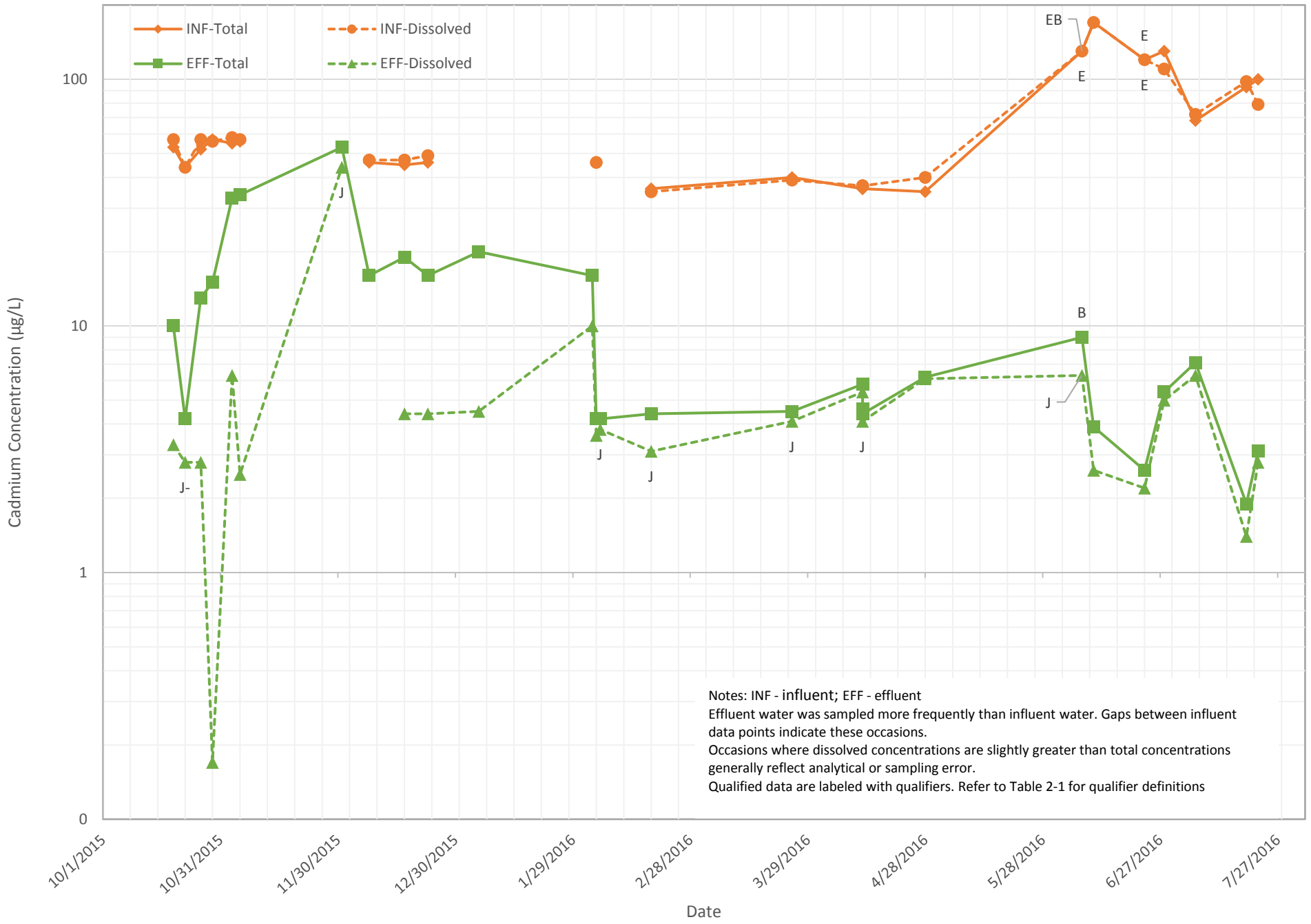

Figure 2-7
Total and Dissolved Cadmium: MIW Influent and Effluent Concentration
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

CDM Smith

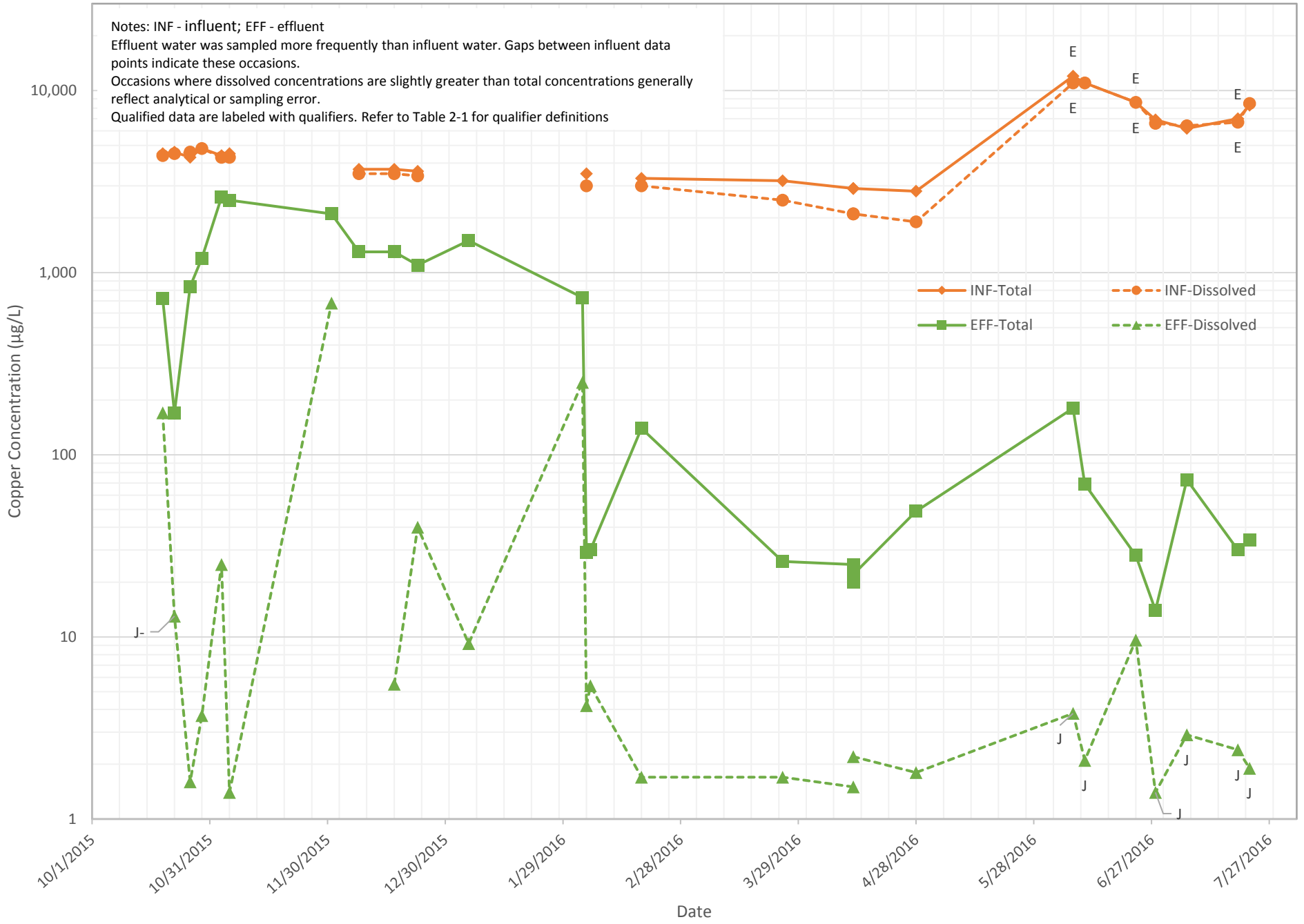

Figure 2-8
Total and Dissolved Copper: MIW Influent and Effluent Concentration
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

CDM Smith

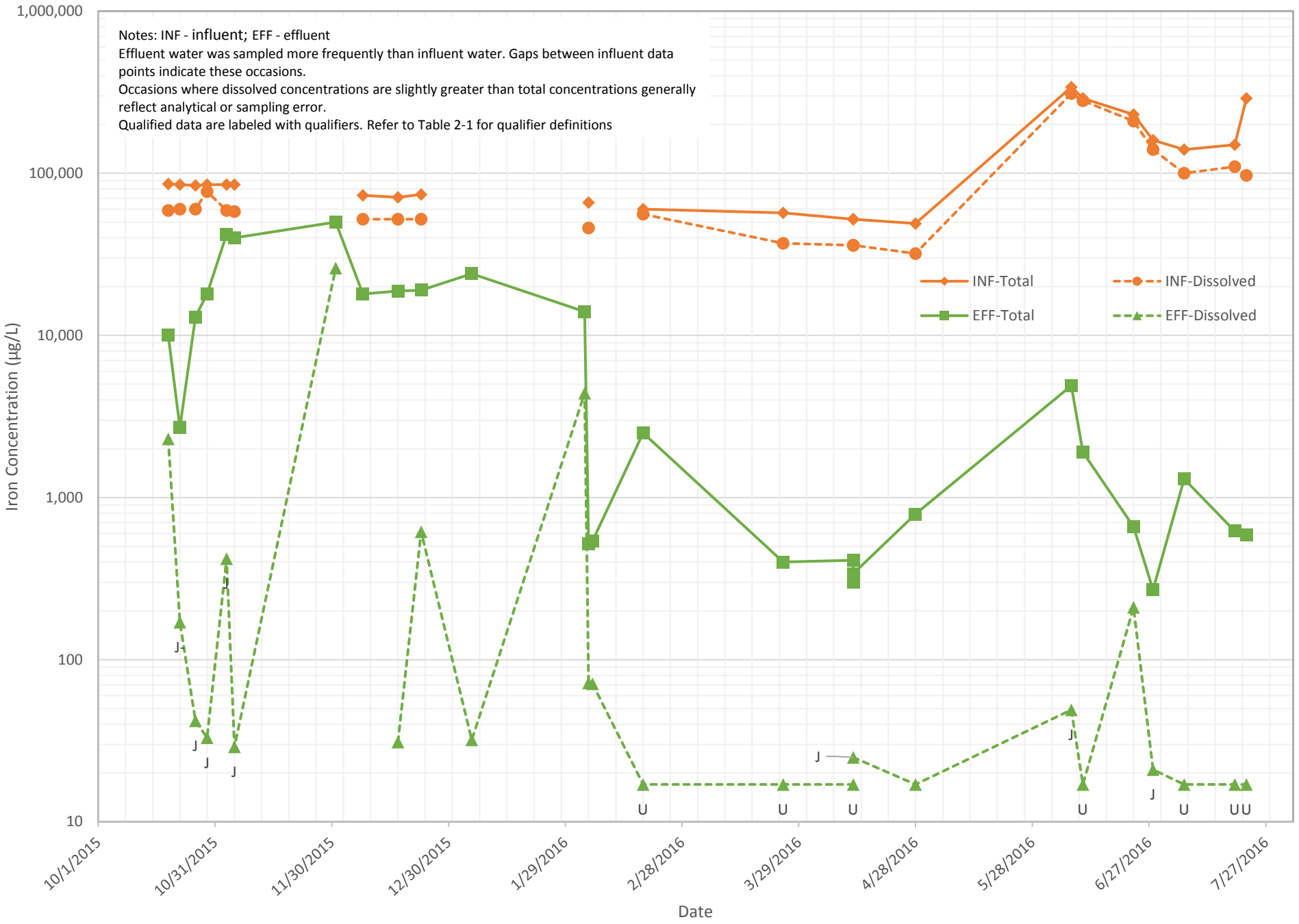

Figure 2-9
Total and Dissolved Iron: MIW Influent and Effluent Concentration
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

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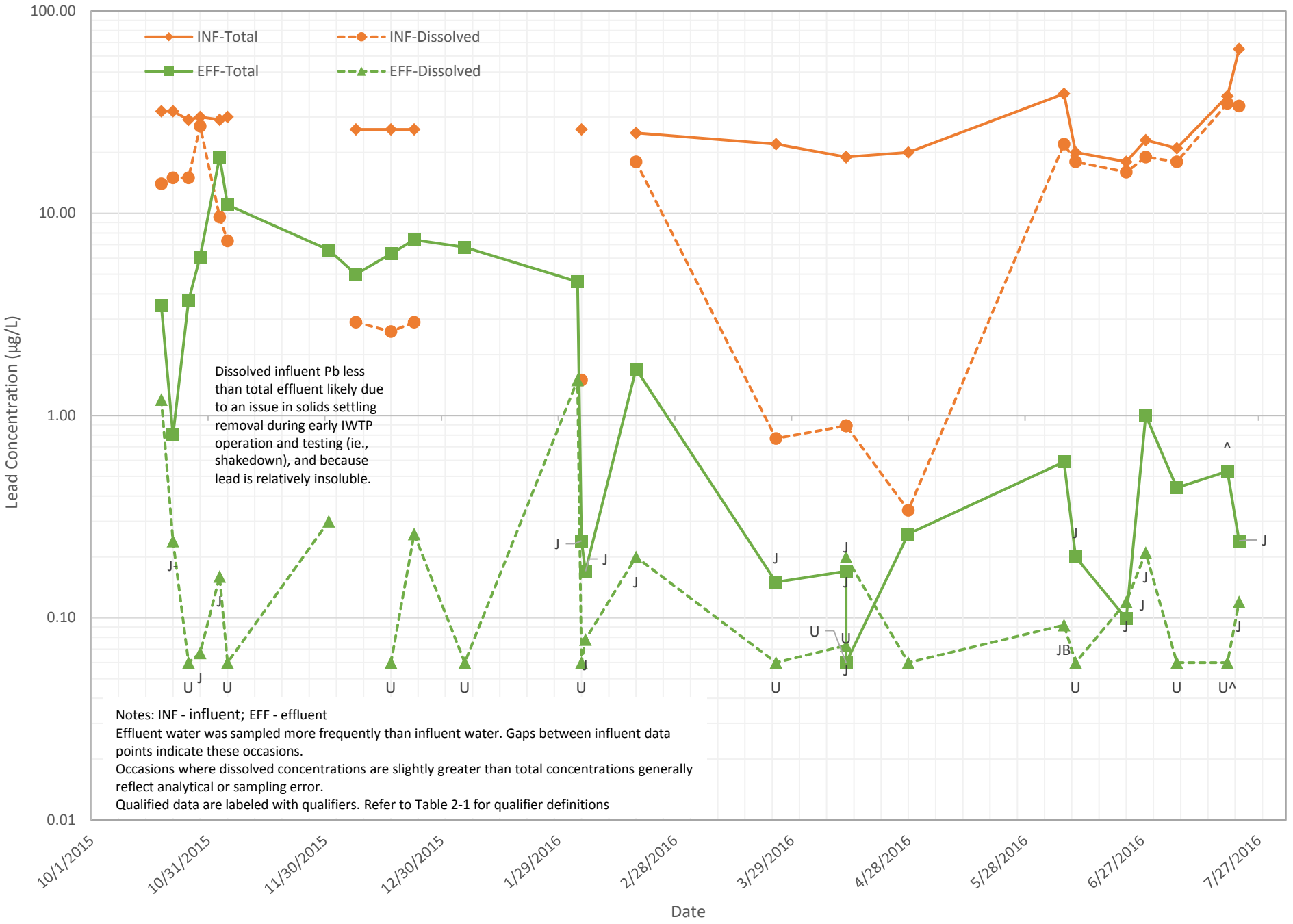

Figure 2-10
Total and Dissolved Lead: MIW Influent and Effluent Concentration
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

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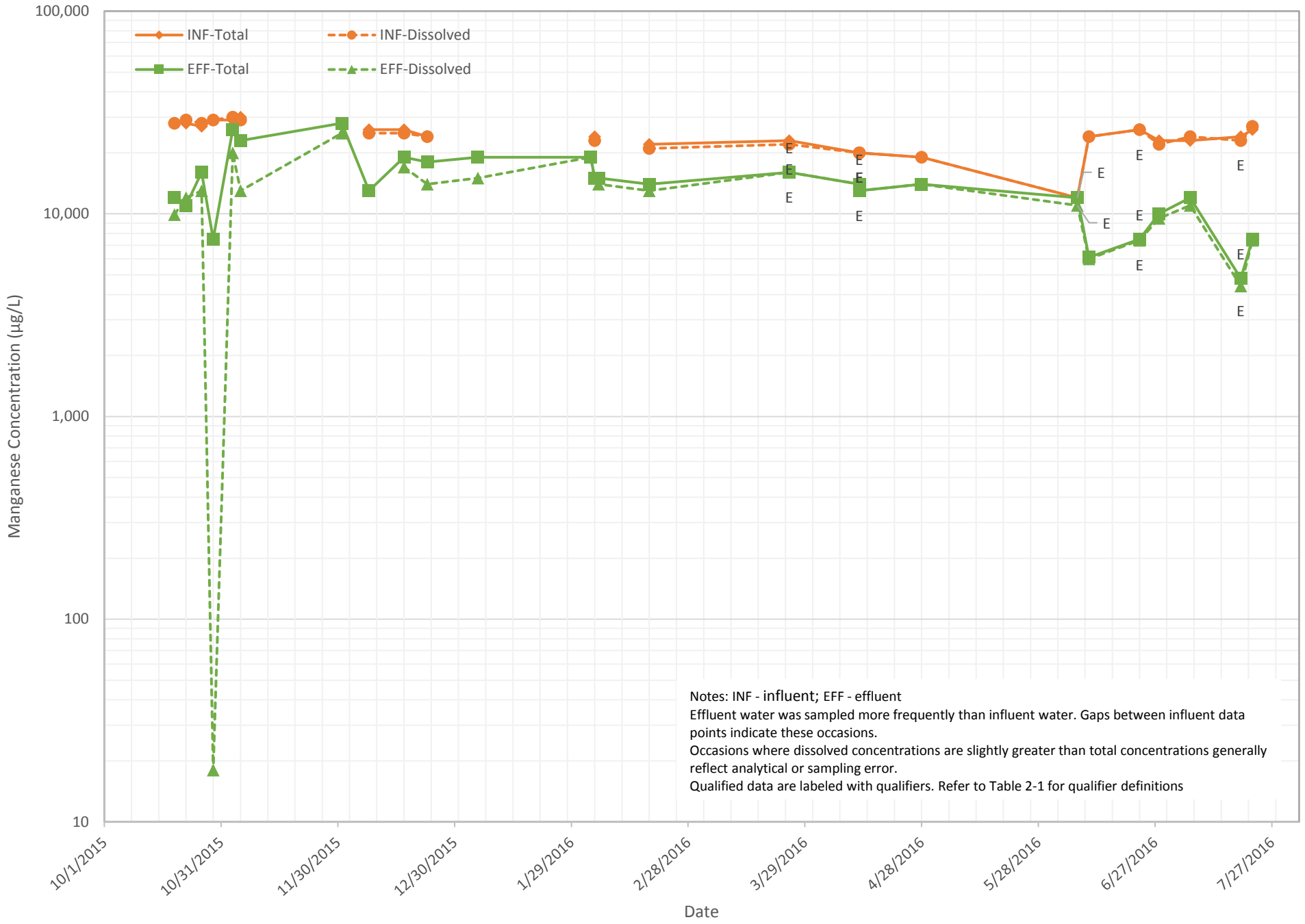

Figure 2-11
Total and Dissolved Manganese: MIW Influent and Effluent Concentration
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

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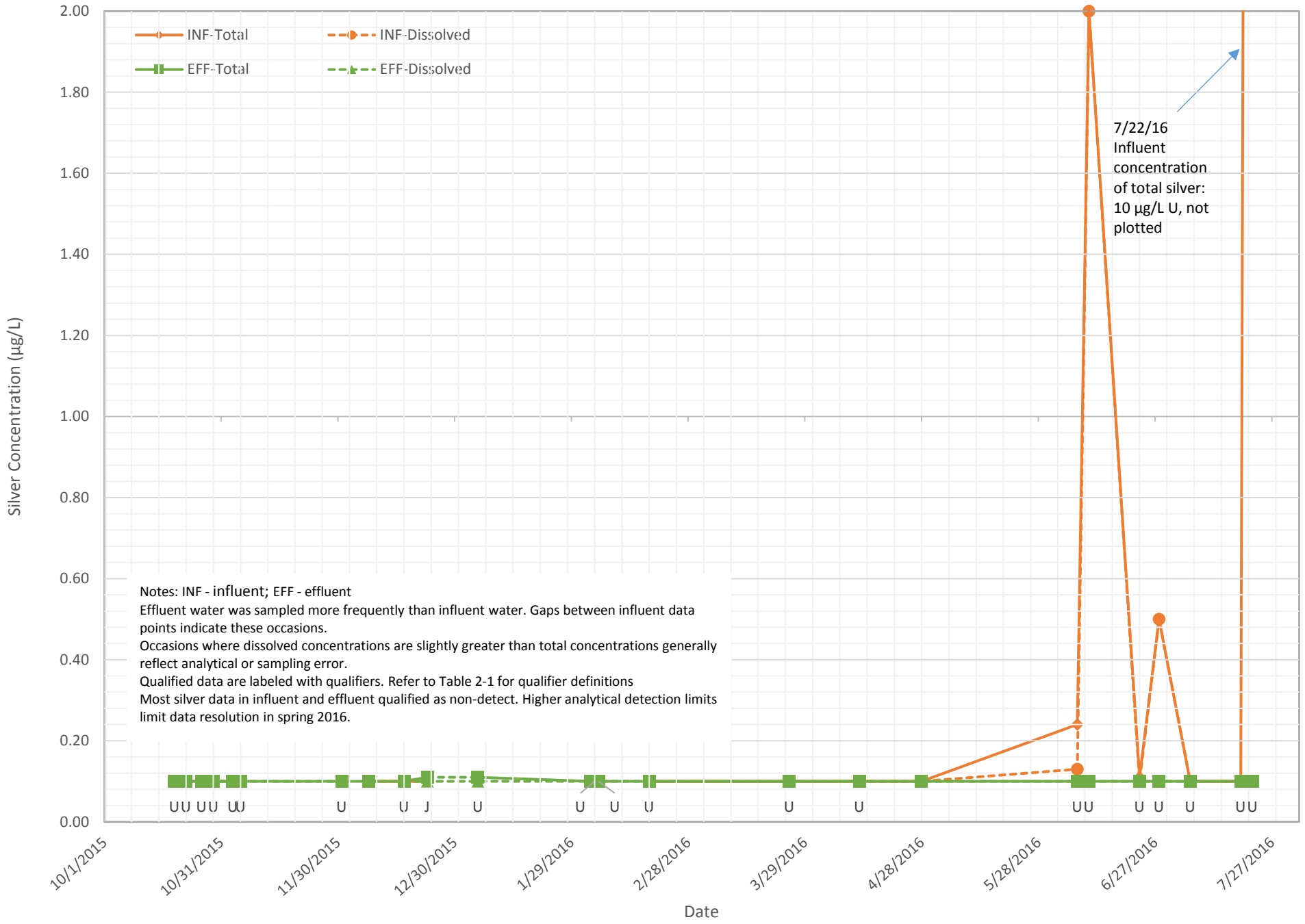

Figure 2-12
Total and Dissolved Silver: MIW Influent and Effluent Concentration
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

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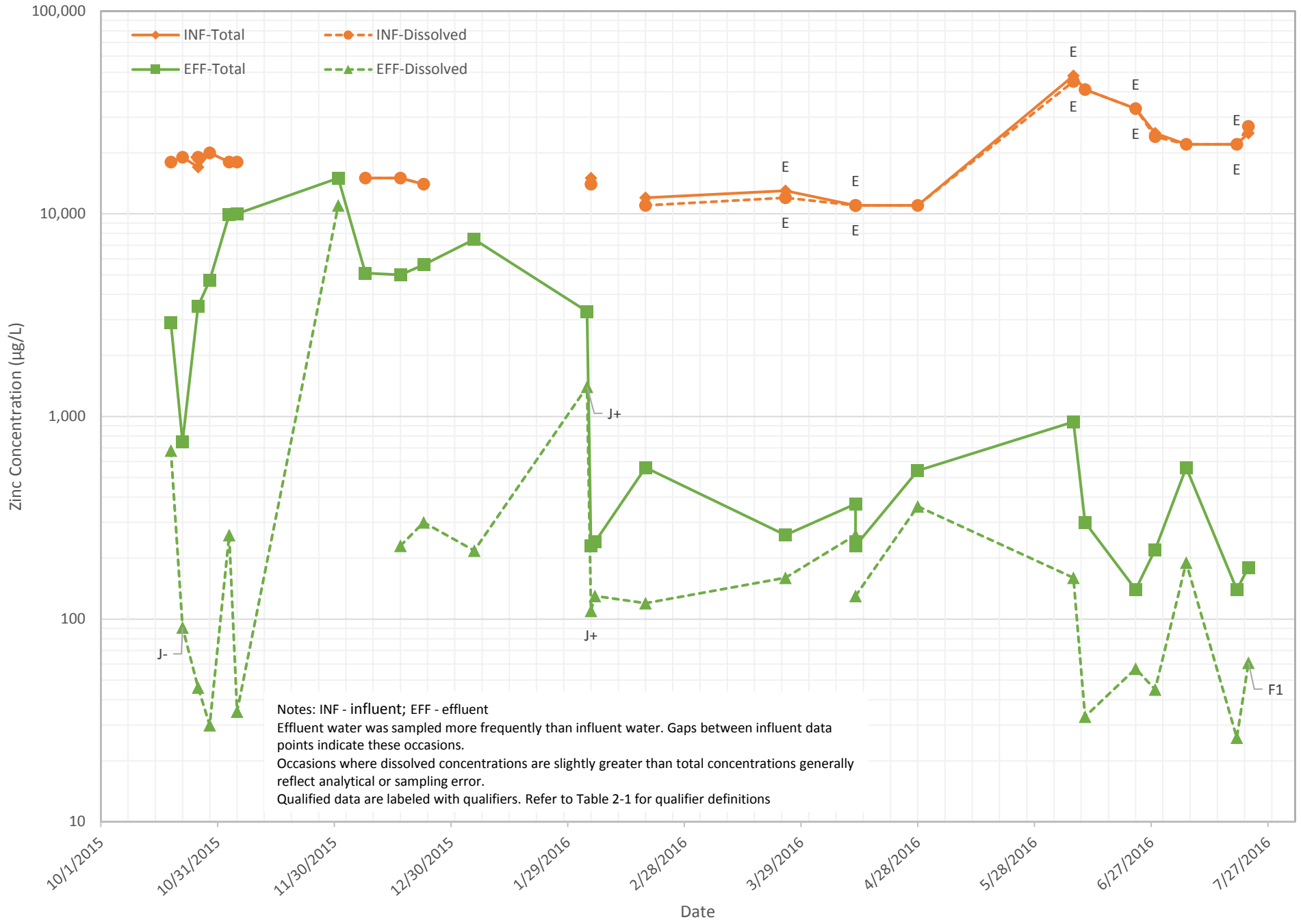

Figure 2-13
Total and Dissolved Zinc: MIW Influent and Effluent Concentration
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

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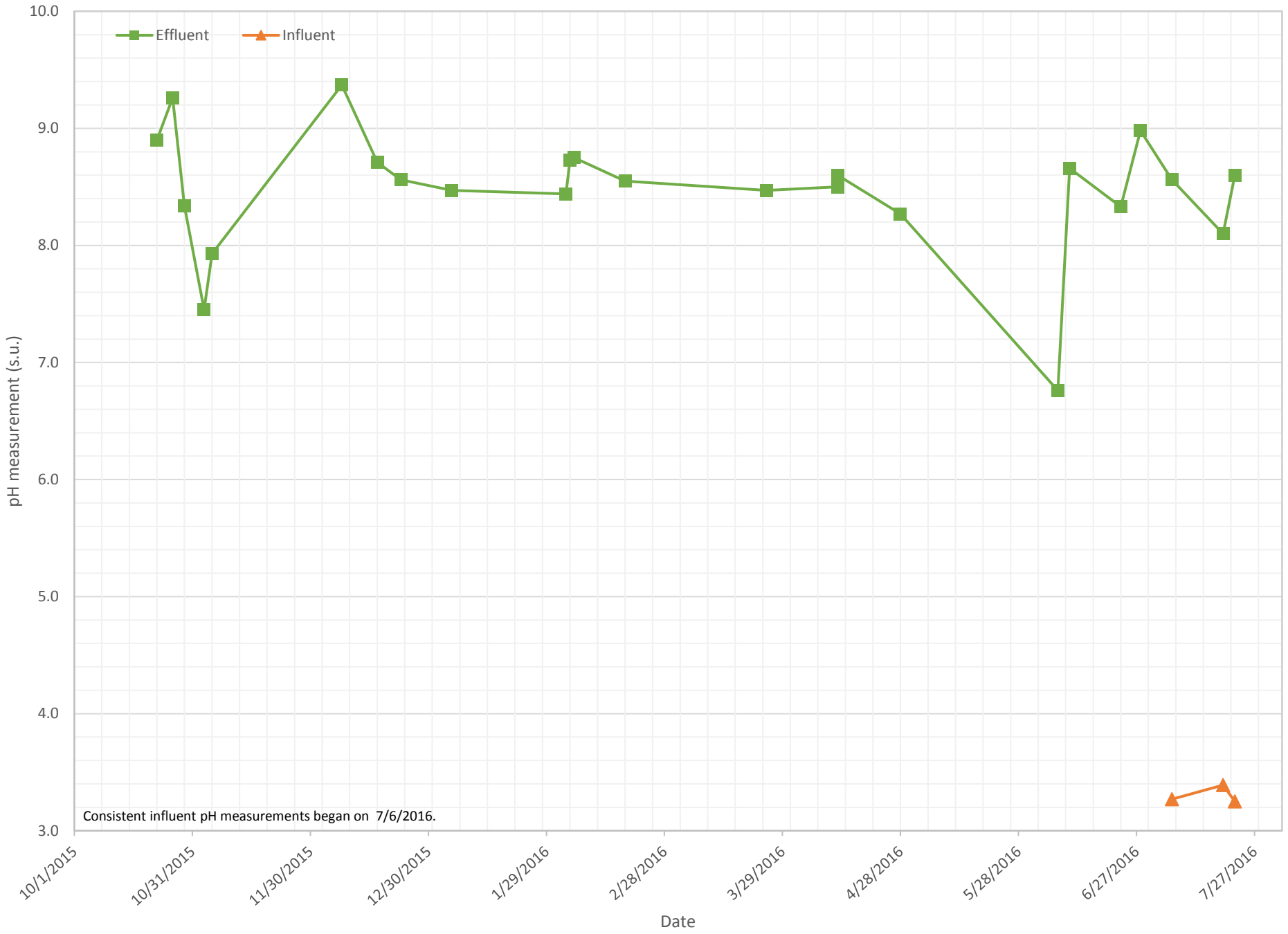

Figure 2-14
MIW Influent and Effluent pH Measurements
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

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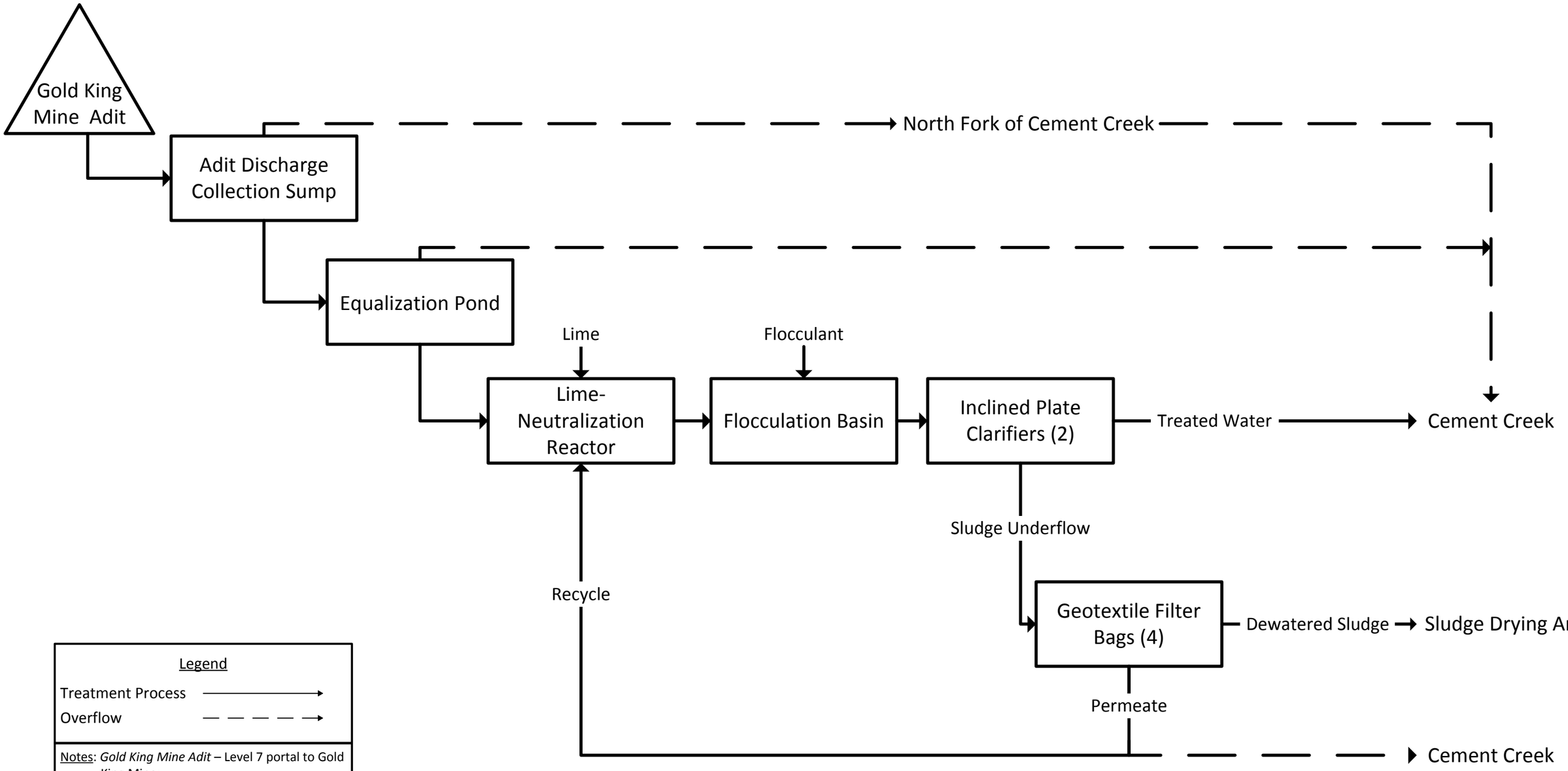

Legend

Treatment Process ——→

Overflow — — — — →

Notes: *Gold King Mine Adit* – Level 7 portal to Gold King Mine;
Inclined Plate Clarifiers - two clarifiers operate in parallel to accommodate higher flows or solids loading;
Geotextile Filter Bags – four filter bags operate in parallel and can be isolated for sludge management

Figure 4-1
Gold King Mine Adit MIW Treatment Process
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

Tables -

- Table 2-1: MIW Influent and Gladstone IWTP Effluent Concentrations
- Table 4-1: MIW Influent and Gladstone IWTP Effluent Percent Removal Results
- Table 4-2: MIW Influent and Gladstone IWTP Effluent Percent Removal Statistics
- Table 4-3: MIW Influent and Gladstone IWTP Effluent Loading Results
- Table 4-4: MIW Influent and Gladstone IWTP Effluent Loading Statistics

Note: An independent data quality review has not been completed by CDM Smith and is presented as provided by EPA.

Table 2-1
MIW Influent and Gladstone IWTP Effluent Concentrations
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

Sample Date		10/19/2015[2]				10/22/2015[2]				10/26/2015				10/29/2015				11/3/2015				11/5/2015				12/1/2015[3,4]				12/8/2015[4]				12/17/2015[4]			
Flow Rate[1] (GPM)		NA				481				422				404				557				570				526				514				571			
Location		Influent		Effluent		Influent		Effluent		Influent		Effluent		Influent		Effluent		Influent		Effluent		Influent		Effluent		Influent		Effluent		Influent		Effluent		Influent		Effluent	
Analyte	Units	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Aluminum	µg/L	20,000		4,100		20,000		1,300		20,000		4,200		21,000		6,500		21,000		12,000		21,000		12,000		NA		9,400		17,000		5,100		17,000		4,800	
Aluminum, Dissolved	µg/L	19,000		1,700		19,000		570	J-	19,000		480		20,000		1,500		19,000		230		19,000		420		NA		2,800	J	12,000		NA		12,000		197	
Antimony	µg/L	2.3		0.4	U	2.5		0.4	U	2.3		0.4	U	2.4		0.4	U	2.3		1		2.3		0.83	J	NA		0.6	J	1.9		0.7		1.9		0.8	
Antimony, Dissolved	µg/L	0.4	U	0.4	U	0.4	U	0.4	UJ	0.48	J	0.55	J	1.9		0.4	U	0.42	J	0.4	U	0.4	U	0.4	U	NA		0.4	U	0.4	U	NA		0.4	U	0.4	U
Arsenic	µg/L	26		0.93	J	29		0.37	U	27		2.3		30		4.2		28		11		29		8.7		NA		6.1		24		5		23		6	
Arsenic, Dissolved	µg/L	1.1		0.37	U	2.1		0.37	UJ	2.6		0.37	U	23		0.37	U	1.5		0.37	U	1.6		0.37	U	NA		0.37	U	1.3		NA		1.3		0.37	U
Barium	µg/L	9.5		8.5		9.6		7.8		9.2		8.7		9.8		9.7		9.5		11		9.6		9.8		NA		9.9		9.7		8.6		9.5		9.2	
Barium, Dissolved	µg/L	9.3		8.8		9.6		8.8	J-	9.3		8.2		9.8		8.1		9.6		8.3		9.7		7.9		NA		9.2		160		NA		41		48	
Beryllium	µg/L	8		1.3		9.4		0.36	J	9.3		1.7		9.8		2.4		8		4.6		7.3		4.2		NA		4.2		7.1		1.97		6.9		2.1	
Beryllium, Dissolved	µg/L	8.1		0.32	J	8.7		0.15	UJ	9		0.15	U	9.3		0.15	U	7		0.15	U	6.9		0.15	U	NA		1.8		5.7		NA		5.6		0.15	U
Cadmium	µg/L	53		10		44		4.2		52		13		57		15		55		33		56		34		NA		53		46		16		45		19	
Cadmium, Dissolved	µg/L	57		3.3		44		2.8	J-	57		2.8		56		0.17	J	58		6.3		57		2.5		NA		44		47		NA		47		4.4	
Calcium	µg/L	340,000		470,000		350,000		470,000		350,000		480,000		380,000		550,000		400,000		510,000		380,000		510,000		NA		440,000		350,000		450,000		350,000		440,000	
Calcium, Dissolved	µg/L	340,000		470,000		350,000		480,000		360,000		480,000		370,000		530,000		390,000		520,000		380,000		510,000		NA		430,000		340,000		NA		350,000		430,000	
Chromium	µg/L	2.5		1	U	2.9		1	U	2.8		1	U	2.8		1.2	J	2.9		1.9	J	2.9		1.8	J	NA		1.5	J	2.6		1.7		2.5		1.8	
Chromium, Dissolved	µg/L	1	U	1	U	1	U	1	UJ	1	U	1	U	2.2		1	U	1	U	1	U	1	U	1	U	NA		1	U	1	U	NA		1	U	1	U
Cobalt	µg/L	79		15		82		8.7		76		21		86		23		80		51		82		49		NA		74		72		21		70		27	
Cobalt, Dissolved	µg/L	79		5.1		82		6.5	J-	80		5.7		81		0.89		81		12		80		3.5		NA		58		69		NA		70		11	
Copper	µg/L	4500		720		4,600		170		4,300		840		4,800		1,200		4,400		2,600		4,500		2,500		NA		2,100		3,700		1,300		3,700		1,300	
Copper, Dissolved	µg/L	4400		170		4,500		13	J-	4,600		1.6		4,800		3.7		4,300		25		4,300		1.4		NA		680		3,500		NA		3,500		5.5	
Iron	µg/L	86,000		10,000		85,000		2,700		84,000		13,000		85,000		18,000		85,000		42,000		85,000		40,000		NA		50,000		73,000		18,000		71,000		18,800	
Iron, Dissolved	µg/L	59,000		2,300		60,000		170	J-	60,000		42	J	77,000		33	J	59,000		420	J	58,000		29	J	NA		26,000		52,000		NA		52,000		31	
Lead	µg/L	32		3.5		32		0.8		29		3.7		30		6.1		29		19		30		11		NA		6.6		26		5		26		6.3	
Lead, Dissolved	µg/L	14		1.2		15		0.24	J-	15		0.06	U	27		0.067	J	9.6		0.16	J	7.3		0.06	U	NA		0.3		2.9		NA		2.6		0.06	U
Magnesium	µg/L	19,000		18,000		20,000		17,000		20,000		18,000		23,000		5,500		22,000		21,000		21,000		19,000		NA		20,000		19,000		17,000		19,000		18,000	
Magnesium, Dissolved	µg/L	19,000		18,000		20,000		18,000		21,000		18,000		22,000		230	J	22,000		19,000		20,000		18,000		NA		19,000		19,000		NA		19,000		17,000	
Manganese	µg/L	28,000		12,000		28,000		11,000		27,000		16,000		29,000		7,500		29,000		26,000		30,000		23,000		NA		28,000		26,000		13,000		26,000		19,000	
Manganese, Dissolved	µg/L	28,000		9,900		29,000		12,000		28,000		13,000		29,000		18		30,000		20,000		29,000		13,000		NA		25,000		25,000		NA		25,000		17,000	
Mercury	µg/L	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	NA		0.1	U	0.08	U	0.08	U	0.08	U	0.08	U
Mercury, Dissolved	µg/L	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	NA		0.1	U	0.08	U	0.08	U	0.08	U	0.08	U
Molybdenum	µg/L	3.3		0.45	U	3.8		0.59	J	3.7		0.9	J	3.9		1.5		3.8		2.3		3.8		1.8		NA		1.4		3.6		1.8		3.4		2	
Molybdenum, Dissolved	µg/L	0.45	U	0.45	U	0.45	U	0.7	J-	0.69	J	0.8	J	3.1		1.1		0.45	U	1.4		0.45	U	0.96	J	NA		0.7	J	0.64	J	NA		0.55	J	1.7	
Nickel	µg/L	45		11		47		7.8		43		14		49		17		46		32		48		32		NA		41		44		20		43		24	
Nickel, Dissolved	µg/L	47		5.9		48		8.4	J-	46		6.5		48		5.1		47		11		47		6.2		NA		33		44		NA		43		15	
pH	s.u.	NA		NA		NA		8.9[#]		NA		9.26		NA		8.34		NA		7.45		NA		7.93		NA		NA		NA		9.37		NA		8.71	
Potassium	µg/L	2,200		2,300		2,200	J+	2,300	J+	2,300		2,400		2,500	J+	2,600	J+	2,300		2,500		2,300		2,400		NA		2,300		1,900		2,000		1,900		2,000	
Potassium, Dissolved	µg/L	2,300		2,400		2,300		2,400	J	2,300	J+	2,400		2,500	J+	2,700	J+	2,300	J+	2,400		2,200	J+	2,300		NA		2,300		1,800		NA		1,900		1,800	
Selenium	µg/L	0.91	J	0.58	U	1.8	J	0.58	U	1.8	J	0.58	U	1.8	J	0.58	U	1.6	J	0.73	J	1.7	J	0.58	U	NA		1	J	1.4	J	1		1.4	J	0.95	J
Selenium, Dissolved	µg/L	0.81	J	0.58	U	1.3	J	0.58	UJ	1.3	J	0.58	U	1.2	J	0.58	U	1.3	J	0.58	U	1.4	J	0.58	U	NA		0.7	U	1.2	J	NA		0.95	J	0.58	U
Silver	µg/L	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	NA		0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
Silver, Dissolved	µg/L	0.1	U	0.1	U	0.1	U	0.1	UJ	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	NA		0.1	U	0.1	U	NA		0.1	U	0.1	U
Sodium	µg/L	7,300		7,100		5,000		7,400		2,200		5,200		1,700		5,100		1,300		3,800		1,400		3,100		NA		2,600		2,100	J+	5,600		2,100	J+	5,300	
Sodium, Dissolved	µg/L	7,700		7,500		5,200		7,900	J-	2,300		5,800		1,800		6,200		1,500		5,600		2,600		5,700		NA		2,900		4,600		NA		2,500		5,600	
Thallium	µg/L	0.22		0.17	J	0.23		0.16	J	0.2		0.17	J	0.25		0.15	J	0.22		0.2		0.21		0.19	J	NA		0.2		0.21		0.16		0.19	J	0.17	J
Thallium, Dissolved	µg/L	0.21		0.17	J	0.23		0.2	J-	0.22		0.16	J	0.24		0.11	J	0.21		0.18	J	0.2		0.14	J	NA		0.2	J	0.1		NA		0.1	U	0.1	U
Total Suspended Solids[7]	mg/L	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Vanadium	µg/L	21		0.83	J	21		0.46	J	20		1.8		21		3.7		21		9.6		21		8.2		NA		5.3		18		4.8		18		5.3	
Vanadium, Dissolved	µg/L	0.3	U	0.3	U	0.51	J	0.3	UJ	0.92	J	0.3	U	16		0.3	U	0.3	U	1	UB	0.3	U	0.3	U	NA		0.3	U	0.3	U	NA		0.3	U	0.3	U
Zinc	µg/L	18,000		2900		19,000		750		17,000		3500		20,000		4,700		18,000		9,900		18,000		10,000		NA		15,000		15,000		5,100		15,000		5,000	
Zinc, Dissolved	µg/L	18,000		680		19,000		91	J-	19,000		46		20,000		30		18,000		260		18,000		35		NA		11,000		15,000		NA		15,000		230	

Notes Information presented in this table was received from EPA on September 2, 2016

GPM - gallons per minute; NA - no measurement or analysis; µg/L - micrograms per liter; s.u. - standard unit; Q - qualifier; U - Analyte was analyzed for but not detected above method detection limit (MDL) which is shown;

UJ - Analyte was analyzed for but not detected above the MDL. The MDL is approximate and may be inaccurate or imprecise; J - Analyte was positively identified, approximate concentration of analyte is shown; E - Concentration of analyte exceeded calibration range of laboratory analysis; B - Compound was found in blank and sample;

F1 - MS/MSD Recovery outside acceptance limits; + - Result is estimated and may be biased high; - - Result is estimated and may be biased low; * - Sample from 12/1/2015 was collected during a 2 hour IWTP upset; ^ - Instrument related QC is outside acceptance limits.

1 - Flow rates through the IWTP, not from the Gold King Mine adit.

2 - Flow records begin 10/22/2015 at 20:22 and the flow rate on 10/22/2015 was estimated using the daily average flow.

3 - The 12/1/2015 sample did not have flow records during the IWTP upset and the flow rate was estimated based on the closest flow measurement to sample collection time.

4 - Results for treatment plant discharges from 12/1, 12/8, 12/17, 12/23, and 1/5 are the weighted average of clarifier overflow (overflow) and filtrate (filtrate) sample concentrations (C). Overflow and sludge flow (Q) measurements reported by Alexco at the times nearest sampling were averaged and used in the following equation: $C_{Effluent} = (C_{Overflow} * Q_{Overflow} + C_{Filtrate} * Q_{Filtrate}) / (Q_{Overflow} + Q_{Filtrate})$.

5 - Filtrate recycle was installed on 1/19/2016 which eliminated filtrate effluent to Cement Creek. The location where the filtrate recycle entered the treatment system was changed on 2/3/2016 to improve particle flocculation.

6 - Samples collected on 4/12/2016 at a flow rate of 746 GPM were only analyzed for total metals and not dissolved metals. All other water treatment samples collected on 4/12/2016 were analyzed for both total and dissolved metals. The flow rates on 4/12/2016 were the flow rates during sample collection time. All other sample events have estimated flow rates based on the three flow measurements taken closest to sample collection time.

7 - Total Suspended Solids analysis began on 6/23/2016.

Table 2-1
MIW Influent and Gladstone IWTP Effluent Concentrations
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

Sample Date		12/23/2015[4]				1/5/2016[4]				2/3/2016[5]				2/4/2016				2/5/2016				2/18/2016				3/25/2016				4/12/2016[6]				4/12/2016[6]			
Flow Rate[1] (GPM)		521				487				614				671				676				508				514				638				746			
Location		Influent		Effluent		Influent		Effluent		Influent		Effluent		Influent		Effluent		Influent		Effluent		Influent		Effluent		Influent		Effluent		Influent		Effluent		Influent		Effluent	
Analyte	Units	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Aluminum	µg/L	18,000		5,000		NA		6,300		NA		3,200		15,000		330		NA		320		14,000		820		14,000		200		13,000		190	J	13,000		170	J
Aluminum, Dissolved	µg/L	12,000		370		NA		210		NA		1,100		8,000		200		NA		190	J	12,000		96	J	5,100		92	J	4,700		100	J	4,700			
Antimony	µg/L	1.9		0.8		NA		0.8	J	NA		0.45	J	1.8		0.4	U	NA		0.4	U	1.8		0.4	U	1.6		0.4	U	1.4		0.4	U	1.4		0.4	U
Antimony, Dissolved	µg/L	0.4	U	0.4	J	NA		0.4	J	NA		0.4	U	0.4	U	0.4	U	NA		0.4	U	1.3		0.4	U	0.48	J	0.57	J	0.42	J	0.4	U	0.42	J		
Arsenic	µg/L	23		6.9		NA		5.9		NA		4		23		0.37	U	NA		0.37	U	21		1		20		0.37	U	17		0.37	U	17		0.37	U
Arsenic, Dissolved	µg/L	1.3		0.49		NA		0.38	U	NA		1.3		1.6		0.37	U	NA		0.37	U	13		0.37	U	0.86	J	0.37	U	1.5		0.37	U	1.5			
Barium	µg/L	9		8.6		NA		9.1		NA		8.9		10		8.4		NA		8.2		10		8.1		10		8.3		9.6		8.4		9.6		8.4	
Barium, Dissolved	µg/L	9.1		9.5		NA		8.2		NA		9.1		10		8.6		NA		8.3		35		39		9.5		25		9.3		8.2		9.3			
Beryllium	µg/L	6.9		2.2		NA		2.8		NA		1.3		6.9		0.15	U	NA		0.15	U	5.8		0.27	J	5.5		0.15	U	5		0.15	U	5		0.15	U
Beryllium, Dissolved	µg/L	5.8		0.2		NA		0.15	U	NA		0.49		4.2		0.15	U	NA		0.15	U	4.6		0.15	U	2.9		0.15	U	2.5		0.15	U	2.5			
Cadmium	µg/L	46		16		NA		20		NA		16		46		4.2		NA		4.2		36		4.4		40		4.5		36		5.8		36		4.6	
Cadmium, Dissolved	µg/L	49		4.4		NA		4.5		NA		10		46		3.6		NA		3.8		35		3.1		39		4.1		37		5.4		37			
Calcium	µg/L	370,000		460,000		NA		460,000		NA		450,000		370,000		450,000		NA		460,000		360,000		450,000		370,000		430,000		360,000		420,000		360,000		420,000	
Calcium, Dissolved	µg/L	360,000		420,000		NA		470,000		NA		440,000		370,000		440,000		NA		440,000		370,000		450,000		370,000		430,000		360,000		420,000		360,000			
Chromium	µg/L	2.2		1.8		NA		1.9		NA		1	U	2.4		1	U	NA		1	U	2.1		1	U	2		1	U	1.8	J	1	U	1.8	J	1	U
Chromium, Dissolved	µg/L	1	U	1	U	NA		1	U	NA		1	U	1	U	1	U	NA		1	U	1.2	J	1	U	1	U	1	U	1	U	1	U	1	U		
Cobalt	µg/L	67		27		NA		33		NA		27		63		9.9		NA		10		61		10		60		12		54		14		54		11	
Cobalt, Dissolved	µg/L	67		10		NA		11		NA		20		61		9.3		NA		9.4		59		8		58		12		53		13		53			
Copper	µg/L	3,600		1,100		NA		1,500		NA		730		3,500		29		NA		30		3,300		140		3,200		26		2,900		25		2,900		20	
Copper, Dissolved	µg/L	3,400		40		NA		9.2		NA		250		3,000		4.2		NA		5.4		3,000		1.7		2,500		1.7		2,100		1.5		2,100			
Iron	µg/L	74,000		19,000		NA		24,000		NA		14,000		66,000		520		NA		540		60,000		2500		57,000		400		52,000		410		52,000		300	
Iron, Dissolved	µg/L	52,000		615		NA		32		NA		4,400		46,000		72		NA		71		56,000		17	U	37,000		17	U	36,000		17	U	36,000			
Lead	µg/L	26		7.4		NA		6.8		NA		4.6		26		0.24	J	NA		0.17	J	25		1.7		22		0.15	J	19		0.17	J	19		0.06	U
Lead, Dissolved	µg/L	2.9		0.26		NA		0.06	U	NA		1.5		1.5		0.06	U	NA		0.078	J	18		0.2	J	0.77		0.06	U	0.89		0.073	J	0.89			
Magnesium	µg/L	19,000		17,000		NA		18,000		NA		17,000		18,000		17,000		NA		17,000		17,000		16,000		17,000		15,000		16,000		14,000		16,000		14000	
Magnesium, Dissolved	µg/L	19,000		16,000		NA		17,000		NA		17,000		18,000		16,000		NA		16,000		18,000		16,000		17,000		16,000		16,000		14,000		16,000			
Manganese	µg/L	24,000		18,000		NA		19,000		NA		19,000		24,000		15,000		NA		15,000		22,000		14,000		23,000	E	16,000	E	20,000	E	14,000	E	20,000	E	14000	E
Manganese, Dissolved	µg/L	24,000		14,000		NA		15,000		NA		19,000		23,000		15,000		NA		14,000		21,000		13,000		22,000	E	16,000	E	20,000	E	14,000	E	20,000	E		
Mercury	µg/L	0.08	U	0.08	U	NA		0.08	U	NA		NA		NA		NA		NA		NA		0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U
Mercury, Dissolved	µg/L	0.08	U	0.08	U	NA		0.08	U	NA		NA		NA		NA		NA		NA		0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U		
Molybdenum	µg/L	3.4		2.1		NA		1.9		NA		1.8		3.4		1.7		NA		1.7		3.2		2.4		3.1		1.8		3		1.4		3		1.2	
Molybdenum, Dissolved	µg/L	0.7J		1.6		NA		1.5		NA		1.7		0.45	U	1.7		NA		1.7		2.2		2.3		0.46		1.7		0.72	J	1.3		0.72	J		
Nickel	µg/L	46		28		NA		31		NA		17		37		8.3		NA		8.5		38		10		37		13		36		16		36		14	
Nickel, Dissolved	µg/L	45		18		NA		19		NA		14		36		8.3		NA		8.4		37		9.1		37		13		36		16		36			
pH	s.u.	NA		8.56		NA		8.47		NA		8.44		NA		8.73		NA		8.75		NA		8.55		NA		8.47		NA		8.5*		NA		8.6*	
Potassium	µg/L	2,100		2,100		NA		2,120		NA		2,700	J+	2,300	J+	2,800	J+	NA		2,800	J+	2,100		2,300		1,900		2,000		1,800		1,800		1,800		1,800	
Potassium, Dissolved	µg/L	2,000	J+	2,000		NA		2,130		NA		2,800	J+	2,500	J+	2,800	J+	NA		2,700	J+	2,100		1,900		1,900		1,900		1,800		1,800		1,800			
Selenium	µg/L	2.1		1.1		NA		1.3		NA		0.58	U	1.7	J	0.58	U	NA		0.58	U	1.5	J	0.58	U	0.83	J	0.58	U	0.61	J	0.58	U	0.61	J	0.58	U
Selenium, Dissolved	µg/L	1.8	J	0.58	U	NA		0.59	U	NA		0.58	U	1.1	J	0.58	U	NA		0.58	U	1.1	J	0.58	U	0.58	U	0.58	U	0.58	U	0.58	U	0.58	U		
Silver	µg/L	0.1	U	0.11	J	NA		0.11	U	NA		0.1	U	0.1	U	0.1	U	NA		0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
Silver, Dissolved	µg/L	0.1	U	0.1	U	NA		0.1	U	NA		0.1	U	0.1	U	0.1	U	NA		0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U		
Sodium	µg/L	2,900		5,600		NA		5,530		NA		4,700		3,600		5,500		NA		5,500		3,400		5,400		2,900		4,900		2,600		4,600		2,600		4,700	
Sodium, Dissolved	µg/L	2,900		5,200		NA		5,770		NA		5,400	J+	3,800	J+	5,600	J+	NA		5,400	J+	4,000		6,100		2,800		5,200		2,500		4,700		2,500			
Thallium	µg/L	0.18	J	0.15	J	NA		0.15		NA		0.15	J	0.17	J	0.12	J	NA		0.12	J	0.18	J	0.12	J	0.17	J	0.14	J	0.15	J	0.12	J	0.15	J	0.13	J
Thallium, Dissolved	µg/L	0.18	J	0.13	J	NA		0.14		NA		0.13	J	0.15	J	0.12	J	NA		0.12	J	0.11	J	0.1	U	0.15	J	0.12	J	0.14	J	0.12	J	0.14	J		
Total Suspended Solids[7]	mg/L	NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA		NA	
Vanadium	µg/L	17		5.1		NA		5.6		NA		3.5		16		0.3	U	NA		0.3	U	16		1		15		0.3	U	13		0.3	U	13		0.3	U
Vanadium, Dissolved	µg/L	0.3	U	0.4		NA		0.3	U	NA		1.2		0.3	U	0.3	U	NA		0.3	U	9.8		0.3	U	0.3	U	0.3	U	0.3	U	0.3	U	0.3	U		
Zinc	µg/L	14,000		5,600		NA		7,480		NA		3,300		15,000		230		NA		240		12,000		560		13,000	E	260		11,000	E	370		11,000	E	240	
Zinc, Dissolved	µg/L	14,000		300		NA		218		NA		1,400	J+	14,000		110	J+	NA		130		11,000		120		12,000	E	160		11,000	E	260		11,000	E		

Notes Information presented in this table was received from EPA on September 2, 2016

GPM - gallons per minute; NA - no measurement or analysis; µg/L - micrograms per liter; s.u. - standard unit; Q - qualifier; U - Analyte was analyzed for but not detected above method detection limit (MDL) which is shown;

UJ - Analyte was analyzed for but not detected above the MDL. The MDL is approximate and may be inaccurate or imprecise; J - Analyte was positively identified, approximate concentration of analyte is shown; E - Concentration of analyte exceeded calibration range of laboratory analysis; B - Compound was found in blank and sample;

F1 - MS/MSD Recovery outside acceptance limits; + - Result is estimated and may be biased high; - - Result is estimated and may be biased low; * - Sample from 12/1/2015 was collected during a 2 hour IWTP upset; ^ - Instrument related QC is outside acceptance limits.

1 - Flow rates through the IWTP, not from the Gold King Mine adit.

2 - Flow records begin 10/22/2015 at 20:22 and the flow rate on 10/22/2015 was estimated using the daily average flow.

3 - The 12/1/2015 sample did not have flow records during the IWTP upset and the flow rate was estimated based on the closest flow measurement to sample collection time.

4 - Results for treatment plant discharges from 12/1, 12/8, 12/17, 12/23, and 1/5 are the weighted average of clarifier overflow (overflow) and filtrate (filtrate) sample concentrations (C). Overflow and sludge flow (Q) measurements reported by Alexco at the times nearest sampling were averaged and used in the following equation: CEffluent = (COverflow*QOverflow + CFiltrate*QFiltrate) / (QOverflow+QFiltrate).

5 - Filtrate recycle was installed on 1/19/2016 which eliminated filtrate effluent to Cement Creek. The location where the filtrate recycle entered the treatment system was changed on 2/3/2016 to improve particle flocculation.

6 - Samples collected on 4/12/2016 at a flow rate of 746 GPM were only analyzed for total metals and not dissolved metals. All other water treatment samples collected on 4/12/2016 were analyzed for both total and dissolved metals. The flow rates on 4/12/2016 were the flow rates during sample collection time. All other sample events have estimated flow rates based on the three flow measurements taken closest to sample collection time.

7 - Total Suspended Solids analysis began on 6/23/2016.

Table 2-1
MIW Influent and Gladstone IWTP Effluent Concentrations
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

Sample Date		4/12/2016[6]				4/28/2016				6/7/2016				6/10/2016				6/23/2016				6/28/2016				7/6/2016				7/19/2016				7/22/2016			
Flow Rate[1] (GPM)		961				429				451				324				647				300				612				446				446			
Location		Influent		Effluent		Influent		Effluent		Influent		Effluent		Influent		Effluent		Influent		Effluent		Influent		Effluent		Influent		Effluent		Influent		Effluent		Influent		Effluent	
Analyte	Units	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q	Result	Q
Aluminum	µg/L	13,000		170	J	13,000		250		75,000		1,400		64,000		860		55,000		860		39,000		630		35,000		840		40,000		1,500		42,000		1,100	
Aluminum, Dissolved	µg/L	4,700		110	J	3,800		56		69,000		190	J	64,000		440		53,000		690		38,000		500		35,000		340		37,000		1,100		37,000		860	
Antimony	µg/L	1.4		0.4	U	1.3		0.4		4.5		0.6	J	8	U	0.4	U	2.3		0.4	U	3	J	0.4	U	1.9		0.4	U	4.6	^	0.4	U^	40	U	0.4	U
Antimony, Dissolved	µg/L	0.42	J	0.4	U	0.51	J	0.45		3.9		0.62	J	8	U	0.4	U	1.8		0.4	U	2	U	0.4	U	0.57	J	0.4	U	1.3	^	0.4	U^	0.65	J	0.4	U
Arsenic	µg/L	17		0.37	U	19		0.37		280		4.6		200		1.7		150		0.37	U	91		1		72		0.37	U	65		0.37	U	180		0.37	U
Arsenic, Dissolved	µg/L	1.5		0.37	U	0.87	J	0.37		250		0.37	U	190		0.37	U	130		0.37	U	65		0.76	J	24		0.37	U	22		0.37	U	12		0.37	U
Barium	µg/L	9.6		8.5		9.2	B	9.6		11		9.1		8.4	J	8.9		8.8		7.2		11		8.3		7.4		8.1		11	^	8.7	^	16		8.8	
Barium, Dissolved	µg/L	9.3		8.7		11	B	8.8		11		8.9		8.1	J	9		8.7		8.3		11		8.2		7.7		8.1		11	^	8.6	^	12		9.6	
Beryllium	µg/L	5		0.15	U	5.8		0.15		7.6		0.15	U	6.9		0.15	U	7.9		0.15	U	6.8		0.15	U	6.6		0.15	U	8		0.15	U	9.4		0.15	U
Beryllium, Dissolved	µg/L	2.5		0.15	U	2.6		0.15		6.6		0.15	U	6.7		0.15	U	7.4		0.15	U	6.6		0.15	U	6.6		0.15	U	7.7		0.15	U	9.2		0.15	U
Cadmium	µg/L	36		4.4		35		6.2		130	EB	9	B	170		3.9		120	E	2.6		130		5.4		68		7.1		93		1.9		100		3.1	
Cadmium, Dissolved	µg/L	37		4.1		40		6.1		130	E	6.3		170		2.6		120	E	2.2		110		5		72		6.3		98		1.4		79		2.8	
Calcium	µg/L	360,000		420,000		350,000		390,000		320,000		930,000		320,000		830,000		350,000		710,000		330,000		590,000		340,000		560,000		380,000		610,000		350,000		590,000	
Calcium, Dissolved	µg/L	360,000		410,000		350,000		390,000		290,000		940,000		320,000		800,000		350,000		730,000		330,000		600,000		340,000		560,000		360,000		560,000		350,000		590,000	
Chromium	µg/L	1.8	J	1	U	2.6		1		22		1	U	13		1	U	13		1	U	8.6		1	U	6.8		1	U	5.8		1	U	15		1	U
Chromium, Dissolved	µg/L	1	U	1	U	1	U	1		20		1	U	13		1	U	13		1	U	8.3		1	U	6		1	U	4.9		1	U	5		1	U
Cobalt	µg/L	54		11		53		15		170		15		130		5.3		140		4.6		110		9.8		96		12		91		2.3		98		4.1	
Cobalt, Dissolved	µg/L	53		11		51		15		150		13		140		4.4		130		4		110		7.8		94		10		87		1.6		100		3.7	
Copper	µg/L	2,900		22		2,800		49		12,000	E	180		11,000		69		8,600	E	28		6,900		14		6,200		73		7,000	E	30		8,300		34	
Copper, Dissolved	µg/L	2,100		2.2		1,900		1.8		11,000	E	3.8	J	11,000		2.1	J	8,600	E	9.6		6,600		1.4	J	6,400		2.9	J	6,700	E	2.4	J	8,500		1.9	J
Iron	µg/L	52,000		340		49,000		790		340,000		4900		290,000		1,900		230,000		660		160,000		270		140,000		1,300		150,000		620		290,000		590	
Iron, Dissolved	µg/L	36,000		25	J	32,000		17		310,000		49	J	280,000		17	U	210,000		210		140,000		21	J	100,000		17	U	110,000		17	U	97,000		17	U
Lead	µg/L	19		0.06	U	20		0.26		39		0.59		20		0.2	J	18		0.099	J	23		1		21		0.44		38	^	0.53	^	65		0.24	J
Lead, Dissolved	µg/L	0.89		0.2	J	0.34		0.06		22	B	0.092	JB	18		0.06	U	16		0.12	J	19		0.21	J	18		0.06	U	35	^	0.06	U^	34		0.12	J
Magnesium	µg/L	16,000		15,000		15,000		14,000		41,000		33,000		37,000		29,000		34,000		29,000		26,000		23,000		25,000		21,000		26,000		13,000		24,000		20,000	
Magnesium, Dissolved	µg/L	16,000		14,000		15,000		14,000		37,000		33,000		37,000		29,000		32,000		28,000		26,000		23,000		25,000		22,000		25,000		12,000		24,000		20,000	
Manganese	µg/L	20,000	E	13,000	E	19,000		14,000		1.2	U	12,000	E	24,000		6,100		26,000	E	7,500	E	23,000		10,000		23,000		12,000		24,000	E	4,800	E	26,000		7,500	
Manganese, Dissolved	µg/L	20,000	E	13,000	E	19,000		14,000		1.2	U	11,000	E	24,000		6,000		26,000	E	7,400	E	22,000		9,500		24,000		11,000		23,000	E	4,400	E	27,000		7,400	
Mercury	µg/L	0.08	U	0.08	U	0.08	U	0.08		0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U
Mercury, Dissolved	µg/L	0.08	U	0.08	U	0.08	U	0.08		0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U	0.08	U
Molybdenum	µg/L	3		1.2		2.6		1.4		13		3.4		13	J	3.2		9.3		2		9.3		1.1		6.8		0.88	J	7		2.2		45	U	1.3	
Molybdenum, Dissolved	µg/L	0.72	J	1		0.45	U	1.5		11		3.2		13	J	3.1		7.7		1.9		5.2		1.1		1.6		0.84	J	2		2.1		45	U	1.4	
Nickel	µg/L	36		14		30		9.7		110		18		71		8.2		88		10		65		7.3		56		8.7		55		2.8	J	62		6.3	
Nickel, Dissolved	µg/L	36		14		30		10		100		17		69		8.9		88		12		65		7.9		57		8.8		55		3.8	J	65		7.7	
pH	s.u.	NA		8.6*		NA		8.27		NA		6.76		NA		8.66		NA		8.33		NA		8.98		3.27		8.56		3.39		8.1		3.25		8.6	
Potassium	µg/L	1,800		1,800		1,800		1,800		1,800		2,900		1,600		2,000	F1	1,900		2,200		1,800		2,000		1,700		1,800		2,400		2,500		2,400		2,500	
Potassium, Dissolved	µg/L	1,800		1,800		1,800		1,800		1,600		2,900		1,600		2,100		1,900		2,300		1,800		2,000		1,700		1,900		2,300		2,400		2,300		2,600	
Selenium	µg/L	0.61	J	0.58	U	0.58	U	0.58		12		2.7		6.1		0.75	J	7.2		0.72	J	4.4		0.92	J	2.8		0.58	U	2.7		0.58	U	3.5		0.58	U
Selenium, Dissolved	µg/L	0.58	U	0.58	U	0.58	U	0.58		9.8		1.9	J	6.3		0.58	U	6.3		1.5	J	4.2		1.1	J	2.5		0.58	U	2.3		0.6	J	1.7	J	0.58	U
Silver	µg/L	0.1	U	0.1	U	0.1	U	0.1		0.24	J	0.1	U	2	U	0.1	U	0.11	J	0.1	U	0.5	U	0.1	U	0.1	U	0.1	U	0.1	J	0.1	U	10	U	0.1	U
Silver, Dissolved	µg/L	0.1	U	0.1	U	0.1	U	0.1		0.13	J	0.1	U	2	U	0.1	U	0.1	U	0.1	U	0.5	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U	0.1	U
Sodium	µg/L	2,600		4,600		2,900		4,400		4,800	U	86,000		5,200		96,000		4,800	U	20,000		3,400		5,000		3,800		4,500		4,200		5,000		2,500		4,800	
Sodium, Dissolved	µg/L	2,500		4,600		2,900		4,300		4,800	U	86,000		4,300	J	94,000		3,500		20,000		3,300		4,900		3,800		4,700		4,100		4,600		2,500		5,200	
Thallium	µg/L	0.15	J	0.13	J	0.17	J	0.13		0.21		0.15	J	2	U	0.29		0.22		0.16	J	0.19	J	0.16	J	0.22		0.2		0.38	^	0.31	^	0.23		0.26	
Thallium, Dissolved	µg/L	0.14	J	0.12	J	0.15	J	0.13		0.18	J	0.15	J	2	U	0.28		0.21		0.14	J	0.19	J	0.17	J	0.21		0.2		0.42	^	0.32	^	0.31		0.27	
Total Suspended Solids[7]	mg/L	NA		NA		NA		NA		NA		NA		NA		NA		220		10		210		7.6		180		11		160		8.4		650		6.3	
Vanadium	µg/L	13		0.3	U	13		0.3		87		1.7		64		0.69	J	50		0.3	U	41		0.3	U	35		0.3	U	35		0.33	J	110		0.3	U
Vanadium, Dissolved	µg/L	0.3	U	0.3	U	3	U	0.3		76		0.3	U	63		0.3	U	39		0.3	U	26		0.3	U	6.5		0.3	U	8.5		0.3	U	4.5		0.3	U
Zinc	µg/L	11,000	E	230		11,000		540		48,000	E	940		41,000		300		33,000	E	140		25,000		220		22,000		560		22,000	E	140		25,000		180	
Zinc, Dissolved	µg/L	11,000	E	130		11,000		360		45,000	E	160		41,000		33		33,000	E	57		24,000		45		22,000		190		22,000	E	26		27,000		61	F1

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GPM - gallons per minute; NA - no measurement or analysis; µg/L - micrograms per liter; s.u. - standard unit; Q - qualifier; U - Analyte was analyzed for but not detected above method detection limit (MDL) which is shown;

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F1 - MS/MSD Recovery outside acceptance limits; + - Result is estimated and may be biased high; - - Result is estimated and may be biased low; * - Sample from 12/1/2015 was collected during a 2 hour IWTP upset; ^ - Instrument related QC is outside acceptance limits.

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7 - Total Suspended Solids analysis began on 6/23/2016.

Table 4-1
MIW Influent and Gladstone IWTP Effluent Percent Removal Results
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

Sample Date	10/19/2015		10/22/2015		10/26/2015		10/29/2015		11/3/2015		11/5/2015		12/1/2015[2]		12/8/2015[2]		12/17/2015[2]		12/23/2015[2]		1/5/2016[2]		2/3/2016[3]		2/4/2016		2/5/2016	
Analyte	% removal[1]		% removal		% removal		% removal		% removal		% removal		% removal		% removal		% removal		% removal		% removal		% removal		% removal		% removal	
Aluminum		79.5%		93.5%		79.0%		69.0%		42.9%		42.9%	NC	--		70.0%		71.8%		72.2%	NC	--	NC	--		97.8%	NC	--
Aluminum, Dissolved		91.1%		97.0%		97.5%		92.5%		98.8%		97.8%	NC	--	NC	--		98.4%		96.9%	NC	--	NC	--		97.5%	NC	--
Antimony	>	82.6%	>	84.0%	>	82.6%	>	83.3%		56.5%		63.9%	NC	--		63.2%		57.9%		57.9%	NC	--	NC	--	>	77.8%	NC	--
Antimony, Dissolved	NC	--	NC	--		-14.6%	>	78.9%	>	4.8%	NC	--	NC	--	NC	--	NC	--		0.0%	NC	--	NC	--	NC	--	NC	--
Arsenic		96.4%	>	98.7%		91.5%		86.0%		60.7%		70.0%	NC	--		79.2%		73.9%		70.0%	NC	--	NC	--	>	98.4%	NC	--
Arsenic, Dissolved	>	66.4%	>	82.4%	>	85.8%	>	98.4%	>	75.3%	>	76.9%	NC	--	NC	--	>	71.5%		62.3%	NC	--	NC	--	>	76.9%	NC	--
Barium		10.5%		18.8%		5.4%		1.0%		-15.8%		-2.1%	NC	--		11.3%		3.2%		4.4%	NC	--	NC	--		16.0%	NC	--
Barium, Dissolved		5.4%		8.3%		11.8%		17.3%		13.5%		18.6%	NC	--	NC	--		-17.1%		-4.4%	NC	--	NC	--		14.0%	NC	--
Beryllium		83.8%		96.2%		81.7%		75.5%		42.5%		42.5%	NC	--		72.3%		69.6%		68.1%	NC	--	NC	--	>	97.8%	NC	--
Beryllium, Dissolved		96.0%	>	98.3%	>	98.3%	>	98.4%	>	97.9%	>	97.8%	NC	--	NC	--	>	97.3%		96.6%	NC	--	NC	--	>	96.4%	NC	--
Cadmium		81.1%		90.5%		75.0%		73.7%		40.0%		39.3%	NC	--		65.2%		57.8%		65.2%	NC	--	NC	--		90.9%	NC	--
Cadmium, Dissolved		94.2%		93.6%		95.1%		99.7%		89.1%		95.6%	NC	--	NC	--		90.6%		91.0%	NC	--	NC	--		92.2%	NC	--
Calcium		-38.2%		-34.3%		-37.1%		-44.7%		-27.5%		-34.2%	NC	--		-28.6%		-25.7%		-24.3%	NC	--	NC	--		-21.6%	NC	--
Calcium, Dissolved		-38.2%		-37.1%		-33.3%		-43.2%		-33.3%		-34.2%	NC	--	NC	--		-22.9%		-16.7%	NC	--	NC	--		-18.9%	NC	--
Chromium	>	60.0%	>	65.5%	>	64.3%		57.1%		34.5%		37.9%	NC	--		34.6%		28.0%		18.2%	NC	--	NC	--	>	58.3%	NC	--
Chromium, Dissolved	NC	--	NC	--	NC	--	>	54.5%	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--
Cobalt		81.0%		89.4%		72.4%		73.3%		36.3%		40.2%	NC	--		70.8%		61.4%		59.7%	NC	--	NC	--		84.3%	NC	--
Cobalt, Dissolved		93.5%		92.1%		92.9%		98.9%		85.2%		95.6%	NC	--	NC	--		84.3%		85.1%	NC	--	NC	--		84.8%	NC	--
Copper		84.0%		96.3%		80.5%		75.0%		40.9%		44.4%	NC	--		64.9%		64.9%		69.4%	NC	--	NC	--		99.2%	NC	--
Copper, Dissolved		96.1%		99.7%		99.97%		99.9%		99.4%		100.0%	NC	--	NC	--		99.8%		98.8%	NC	--	NC	--		99.9%	NC	--
Iron		88.4%		96.8%		84.5%		78.8%		50.6%		52.9%	NC	--		75.3%		73.5%		74.3%	NC	--	NC	--		99.2%	NC	--
Iron, Dissolved		96.1%		99.7%		99.9%		100.0%		99.3%		100.0%	NC	--	NC	--		99.9%		98.8%	NC	--	NC	--		99.8%	NC	--
Lead		89.1%		97.5%		87.2%		79.7%		34.5%		63.3%	NC	--		80.8%		75.8%		71.5%	NC	--	NC	--		99.1%	NC	--
Lead, Dissolved		91.4%		98.4%	>	99.6%		99.8%		98.3%	>	99.2%	NC	--	NC	--	>	97.7%		91.0%	NC	--	NC	--	>	96.0%	NC	--
Magnesium		5.3%		15.0%		10.0%		76.1%		4.5%		9.5%	NC	--		10.5%		5.3%		10.5%	NC	--	NC	--		5.6%	NC	--
Magnesium, Dissolved		5.3%		10.0%		14.3%		99.0%		13.6%		10.0%	NC	--	NC	--		10.5%		15.8%	NC	--	NC	--		11.1%	NC	--
Manganese		57.1%		60.7%		40.7%		74.1%		10.3%		23.3%	NC	--		50.0%		26.9%		25.0%	NC	--	NC	--		37.5%	NC	--
Manganese, Dissolved		64.6%		58.6%		53.6%		99.9%		33.3%		55.2%	NC	--	NC	--		32.0%		41.7%	NC	--	NC	--		34.8%	NC	--
Mercury	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--
Mercury, Dissolved	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--
Molybdenum	>	86.4%		84.5%		75.7%		61.5%		39.5%		52.6%	NC	--		50.0%		41.2%		38.2%	NC	--	NC	--		50.0%	NC	--
Molybdenum, Dissolved	NC	--	<	-55.6%		-15.9%		64.5%	<	-211.1%	<	-113.3%	NC	--	NC	--		-209.1%		-128.6%	NC	--	NC	--	<	-277.8%	NC	--
Nickel		75.6%		83.4%		67.4%		65.3%		30.4%		33.3%	NC	--		54.5%		44.2%		39.1%	NC	--	NC	--		77.6%	NC	--
Nickel, Dissolved		87.4%		82.5%		85.9%		89.4%		76.6%		86.8%	NC	--	NC	--		65.1%		60.0%	NC	--	NC	--		76.9%	NC	--
Potassium		-4.5%		-4.5%		-4.3%		-4.0%		-8.7%		-4.3%	NC	--		-5.3%		-5.3%		0.0%	NC	--	NC	--		-21.7%	NC	--
Potassium, Dissolved		-4.3%		-4.3%		-4.3%		-8.0%		-4.3%		-4.5%	NC	--	NC	--		5.3%		0.0%	NC	--	NC	--		-12.0%	NC	--
Selenium	>	36.3%	>	67.8%	>	67.8%	>	67.8%		54.4%	>	65.9%	NC	--		28.6%		32.1%		47.6%	NC	--	NC	--	>	65.9%	NC	--
Selenium, Dissolved	>	28.4%	>	55.4%	>	55.4%	>	51.7%	>	55.4%	>	58.6%	NC	--	NC	--	>	38.9%	>	67.8%	NC	--	NC	--	>	47.3%	NC	--
Silver	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	<	-10.0%	NC	--	NC	--	NC	--	NC	--
Silver, Dissolved	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--
Sodium		2.7%		-48.0%		-136.4%		-200.0%		-192.3%		-121.4%	NC	--		-166.7%		-152.4%		-93.1%	NC	--	NC	--		-52.8%	NC	--
Sodium, Dissolved		2.6%		-51.9%		-152.2%		-244.4%		-273.3%		-119.2%	NC	--	NC	--		-124.0%		-79.3%	NC	--	NC	--		-47.4%	NC	--
Thallium		22.7%		30.4%		15.0%		40.0%		9.1%		9.5%	NC	--		23.8%		10.5%		16.7%	NC	--	NC	--		29.4%	NC	--
Thallium, Dissolved		19.0%		13.0%		27.3%		54.2%		14.3%		30.0%	NC	--	NC	--	NC	--		27.8%	NC	--	NC	--		20.0%	NC	--
Total Suspended Solids[5]	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--
Vanadium		96.0%		97.8%		91.0%		82.4%		54.3%		61.0%	NC	--		73.3%		70.6%		70.0%	NC	--	NC	--	>	98.1%	NC	--
Vanadium, Dissolved	NC	--	>	41.2%	>	67.4%	>	98.1%	<	-233.3%	NC	--	NC	--	NC	--	NC	--	<	-33.3%	NC	--	NC	--	NC	--	NC	--
Zinc		83.9%		96.1%		79.4%		76.5%		45.0%		44.4%	NC	--		66.0%		66.7%		60.0%	NC	--	NC	--		98.5%	NC	--
Zinc, Dissolved		96.2%		99.5%		99.8%		99.9%		98.6%		99.8%	NC	--	NC	--		98.5%		97.9%	NC	--	NC	--		99.2%	NC	--

Notes: Analytes with negative percent removal values are explained by one of the following a) influent and effluent concentrations are near the detection limit and within a reasonable percent error of each other, so it is more accurate to consider the percent removal to be 0%, b) both Ca and Na are added to the influent as part of the treatment process; therefore, Ca and Na concentrations increase, resulting in a negative percent removal.

NC - calculation qualifer; > - actual removal efficiency is greater than calculated percentage; < - actual removal efficiency is less than calculated percentage;

-- - percent removal was not calculated for one of the following reasons:

Treated water effulent is non-detect (U, UJ), and influent water has a concentration less than the treated water effluent concentration;

Influent water is non-detect (U, UJ), and treated water effluent has a concentration less than the influent water concentration; or

Both influent water and treated water effluent are non-detect (U, UJ).

1 - Percent removal compares influent concentrations to effluent concentration.

2 - Results for treatment plant discharges from 12/1, 12/8, 12/17, 12/23, and 1/5 are the weighted average of clarifier overflow (overflow) and filtrate (filtrate) sample concentrations (C). Overflow and sludge flow (Q) measurements reported by Alexco at the times nearest sampling were averaged and used in the following equation: $C_{Effluent} = (C_{Overflow}*Q_{Overflow} + C_{Filtrate}*Q_{Filtrate}) / (Q_{Overflow}+Q_{Filtrate})$.

3 - Filtrate recycle was installed on 1/19/2016 which eliminated filtrate effluent to Cement Creek. The location where the filtrate recycle entered the treatment system was changed on 2/3/2016 to improve particle flocculation.

4 - Samples collected on 4/12/2016 at a flow rate of 746 GPM were analyzed for total metals and not dissolved metals. All other water treatment samples collected on 4/12/2016 were analyzed for both total and dissolved metals.

5 - Total Suspended Solids analysis began on 6/23/2016.

Table 4-1
MIW Influent and Gladstone IWTP Effluent Percent Removal Results
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

Sample Date	2/18/2016		3/25/2016		4/12/2016		4/12/2016[4]		4/12/2016		4/28/2016		6/7/2016		6/10/2016		6/23/2016		6/28/2016		7/6/2016		7/19/2016		7/22/2016	
Analyte		% removal		% removal		% removal		% removal		% removal		% removal		% removal		% removal		% removal		% removal		% removal		% removal		% removal
Aluminum		94.1%		98.6%		98.5%		98.7%		98.7%		98.1%		98.1%		98.7%		98.4%		98.4%		97.6%		96.3%		97.4%
Aluminum, Dissolved		99.2%		98.2%		97.9%	NC	--		97.7%		98.5%		99.7%		99.3%		98.7%		98.7%		99.0%		97.0%		97.7%
Antimony	>	77.8%	>	75.0%	>	71.4%	>	71.4%	>	71.4%		69.2%		86.7%	NC	--	>	82.6%	>	86.7%	>	78.9%		91.3%	NC	--
Antimony, Dissolved	>	69.2%		-18.8%	>	4.8%	NC	--	>	4.8%		11.8%		84.1%	NC	--	>	77.8%	NC	--	>	29.8%		69.2%	>	38.5%
Arsenic		95.2%	>	98.2%	>	97.8%	>	97.8%	>	97.8%		98.1%		98.4%		99.2%	>	99.8%		98.9%	>	99.5%	>	99.4%	>	99.8%
Arsenic, Dissolved	>	97.2%	>	57.0%	>	75.3%	NC	--	>	75.3%		57.5%	>	99.9%	>	99.8%	>	99.7%		98.8%	>	98.5%	>	98.3%	>	96.9%
Barium		19.0%		17.0%		12.5%		12.5%		11.5%		-4.3%		17.3%		-6.0%		18.2%		24.5%		-9.5%		20.9%		45.0%
Barium, Dissolved		-11.4%		-163.2%		11.8%	NC	--		6.5%		20.0%		19.1%		-11.1%		4.6%		25.5%		-5.2%		21.8%		20.0%
Beryllium		95.3%	>	97.3%	>	97.0%	>	97.0%	>	97.0%		97.4%	>	98.0%	>	97.8%	>	98.1%	>	97.8%	>	97.7%	>	98.1%	>	98.4%
Beryllium, Dissolved	>	96.7%	>	94.8%	>	94.0%	NC	--	>	94.0%		94.2%	>	97.7%	>	97.8%	>	98.0%	>	97.7%	>	97.7%	>	98.1%	>	98.4%
Cadmium		87.8%		88.8%		83.9%		87.2%		87.8%		82.3%		93.1%		97.7%		97.8%		95.8%		89.6%		98.0%		96.9%
Cadmium, Dissolved		91.1%		89.5%		85.4%	NC	--		88.9%		84.8%		95.2%		98.5%		98.2%		95.5%		91.3%		98.6%		96.5%
Calcium		-25.0%		-16.2%		-16.7%		-16.7%		-16.7%		-11.4%		-190.6%		-159.4%		-102.9%		-78.8%		-64.7%		-60.5%		-68.6%
Calcium, Dissolved		-21.6%		-16.2%		-16.7%	NC	--		-13.9%		-11.4%		-224.1%		-150.0%		-108.6%		-81.8%		-64.7%		-55.6%		-68.6%
Chromium	>	52.4%	>	50.0%	>	44.4%	>	44.4%	>	44.4%		61.5%	>	95.5%	>	92.3%	>	92.3%	>	88.4%	>	85.3%	>	82.8%	>	93.3%
Chromium, Dissolved	>	16.7%	NC	--	NC	--	NC	--	NC	--		0.0%	>	95.0%	>	92.3%	>	92.3%	>	88.0%	>	83.3%	>	79.6%	>	80.0%
Cobalt		83.6%		80.0%		74.1%		79.6%		79.6%		71.7%		91.2%		95.9%		96.7%		91.1%		87.5%		97.5%		95.8%
Cobalt, Dissolved		86.4%		79.3%		75.5%	NC	--		79.2%		70.6%		91.3%		96.9%		96.9%		92.9%		89.4%		98.2%		96.3%
Copper		95.8%		99.2%		99.1%		99.3%		99.2%		98.3%		98.5%		99.4%		99.7%		99.8%		98.8%		99.6%		99.6%
Copper, Dissolved		99.9%		99.9%		99.9%	NC	--		99.9%		99.9%		100.0%		100.0%		99.9%		99.98%		99.95%		99.96%		99.98%
Iron		95.8%		99.3%		99.2%		99.4%		99.3%		98.4%		98.6%		99.3%		99.7%		99.8%		99.1%		99.6%		99.8%
Iron, Dissolved	>	99.97%	>	99.95%	>	99.95%	NC	--		99.9%		99.9%		99.98%	>	99.99%		99.9%		99.99%	>	99.98%	>	99.98%	>	99.98%
Lead		93.2%		99.3%		99.1%	>	99.7%	>	99.7%		98.7%		98.5%		99.0%		99.5%		95.7%		97.9%		98.6%		99.6%
Lead, Dissolved		98.9%	>	92.2%		91.8%	NC	--		77.5%		82.4%		99.6%	>	99.7%		99.3%		98.9%	>	99.7%		99.8%		99.6%
Magnesium		5.9%		11.8%		12.5%		12.5%		6.3%		6.7%		19.5%		21.6%		14.7%		11.5%		16.0%		50.0%		16.7%
Magnesium, Dissolved		11.1%		5.9%		12.5%	NC	--		12.5%		6.7%		10.8%		21.6%		12.5%		11.5%		12.0%		52.0%		16.7%
Manganese		36.4%		30.4%		30.0%		30.0%		35.0%		26.3%	NC	--		74.6%		71.2%		56.5%		47.8%		80.0%		71.2%
Manganese, Dissolved		38.1%		27.3%		30.0%	NC	--		35.0%		26.3%	NC	--		75.0%		71.5%		56.8%		54.2%		80.9%		72.6%
Mercury	NC	--	NC	--	NC	--	NC	--	NC	--		0.0%	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--
Mercury, Dissolved	NC	--	NC	--	NC	--	NC	--	NC	--		0.0%	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--
Molybdenum		25.0%		41.9%		53.3%		60.0%		60.0%		46.2%		73.8%		75.4%		78.5%		88.2%		87.1%		68.6%	NC	--
Molybdenum, Dissolved		-4.5%		-269.6%		-80.6%	NC	--		-38.9%	<	-233.3%		70.9%		76.2%		75.3%		78.8%		47.5%		-5.0%	NC	--
Nickel		73.7%		64.9%		55.6%		61.1%		61.1%		67.7%		83.6%		88.5%		88.6%		88.8%		84.5%		94.9%		89.8%
Nickel, Dissolved		75.4%		64.9%		55.6%	NC	--		61.1%		66.7%		83.0%		87.1%		86.4%		87.8%		84.6%		93.1%		88.2%
Potassium		-9.5%		-5.3%		0.0%		0.0%		0.0%		0.00%		-61.1%		-25.0%		-15.8%		-11.1%		-5.9%		-4.2%		-4.2%
Potassium, Dissolved		9.5%		0.0%		0.0%	NC	--		0.0%		0.00%		-81.3%		-31.3%		-21.1%		-11.1%		-11.8%		-4.3%		-13.0%
Selenium	>	61.3%	>	30.1%	>	4.9%	>	4.9%	>	4.9%		0.00%		77.5%		87.7%		90.0%		79.1%	>	79.3%	>	78.5%	>	83.4%
Selenium, Dissolved	>	47.3%	NC	--	NC	--	NC	--	NC	--		0.00%		80.6%	>	90.8%		76.2%		73.8%	>	76.8%		73.9%	>	65.9%
Silver	NC	--	NC	--	NC	--	NC	--	NC	--		0.00%	>	58.3%	NC	--	>	9.1%	NC	--	NC	--		0.0%	NC	--
Silver, Dissolved	NC	--	NC	--	NC	--	NC	--	NC	--		0.00%	>	23.1%	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--
Sodium		-58.8%		-69.0%		-76.9%		-80.8%		-76.9%		-51.7%	<	-1691.7%		-1746.2%	<	-316.7%		-47.1%		-18.4%		-19.0%		-92.0%
Sodium, Dissolved		-52.5%		-85.7%		-88.0%	NC	--		-84.0%		-48.3%	<	-1691.7%		-2086.0%		-471.4%		-48.5%		-23.7%		-12.2%		-108.0%
Thallium		33.3%		17.6%		20.0%		13.3%		13.3%		23.5%		28.6%	NC	--		27.3%		15.8%		9.1%		18.4%		-13.0%
Thallium, Dissolved	>	9.1%		20.0%		14.3%	NC	--		14.3%		13.3%		16.7%	NC	--		33.3%		10.5%		4.8%		23.8%		12.9%
Total Suspended Solids[5]	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--	NC	--
Vanadium		93.8%	>	98.0%	>	97.7%	>	97.7%	>	97.7%		97.7%		98.0%		98.9%	>	99.4%	>	99.3%	>	99.1%		99.1%	>	99.7%
Vanadium, Dissolved	>	96.9%	NC	--	NC	--	NC	--	NC	--	NC	--	>	99.6%	>	99.5%	>	99.2%	>	98.8%	>	95.4%	>	96.5%	>	93.3%
Zinc		95.3%		98.0%		96.6%		97.8%		97.9%		95.1%		98.0%		99.3%		99.6%		99.1%		97.5%		99.4%		99.3%
Zinc, Dissolved		98.9%		98.7%		97.6%	NC	--		98.8%		96.7%		99.6%		99.9%		99.8%		99.8%		99.1%		99.9%		99.8%

Notes: Analytes with negative percent removal values are explained by one of the following a) influent and effluent concentrations are near the detection limit and within a reasonable percent error of each other, so it is more accurate to consider the percent removal to be 0%, b) both Ca and Na are added to the influent as part of the treatment process; therefore, Ca and Na concentrations increase, resulting in a negative percent removal.

NC - calculation qualifer; > - actual removal efficiency is greater than calculated percentage; < - actual removal efficiency is less than calculated percentage;

-- - percent removal was not calculated for one of the following reasons:

Treated water effulent is non-detect (U, UJ), and influent water has a concentration less than the treated water effluent concentration;

Influent water is non-detect (U, UJ), and treated water effluent has a concentration less than the influent water concentration; or

Both influent water and treated water effluent are non-detect (U, UJ).

1 - Percent removal compares influent concentrations to effluent concentration.

2 - Results for treatment plant discharges from 12/1, 12/8, 12/17, 12/23, and 1/5 are the weighted average of clarifier overflow (overflow) and filtrate (filtrate) sample concentrations (C). Overflow and sludge flow (Q) measurements reported by Alexco at the times nearest sampling were averaged and used in the following equation: CEffluent = (COverflow*QOverflow + CFiltrate*QFiltrate) / (QOverflow+QFiltrate).

3 - Filtrate recycle was installed on 1/19/2016 which eliminated filtrate effluent to Cement Creek. The location where the filtrate recycle entered the treatment system was changed on 2/3/2016 to improve particle flocculation.

4 - Samples collected on 4/12/2016 at a flow rate of 746 GPM were analyzed for total metals and not dissolved metals. All other water treatment samples collected on 4/12/2016 were analyzed for both total and dissolved metals.

5 - Total Suspended Solids analysis began on 6/23/2016.

Table 4-2
MIW Influent and Gladstone IWTP Effluent Percent Removal Statistics
Gold King Mine Adit and Gladstone IWTP
Bonita Peak Mining District Superfund Site, CO

Statistic	Minimum	Maximum	Average
Analyte	Percent Reduction		
Aluminum, Total	43%	98.7%	87%
Aluminum, Dissolved	91%	99.7%	98%
Antimony	57%	91%	75%
Antimony, Dissolved	-19%	84%	31%
Arsenic	61%	99.8%	92%
Arsenic, Dissolved	57%	99.9%	83%
Barium	-16%	45%	10%
Barium, Dissolved	-163%	25%	0.3%
Beryllium	42%	98%	87%
Beryllium, Dissolved	94%	98%	97%
Cadmium	39%	98%	81%
Cadmium, Dissolved	85%	99.7%	93%
Calcium	-191%	-11%	-50%
Calcium, Dissolved	-224%	-11%	-53%
Chromium	18%	95%	60%
Chromium, Dissolved	0%	95%	68%
Cobalt	36%	97%	78%
Cobalt, Dissolved	71%	98.9%	89%
Copper	41%	99.8%	87%
Copper, Dissolved	96%	99.98%	99.7%
Iron n=23	51%	99.8%	90%
Iron, Dissolved	96%	99.99%	99.7%
Lead	34%	99.7%	89%
Lead, Dissolved	78%	99.8%	96%
Magnesium	5%	76%	16%
Magnesium, Dissolved	5%	99.0%	18%
Manganese	10%	80%	45%
Manganese, Dissolved	26%	99.9%	52%
Mercury	NA	NA	NA
Mercury, Dissolved	NA	NA	NA
Molybdenum	25%	88%	61%
Molybdenum, Dissolved	-278%	79%	-65%
Nickel	30%	95%	68%
Nickel, Dissolved	56%	93%	78%
Potassium	-61%	0%	-9%
Potassium, Dissolved	-81%	10%	-10%
Selenium	0%	90%	53%
Selenium, Dissolved	0%	91%	58%
Silver	-10%	58%	11%
Silver, Dissolved	0%	23%	12%
Sodium	-1746%	2.7%	-239%
Sodium, Dissolved	-2086%	2.6%	-280%
Thallium	-13%	40%	19%
Thallium, Dissolved	4.8%	54%	20%
Total Suspended Solids	94%	99%	96%
Vanadium	54%	99.7%	90%
Vanadium, Dissolved	-233%	99.6%	55%
Zinc	44%	99.6%	86%
Zinc, Dissolved	96%	99.9%	99.0%

Notes: Statistics of reduction rates from 10/19/2015 to 7/22/2016.

Analytes with negative percent removal values are explained by one of the following situations:

a) influent and effluent concentrations are near the detection limit; percent removal is effectively 0%

b) both Ca and Na are added as part of the treatment process, resulting in higher effluent concentrations

Table 4-3
MIW Influent and Gladstone IWTP Effluent Loading Results
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

Sample Date	10/19/2015[2]		10/22/2015[2]		10/26/2015		10/29/2015		11/3/2015		11/5/2015		12/1/2015[3,4]		12/8/2015[4]		12/17/2015[4]		12/23/2015[4]		1/5/2016[4]		2/3/2016[5]		2/4/2016		2/5/2016	
Flow Rate[1] (GPM)	NA		481		422		404		557		570		526		514		571		521		487		614		671		676	
Location	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
Analyte	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)
Aluminum	NA	NA	116	7.5	101	21	102	31.6	141	80.3	121	82.2	NA	59.4	105	31.5	117	32.9	104	31.3	NA	36.9	NA	23.6	121	2.7	NA	2.6
Aluminum, Dissolved	NA	NA	110	3.3	96	2.4	97	7.3	127	1.5	130	2.9	NA	17.7	74	NA	82	1.4	75	2.3	NA	1.2	NA	8.1	65	1.6	NA	1.5
Antimony	NA	NA	0.01	0.0	0.01	0.00	0.01	0.00	0.02	0.01	0.02	0.01	NA	0.00	0.01	0.0	0.01	0.01	0.01	0.01	NA	0.0	NA	0.0	0.01	0.00	NA	0.00
Antimony, Dissolved	NA	NA	0.00	0.0	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	NA	0.00	0.00	NA	0.00	0.00	0.00	0.00	NA	0.0	NA	0.00	0.00	0.00	NA	0.00
Arsenic	NA	NA	0.17	0.00	0.14	0.01	0.15	0.02	0.19	0.07	0.20	0.06	NA	0.04	0.15	0.03	0.16	0.04	0.14	0.04	NA	0.03	NA	0.03	0.19	0.00	NA	0.00
Arsenic, Dissolved	NA	NA	0.01	0.00	0.01	0.00	0.11	0.00	0.01	0.00	0.01	0.00	NA	0.00	0.01	NA	0.01	0.00	0.01	0.00	NA	0.00	NA	0.01	0.01	0.00	NA	0.00
Barium	NA	NA	0.06	0.0	0.05	0.04	0.05	0.05	0.06	0.1	0.07	0.1	NA	0.1	0.06	0.1	0.07	0.06	0.06	0.05	NA	0.1	NA	0.07	0.08	0.07	NA	0.07
Barium, Dissolved	NA	NA	0.06	0.1	0.05	0.04	0.05	0.04	0.06	0.1	0.07	0.1	NA	0.1	0.99	NA	0.28	0.33	0.06	0.06	NA	0.0	NA	0.07	0.08	0.07	NA	0.07
Beryllium	NA	NA	0.05	0.00	0.05	0.01	0.05	0.01	0.05	0.03	0.05	0.03	NA	0.03	0.04	0.01	0.05	0.01	0.04	0.01	NA	0.02	NA	0.01	0.06	0.00	NA	0.00
Beryllium, Dissolved	NA	NA	0.05	0.00	0.05	0.00	0.05	0.00	0.05	0.00	0.05	0.00	NA	0.01	0.04	NA	0.04	0.00	0.04	0.00	NA	0.00	NA	0.00	0.03	0.00	NA	0.00
Cadmium	NA	NA	0.25	0.02	0.26	0.07	0.28	0.07	0.37	0.22	0.38	0.23	NA	0.34	0.28	0.10	0.31	0.13	0.29	0.10	NA	0.12	NA	0.12	0.37	0.03	NA	0.03
Cadmium, Dissolved	NA	NA	0.25	0.02	0.29	0.01	0.27	0.00	0.39	0.04	0.39	0.02	NA	0.28	0.29	NA	0.32	0.03	0.31	0.03	NA	0.03	NA	0.07	0.37	0.03	NA	0.03
Calcium	NA	NA	2,023	2,717	1,775	2,434	1,845	2,670	2,677	3,414	2,603	3,493	NA	2,781	2,162	2,780	2,402	3,019	2,317	2,880	NA	2,692	NA	3,320	2,984	3,629	NA	3,737
Calcium, Dissolved	NA	NA	2,023	2,775	1,826	2,434	1,796	2,573	2,611	3,481	2,603	3,493	NA	2,718	2,100	NA	2,402	2,951	2,254	2,630	NA	2,751	NA	3,247	2,984	3,548	NA	3,574
Chromium	NA	NA	0.02	0.0	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.01	NA	0.01	0.02	0.01	0.02	0.01	0.01	0.01	NA	0.01	NA	0.01	0.02	0.01	NA	0.01
Chromium, Dissolved	NA	NA	0.0	0.0	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	NA	0.01	0.01	NA	0.01	0.01	0.01	0.01	NA	0.01	NA	0.01	0.01	0.01	NA	0.01
Cobalt	NA	NA	0.47	0.1	0.39	0.11	0.42	0.11	0.54	0.34	0.56	0.34	NA	0.47	0.44	0.13	0.48	0.19	0.42	0.17	NA	0.19	NA	0.20	0.51	0.08	NA	0.08
Cobalt, Dissolved	NA	NA	0.47	0.0	0.41	0.03	0.39	0.00	0.54	0.08	0.55	0.02	NA	0.37	0.43	NA	0.48	0.08	0.42	0.06	NA	0.06	NA	0.15	0.49	0.07	NA	0.08
Copper	NA	NA	27	1.0	22	4.3	23	5.8	29	17.4	31	17.1	NA	13.3	23	8.0	25	8.9	23	6.9	NA	8.8	NA	5.4	28	0.23	NA	0.24
Copper, Dissolved	NA	NA	26	0.1	23	0.01	23	0.02	29	0.17	29	0.01	NA	4.3	22	NA	24	0.04	21	0.25	NA	0.05	NA	1.8	24	0.03	NA	0.04
Iron	NA	NA	491	16	426	66	413	87	569	281	582	274	NA	316	451	111	487	129	463	119	NA	140	NA	103	532	4.2	NA	4.4
Iron, Dissolved	NA	NA	347	1.0	304	0.21	374	0.2	395	2.8	397	0.2	NA	164.4	321	NA	357	0.2	326	3.9	NA	0.19	NA	32.5	371	0.58	NA	0.58
Lead	NA	NA	0.18	0.00	0.15	0.02	0.15	0.03	0.19	0.13	0.21	0.08	NA	0.04	0.16	0.03	0.18	0.04	0.16	0.05	NA	0.04	NA	0.03	0.21	0.00	NA	0.00
Lead, Dissolved	NA	NA	0.09	0.00	0.08	0.00	0.13	0.00	0.06	0.00	0.05	0.00	NA	0.00	0.02	NA	0.02	0.00	0.02	0.00	NA	0.00	NA	0.01	0.01	0.00	NA	0.00
Magnesium	NA	NA	116	98	101	91	112	27	147	141	144	130	NA	126	117	105	130	124	119	106	NA	105	NA	125	145	137	NA	138
Magnesium, Dissolved	NA	NA	116	104	106	91	107	1.1	147	127	137	123	NA	120	117	NA	130	117	119	100	NA	99	NA	125	145	129	NA	130
Manganese	NA	NA	162	64	137	81	141	36	194	174	205	158	NA	177	161	80	178	130	150	113	NA	111	NA	140	194	121	NA	122
Manganese, Dissolved	NA	NA	168	69	142	66	141	0.09	201	134	199	89	NA	158	154	NA	172	117	150	88	NA	88	NA	140	185	121	NA	114
Mercury	NA	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	0.00	NA	NA	NA	NA	NA	NA
Mercury, Dissolved	NA	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	0.00	NA	NA	NA	NA	NA	NA
Molybdenum	NA	NA	0.02	0.00	0.02	0.00	0.02	0.01	0.03	0.02	0.03	0.01	NA	0.01	0.02	0.01	0.02	0.01	0.02	0.01	NA	0.01	NA	0.01	0.03	0.01	NA	0.01
Molybdenum, Dissolved	NA	NA	0.00	0.0	0.00	0.00	0.02	0.0	0.00	0.01	0.00	0.01	NA	0.00	0.00	NA	0.00	0.01	0.00	0.01	NA	0.01	NA	0.01	0.00	0.01	NA	0.01
Nickel	NA	NA	0.27	0.0	0.22	0.07	0.24	0.1	0.31	0.21	0.33	0.22	NA	0.26	0.27	0.12	0.30	0.16	0.29	0.18	NA	0.18	NA	0.13	0.30	0.07	NA	0.07
Nickel, Dissolved	NA	NA	0.28	0.0	0.23	0.03	0.23	0.02	0.31	0.07	0.32	0.04	NA	0.21	0.27	NA	0.30	0.10	0.28	0.11	NA	0.11	NA	0.10	0.29	0.07	NA	0.07
Potassium	NA	NA	13	13	12	12	12	13	15	17	16	16	NA	15	12	12	13	14	13	13	NA	12	NA	20	19	23	NA	23
Potassium, Dissolved	NA	NA	13	14	12	12	12	13	15	16	15	16	NA	15	11	NA	13	12	13	13	NA	12	NA	21	20	23	NA	22
Selenium	NA	NA	0.01	0.00	0.01	0.00	0.01	0.00	0	0.00	0.01	0.00	NA	0.01	0.01	0.01	0.01	0.01	0.01	0.01	NA	0.01	NA	0.00	0.01	0.00	NA	0.00
Selenium, Dissolved	NA	NA	0.01	0.00	0.01	0.00	0.01	0.00	0	0.00	0.01	0.00	NA	0.00	0.01	NA	0.01	0.00	0.01	0.00	NA	0.00	NA	0.00	0.01	0.00	NA	0.00
Silver	NA	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	0.00	NA	0.00	0.00	0.00	NA	0.00
Silver, Dissolved	NA	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	0.00	0.00	NA	0.00	0.00	0.00	0.00	NA	0.00	NA	0.00	0.00	0.00	NA	0.00
Sodium	NA	NA	29	43	11	26	8.3	25	8.7	25	10	21	NA	16	13	35	14	36	18	35	NA	32	NA	35	29	44	NA	45
Sodium, Dissolved	NA	NA	30	46	12	29	8.7	30	10.0	37	18	39	NA	18	28	NA	17	38	18	33	NA	34	NA	40	31	45	NA	44
Thallium	NA	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	0.00	0.00	0.00	0	0.00	0.00	0.00	NA	0.00	NA	0.00	0.00	0.00	NA	0.00
Thallium, Dissolved	NA	NA	0.00	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	NA	0.00	0.00	NA	0	0.00	0.00	0.00	NA	0.00	NA	0.00	0.00	0.00	NA	0.00
Total Suspended Solids[7]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	0.12	0.00	0.10	0.01	0.10	0.02	0.14	0.06	0.14	0.06	NA	0.03	0.11	0.03	0	0.04	0.11	0.03	NA	0.03	NA	0.03	0.13	0.00	NA	0.00
Vanadium, Dissolved	NA	NA	0.00	0.00	0.00	0.00	0.08	0.00	0.00	0.01	0.00	0.00	NA	0.00	0.00	NA	0	0.00	0.00	0.00	NA	0.00	NA	0.01	0.00	0.00	NA	0.00
Zinc	NA	NA	110	4.3	86	18	97	22.8	120	66.3	123	68.5	NA	94.8	93	31.5	103	34.3	88	35.1	NA	43.8	NA	24.3	121	1.9	NA	1.9
Zinc, Dissolved	NA	NA	110	0.5	96	0.23	97	0.1	120	1.7	123	0.24	NA	69.5	93	NA	103	1.6	88	1.9	NA	1.3	NA	10.3	113	0.9	NA	1.1

Notes GPM - gallons per minute; lb/day - pound per day; NA - no load calculated due to lack of data; * - Sample from 12/1/2015 was collected during a 2 hour IWTP upset

1 - Flow rates through the IWTP, not from the Gold King Mine adit.

2 - Flow records begin 10/22/2015 at 20:22 and the flow rate on 10/22/2015 was estimated using the daily average flow.

3 - The 12/1/2015 sample did not have flow records during the IWTP upset and the flow rate was estimated based on the closest flow measurement to sample collection time.

4 - Results for treatment plant discharges from 12/1, 12/8, 12/17, 12/23, and 1/5 are the weighted average of clarifier overflow (overflow) and filtrate (filtrate) sample concentrations (C). Overflow and sludge flow (Q) measurements reported by Alexco at the times nearest sampling were averaged and used in the following equation: $C_{Effluent} = (C_{Overflow}*Q_{Overflow} + C_{Filtrate}*Q_{Filtrate}) / (Q_{Overflow}+Q_{Filtrate})$.

5 - Filtrate recycle was installed on 1/19/2016 which eliminated filtrate effluent to Cement Creek. The location where the filtrate recycle entered the treatment system was changed on 2/3/2016 to improve particle flocculation.

6 - Samples collected on 4/12/2016 at a flow rate of 746 GPM were only analyzed for total metals and not dissolved metals. All other water treatment samples collected on 4/12/2016 were analyzed for both total and dissolved metals. The flow rates on 4/12/2016 were the flow rates during sample collection time. All other sample events have estimated flow rates based on the three flow measurements taken closest to sample collection time.

7 - Total Suspended Solids analysis began on 6/23/2016.

Table 4-3
MIW Influent and Gladstone IWTP Effluent Loading Results
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

Sample Date	2/18/2016		3/25/2016		4/12/2016[6]		4/12/2016[6]		4/12/2016[6]		4/28/2016		6/7/2016		6/10/2016		6/23/2016		6/28/2016		7/6/2016		7/19/2016		7/22/2016	
Flow Rate[1] (GPM)	508		514		638		746		961		429		451		324		647		300		612		446		446	
Location	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
Analyte	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)	Load (lb/day)
Aluminum	81	5.0	86	1.2	100	1.5	117	1.5	150	2.0	67	1.3	406	7.6	249	3.3	428	6.7	141	2.3	257	6.2	214	8.0	225	5.9
Aluminum, Dissolved	73	0.59	32	0.57	36	0.77	42	NA	54	1.3	20	0.29	374	1.0	249	1.7	412	5.4	137	1.8	257	2.5	198	5.9	198	4.6
Antimony	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.02	0.00	0.01	0.00	0.02	0.00	0.03	0.00	0.02	0.00	0.01	0.0	0.01	0.0	0.02	0.00	0.21	0.00
Antimony, Dissolved	0.01	0.00	0.00	0.00	0.00	0.00	0.00	NA	0.00	0.00	0.00	0.00	0.02	0.00	0.03	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00
Arsenic	0.13	0.01	0.12	0.00	0.13	0.00	0.15	0.00	0.20	0.00	0.10	0.00	1.5	0.02	0.78	0.01	1.17	0.00	0.33	0.00	0.53	0.00	0.35	0.00	0.96	0.00
Arsenic, Dissolved	0.08	0.00	0.01	0.00	0.01	0.00	0.01	NA	0.02	0.00	0.00	0.00	1.4	0.00	0.74	0.00	1.01	0.00	0.23	0.00	0.18	0.00	0.12	0.00	0.06	0.00
Barium	0.06	0.05	0.06	0.05	0.07	0.06	0.09	0.08	0.11	0.10	0.05	0.0	0.06	0.0	0.03	0.0	0.07	0.1	0.04	0.03	0.05	0.06	0.06	0.05	0.09	0.05
Barium, Dissolved	0.21	0.24	0.06	0.15	0.07	0.06	0.08	NA	0.11	0.10	0.06	0.0	0.06	0.0	0.03	0.0	0.07	0.1	0.04	0.03	0.06	0.06	0.06	0.05	0.06	0.05
Beryllium	0.04	0.00	0.03	0.00	0.04	0.00	0.04	0.00	0.06	0.00	0.03	0.00	0.04	0.00	0.03	0.00	0.06	0.00	0.02	0.00	0.05	0.00	0.04	0.00	0.05	0.00
Beryllium, Dissolved	0.03	0.00	0.02	0.00	0.02	0.00	0.02	NA	0.03	0.00	0.01	0.00	0.04	0.00	0.03	0.00	0.06	0.00	0.02	0.00	0.05	0.00	0.04	0.00	0.05	0.00
Cadmium	0.22	0.03	0.25	0.03	0.28	0.04	0.32	0.04	0.42	0.05	0.18	0.03	0.70	0.05	0.66	0.02	0.93	0.02	0.47	0.02	0.50	0.05	0.50	0.01	0.54	0.02
Cadmium, Dissolved	0.21	0.02	0.24	0.03	0.28	0.04	0.33	NA	0.43	0.05	0.21	0.03	0.70	0.03	0.66	0.01	0.93	0.02	0.40	0.02	0.53	0.05	0.53	0.01	0.42	0.02
Calcium	2,198	2,747	2,285	2,656	2,760	3,220	3,227	3,765	4,158	4,850	1,804	2,011	1,734	5,040	1,246	3,232	2,721	5,520	1,190	2,127	2,501	4,119	2,037	3,269	1,876	3,162
Calcium, Dissolved	2,259	2,747	2,285	2,656	2,760	3,220	3,227	NA	4,158	4,735	1,804	2,011	1,572	5,095	1,246	3,115	2,721	5,676	1,190	2,163	2,501	4,119	1,930	3,001	1,876	3,162
Chromium	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.02	0.01	0.01	0.01	0.12	0.01	0.05	0.00	0.10	0.01	0.03	0.00	0.05	0.01	0.03	0.01	0.08	0.01
Chromium, Dissolved	0.01	0.01	0.01	0.01	0.01	0.01	0.01	NA	0.01	0.01	0.01	0.01	0.11	0.01	0.05	0.00	0.10	0.01	0.03	0.00	0.04	0.01	0.03	0.01	0.03	0.01
Cobalt	0.37	0.06	0.37	0.07	0.41	0.11	0.48	0.10	0.62	0.13	0.27	0.08	0.92	0.08	0.51	0.02	1.09	0.04	0.40	0.04	0.71	0.09	0.49	0.01	0.53	0.02
Cobalt, Dissolved	0.36	0.05	0.36	0.07	0.41	0.10	0.48	NA	0.61	0.13	0.26	0.08	0.81	0.07	0.55	0.02	1.01	0.03	0.40	0.03	0.69	0.07	0.47	0.01	0.54	0.02
Copper	20	0.85	20	0.16	22	0.19	26	0.18	33	0.25	14	0.25	65	0.98	43	0.27	67	0.22	25	0.05	46	0.54	38	0.16	44	0.18
Copper, Dissolved	18	0.01	15	0.0	16	0.0	19	NA	24	0.03	10	0.01	60	0.02	43	0.01	67	0.07	24	0.01	47	0.02	36	0.01	46	0.01
Iron	366	15	352	2.5	399	3.1	466	2.7	601	3.9	253	4.1	1,843	27	1,129	7.4	1,788	5.1	577	1.0	1,030	10	804	3.3	1,554	3.2
Iron, Dissolved	342	0.10	229	0.11	276	0.13	323	NA	416	0.3	165	0.09	1,680	0.27	1,090	0.07	1,633	1.6	505	0.08	735	0.13	590	0.09	520	0.09
Lead	0.15	0.01	0.14	0.0	0.15	0.00	0.17	0.00	0.22	0.0	0.10	0.00	0.21	0.00	0.08	0.00	0.14	0.00	0.08	0.00	0.15	0.00	0.20	0.00	0.35	0.00
Lead, Dissolved	0.11	0.00	0.00	0.0	0.01	0.00	0.01	NA	0.01	0.0	0.00	0.00	0.12	0.00	0.07	0.00	0.12	0.00	0.07	0.00	0.13	0.00	0.19	0.00	0.18	0.00
Magnesium	104	98	105	93	123	107	143	126	185	173	77	72	222	179	144	113	264	225	94	83	184	154	139	70	129	107
Magnesium, Dissolved	110	98	105	99	123	107	143	NA	185	162	77	72	201	179	144	113	249	218	94	83	184	162	134	64	129	107
Manganese	134	85	142	99	153	107	179	126	231	150	98	72	0.01	65	93	24	202	58	83	36	169	88	129	26	139	40
Manganese, Dissolved	128	79	136	99	153	107	179	NA	231	150	98	72	0.01	60	93	23	202	58	79	34	177	81	123	24	145	40
Mercury	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Mercury, Dissolved	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Molybdenum	0.02	0.01	0.02	0.01	0.02	0.01	0.03	0.01	0.03	0.01	0.01	0.01	0.07	0.02	0.05	0.01	0.07	0.02	0.03	0.00	0.05	0.01	0.04	0.01	0.24	0.01
Molybdenum, Dissolved	0.01	0.01	0.00	0.01	0.01	0.01	0.01	NA	0.01	0.01	0.00	0.01	0.06	0.02	0.05	0.01	0.06	0.01	0.02	0.00	0.01	0.01	0.01	0.01	0.24	0.01
Nickel	0.23	0.06	0.23	0.08	0.28	0.12	0.32	0.13	0.42	0.16	0.15	0.05	0.60	0.10	0.28	0.03	0.68	0.08	0.23	0.03	0.41	0.06	0.29	0.02	0.33	0.03
Nickel, Dissolved	0.23	0.06	0.23	0.08	0.28	0.12	0.32	NA	0.42	0.16	0.15	0.05	0.54	0.09	0.27	0.03	0.68	0.09	0.23	0.03	0.42	0.06	0.29	0.02	0.35	0.04
Potassium	13	14	12	12	14	14	16	16	21	21	9.3	9.3	10	16	6.2	7.8	15	17	6.5	7.2	13	13	13	13	13	13
Potassium, Dissolved	13	12	12	12	14	14	16	NA	21	21	9.3	9.3	8.7	16	6.2	8.2	15	18	6.5	7.2	13	14	12	13	12	14
Selenium	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.07	0.01	0.02	0.00	0.06	0.01	0.02	0.00	0.02	0.00	0.01	0.00	0.02	0.00
Selenium, Dissolved	0.01	0.00	0.00	0.00	0.00	0.00	0.01	NA	0.01	0.01	0.00	0.00	0.05	0.01	0.02	0.00	0.05	0.01	0.02	0.00	0.02	0.00	0.01	0.00	0.01	0.00
Silver	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00
Silver, Dissolved	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sodium	21	33	18	30	20	35	23	42	30	53	15	23	26	466	20	374	37	156	12	18	28	33	23	27	13	26
Sodium, Dissolved	24	37	17	32	19	36	22	NA	29	53	15	22	26	466	17	366	27	156	12	18	28	35	22	25	13	28
Thallium	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Thallium, Dissolved	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NA	0.00	0.00	0.00	0.0	0.00	0.0	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Suspended Solids[7]	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1,711	77.8	757	27	1,324	81	858	45	3,484	34
Vanadium	0.10	0.01	0.09	0.00	0.10	0.00	0.12	0.00	0.15	0.00	0.07	0.00	0.47	0.01	0.25	0.00	0.39	0.00	0.15	0.00	0.26	0.00	0.19	0.00	0.59	0.00
Vanadium, Dissolved	0.06	0.00	0.00	0.00	0.00	0.00	0.00	NA	0.00	0.00	0.02	0.00	0.41	0.00	0.25	0.00	0.30	0.00	0.09	0.00	0.05	0.00	0.05	0.00	0.02	0.00
Zinc	73	3.4	80	1.6	84	2.8	99	2.2	127	2.7	57	2.8	260	5.1	160	1.2	257	1.1	90	0.8	162	4.1	118	0.8	134	1.0
Zinc, Dissolved	67	0.7	74	1.0	84	2.0	99	NA	127	1.5	57	1.9	244	0.87	160	0.13	257	0.44	87	0.16	162	1.4	118	0.14	145	0.3

Notes GPM - gallons per minute; lb/day - pound per day; NA - no load calculated due to lack of data; * - Sample from 12/1/2015 was collected during a 2 hour IWTP upset

1 - Flow rates through the IWTP, not from the Gold King Mine adit.

2 - Flow records begin 10/22/2015 at 20:22 and the flow rate on 10/22/2015 was estimated using the daily average flow.

3 - The 12/1/2015 sample did not have flow records during the IWTP upset and the flow rate was estimated based on the closest flow measurement to sample collection time.

4 - Results for treatment plant discharges from 12/1, 12/8, 12/17, 12/23, and 1/5 are the weighted average of clarifier overflow (overflow) and filtrate (filtrate) sample concentrations (C). Overflow and sludge flow (Q) measurements reported by Alexco at the times nearest sampling were averaged and used in the following equation: CEffluent = (COverflow*QOverflow + CFiltrate*QFiltrate) / (QOverflow+QFiltrate).

5 - Filtrate recycle was installed on 1/19/2016 which eliminated filtrate effluent to Cement Creek. The location where the filtrate recycle entered the treatment system was changed on 2/3/2016 to improve particle flocculation.

6 - Samples collected on 4/12/2016 at a flow rate of 746 GPM were only analyzed for total metals and not dissolved metals. All other water treatment samples collected on 4/12/2016 were analyzed for both total and dissolved metals. The flow rates on 4/12/2016 were the flow rates during sample collection time. All other sample events have estimated flow rates based on the three flow measurements taken closest to sample collection time.

7 - Total Suspended Solids analysis began on 6/23/2016.

Table 4-4
MIW Influent and Gladstone IWTP Effluent Loading Statistics
Gladstone IWTP EE/CA
Bonita Peak Mining District Superfund Site

Location	Influent			Effluent		
Statistic	Minimum	Maximum	Average	Minimum	Maximum	Average
Analyte	Load (lb/day)			Load (lb/day)		
Aluminum	67	428	161	1.2	82	19
Aluminum, Dissolved	20	412	134	0.29	18	3.2
Antimony	0.0067	0.21	0.024	0.0014	0.0067	0.0033
Antimony, Dissolved	0.0023	0.031	0.0065	0.0014	0.0046	0.0027
Arsenic	0.10	1.52	0.36	0.0019	0.074	0.018
Arsenic, Dissolved	0.0045	1.35	0.18	0.0014	0.010	0.0027
Barium	0.033	0.11	0.063	0.030	0.10	0.057
Barium, Dissolved	0.032	1.0	0.12	0.030	0.33	0.078
Beryllium	0.025	0.061	0.044	0.00054	0.031	0.0073
Beryllium, Dissolved	0.013	0.058	0.036	0.00054	0.011	0.0015
Cadmium	0.18	0.93	0.40	0.010	0.34	0.077
Cadmium, Dissolved	0.21	0.93	0.40	0.00083	0.28	0.037
Calcium	1,190	4,158	2,297	2,011	5,520	3,280
Calcium, Dissolved	1,190	4,158	2,278	2,011	5,676	3,245
Chromium	0.012	0.12	0.032	0.0036	0.013	0.0079
Chromium, Dissolved	0.0051	0.11	0.023	0.0036	0.012	0.0064
Cobalt	0.27	1.1	0.52	0.012	0.47	0.13
Cobalt, Dissolved	0.26	1.0	0.51	0.0043	0.37	0.072
Copper	14	67	32	0.050	17	3.9
Copper, Dissolved	10	67	29	0.0050	4.3	0.29
Iron	253	1,843	708	1.0	316	67
Iron, Dissolved	165	1,680	532	0.066	164	8.7
Lead	0.078	0.35	0.17	0.00054	0.13	0.020
Lead, Dissolved	0.0018	0.19	0.068	0.00023	0.011	0.0012
Magnesium	77	264	138	27	225	117
Magnesium, Dissolved	77	249	136	1.1	218	114
Manganese	0.0065	231	149	24	177	96
Manganese, Dissolved	0.0065	231	148	0.087	158	84
Mercury	0.00029	0.00092	0.00051	0.00029	0.00092	0.00051
Mercury, Dissolved	0.00029	0.00092	0.00051	0.00029	0.00092	0.00050
Molybdenum	0.013	0.24	0.041	0.0034	0.018	0.011
Molybdenum, Dissolved	0.0023	0.24	0.024	0.0040	0.017	0.010
Nickel	0.15	0.68	0.32	0.015	0.26	0.11
Nickel, Dissolved	0.15	0.68	0.32	0.020	0.21	0.077
Potassium	6.2	21	13	7.2	23	14
Potassium, Dissolved	6.2	21	13	7.2	23	14
Selenium	0.0030	0.065	0.016	0.0028	0.015	0.0049
Selenium, Dissolved	0.0030	0.053	0.013	0.0023	0.012	0.0044
Silver	0.00049	0.054	0.0035	0.00036	0.0012	0.00065
Silver, Dissolved	0.00049	0.0078	0.0011	0.00036	0.0012	0.00064
Sodium	8.3	37	19	16	466	67
Sodium, Dissolved	8.7	31	20	18	466	71
Thallium	0.00068	0.0078	0.0016	0.00058	0.0017	0.0011
Thallium, Dissolved	0.00062	0.0078	0.0015	0.00053	0.0017	0.0010
Total Suspended Solids	757	3,484	1,627	27	81	53
Vanadium	0.067	0.59	0.18	0.0011	0.064	0.015
Vanadium, Dissolved	0.0019	0.41	0.062	0.0011	0.0089	0.0024
Zinc	57	260	120	0.75	95	18
Zinc, Dissolved	57	257	119	0.13	70	4.2

Notes Statistics of loading data from 10/22/2015 to 7/22/2016.

Appendix A

Technical Memo: Gladstone Interim Water Treatment Plant Design and Unknowns

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Technical Memorandum

1 PURPOSE

MineWater LLC has developed this Technical Memorandum to provide support to the development of an engineering evaluation (EE/CA) pertaining to the Bonita Peak Mining District Superfund Site; Gladstone Interim Water Treatment Plant (IWTP). The IWTP was constructed very rapidly to address emergency conditions in the aftermath of the release from the Mine on August 5th 2015. This EE/CA will provide support for development of a more methodical approach to determine the need for a treatment facility and to support the eventual transition from emergency operations to the formalized remediation approach as set forth in the NCP.

In the development of this technical memorandum, which is intended to become an appendix to the EE/CA, we have looked at the plant requirements that were set forth in the RFP issued August 21, 2015, and the design that was accepted by ER LLC that was submitted by Alexco on August 26th and amended on September 8th and September 24th 2015 and highlighted the components of the actual delivered facility to the extent that the final as-built facility varied from the initial plan during delivery over the Winter 2015 into Spring 2016.

2 THE RFP REQUIREMENTS & ALEXCO'S BID

The RFP required a "fully automated water treatment facility" that could treat between 200 and 900 gpm with an anticipated average of 600 gpm of acid mine drainage from the Gold King Mine whose characteristics included pH 3.0, iron around 120 mg/L, copper about 6 mg/L, cadmium about 0.1 mg/L, and aluminum, manganese and zinc each around 20 – 25 mg/L. The RFP was interpreted to require the capability to handle a hydraulic spike up to 1,200 gpm. The discharge from the treatment plant was to not have visible turbidity or color development, and meet ARARs which were not defined.

In Alexco's initial response, the attainment of ARARs target was interpreted to mean removal of all metals to very high efficiency, including to 3.2 ppb cadmium, and less than 2 mg/L Mn to prevent color development in the discharge. The cost of achieving these goals was a capital expenditure of $1.8 million and $20,000 per week in operating costs (Alexco, August 26th offer). Upon discussion with the EPA OSC team, a target of 85% removal of the contaminants of concern (Cu, Cd & Zn) was provided to all offerors and best and final offers were then collected from the respondents.

Alexco's bid was accepted and authorized for construction on September 25th 2015, and provided a very tight 21-day construction timeline to be online and fully operational by COB October 16th.

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3 CONSTRUCTION TIMELINE

A 15" thick, rebar-reinforced concrete foundation to support the lime silo was poured during the first week (after Notice to Proceed) and allowed to cure. A lamella-type inclined plate clarifier was procured from Ohio for delivery in the 2nd week of construction along with a 22,000-gallon continuous stirred tank reactor (CSTR). During the 3rd week the high-density polyethylene (HDPE) liner for the geotextile bags was installed, the electrical system (powered by generators) was installed, the plumbing of all treatment components was completed, and the internet-enabled satellite communication and treatment control system was commissioned.

After commissioning of fully automated plant operations on October 16th, there was a 4-week period of working out the control system and testing major components while construction of the steel frame building around the operating plant was underway.

The last major part of the plant building construction was completed on Sunday November 29th with the hanging of a 16-foot rollup door on the polyurethane-insulated steel building.

Figure 1 - Left to Right, Reactor Tank, Silo, and Clarifier as the building is being erected in Nov. 2015

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4 TREATMENT PROCESS

Acid mine drainage (AMD) is delivered by gravity from the Mine collection sump in a 4,000-foot-long HDPE pipeline which varies in diameter from 12" to 6" for pipeline pressure management reasons. The AMD is stored in ponds at the upper Gladstone area, and then drained by gravity to the IWTP treatment reactor tank.

Lime slurry made from hydrated lime $Ca(OH)_2$ by an on-demand fed-batch semi-continuous mixing process is pumped using peristaltic pumps to the agitated and baffled treatment reactor tank under the 4/20 mA control signal from the pH probes mounted in the flocculation basin immediately after the treatment reactor. The treatment reactor has a design retention time of about 36 minutes. After achieving a pH target of between 7.5 and 9.0 (typically 8.5) the treated mixture is then mixed in the flash mixer with a polymer flocculant which coagulates the metal hydroxide sludge particles and helps to promote separation of clear water from the settling sludge particles. From the flash mixer the treated mixture enters the slowly agitated flocculation basin where particle growth is enhanced during 1-4 minutes of additional retention time, and then the flow enters the inclined plate clarifier. The clarifier plates are set at a 55-degree angle which allows for settling of the sludge counter-current to the rising water, so that clear water leaves the overflow for direct discharge to the Creek while sludge settles to the cone at the bottom where a pipeline conveys the under-flowing sludge/water mixture to the geotextile bags. The expressed water (bag filtrate) can then be either pumped back into the flocculation basin or allowed to directly discharge to the creek. For several reasons including 1) ease of monitoring, 2) due to some solids making it through the bags at times, and 3) so that there is only one discharge pipe, the expressed filtrate from the bags is currently pumped back to the treatment system.

5 DESIGN CAPACITIES OF THE TREATMENT PROCESS

Clarifier: The inclined plate clarifier is designed (according to the manufacturer) to settle 500 mg/L total suspended solids (TSS) from 1,000 gpm of flow. The design TSS is about 330 mg/L of suspended solids at 900 gpm, so it is expected to handle a hydraulic flow spike of 1,200 gpm for a short period of time. Since construction of the IWTP, the flow has very infrequently surged as high as 800 GPM and during testing to over 1,200 GPM, but the typical test of the settling capacity of the clarifier has been the increase in loading of solids from either the periodic rapid breakdown of a buildup of sludge from settling in the surge pond, or an increase in the loading of dissolved solids due to a rapid decrease in the pH of the discharge from the mine from 3-3.5 S.U to less than 2.0 S.U.

Lime slurry production system: Hydrated lime is delivered by pneumatic trucks and stored in a horizontal lime silo (4,100 cubic foot [CF] capacity) also called the storage pig. The hydrated lime powder is transferred from this storage pig using air from a 50 HP blower, into a 1,425 CF vertical silo. Hydrated lime product is then dosed by a screw feeder under automated feedback (4/20 mA signal) from the pH probe in the flocculation basin. The design duration of storage on-site is greater than 150 days between

lime truckload deliveries. No deliveries of lime to the project occurred from December 31st 2015 until May 6, 2016 due to snow and ice accumulation on the driveway adjacent to the treatment facility. The plant is designed to deliver 3.1-4.4 lbs of hydrated lime per 1,000 gallons of influent, which was a design dosage sufficient to achieve neutralization of the expected mine drainage delivered to the IWTP. The system is designed to achieve a removal performance of combined 85% of heavy metals (Cd, Cu, Zn). The dosing of the lime slurry into the influent water entering the IWTP and the production of the lime slurry from the lime silo is under the continuous control of a pH set point-driven PLC.

Polymer flocculent dosing system: A polymer mixing system was installed that allows the operator to create large batches of polymer (up to 4,000 gallons); the polymer functions to link small particles of iron hydroxide sludge together to make larger particles, which tend to settle out of solution at a faster rate proportional to the size of the particle. The polyacrylamide – based polymer is introduced at the flash tank on the clarifier, where it is mixed with incoming waters by the electric flash mixer, and polymer is also dosed into the underflow to condition the sludge for better filtration in the geotextile bags. Polymer addition rates can be adjusted remotely and are continuously monitored by a programmable logic controller (PLC) where more or less polymer is added to minimize turbidity of the discharge flow to maintain turbidity below 3 NTUs. Initially a mildly anionic polymer was used (October 2015-May 2016) but in May 2016 a change was made to use a cationic polymer which creates larger flocs and once optimized, exhibited better settling characteristics and overall clarity of effluent.

Power is supplied to the IWTP via three 25 kVA pole-mounted pot transformers that supply 480V, 200 amps to a main panel within the building. The critical components of the treatment system can be powered by a back-up generator that is activated by an Automatic Transfer Switch during grid power failures. Fuel for the back-up generator is supplied from a double-walled fuel tank located nearby.

Interim sludge storage and densification system: The sludge particles tend to compress rapidly to a density of about 0.5% in the bottom of the clarifier cone. After settling in the cone, the accumulated sludge is gravity drained every few minutes to the geotextile bags located outside of the treatment building on a 36 mil HDPE liner system. Within the geotextile bags the sludge can rapidly densify to about 3% solids (within a few hours) and then slowly densify thereafter over many months to reach ultimate densities of between 10 – 15% solids (or more if bags are stacked).

Control system: At the heart of the control system are two Walchem Webmaster controllers linked to a satellite dish -based internet service. These Webmaster controllers can be accessed from any internet connection (behind two layers of password – protection) to directly control most of the operations of the treatment system. For example, the duration and frequency of the sludge flow valve opening and closing can be controlled real-time, the pH setpoints can be altered, the rate of change of the lime slurry pump relative to the pH differential can be modified, to name a few typical control parameters. The system can run unattended under the automated control of the Webmaster controllers for several days (possibly up to a week at a time) during the period from late autumn until just prior to snow melt. Due to changes to the flocculent dosing system, summer-time (variable) conditions and the use of flocculent in the conditioning of the sludge, the system is presently only able to go about two days without

operator support. One controller is focused on ensuring the pH dosing is correct, while the other controller is focused on making sure that the flows of sludge and water are properly controlled and monitored.

6 SUBSEQUENT UPGRADES:

A second clarifier was installed in May 2016 to address the potential for mass load increases as a result of the spring melt. While the potential for increases in water flow volumes from the Mine is unknown, the recent history of the mine indicates that the mass load and concentrations of contaminants dramatically increases in the late May – July time period each year. In 2016 the operating team observed increased contaminant loading as much as 5-fold and a concurrent decrease in pH from about 3.1 to less than 2.0 S.U. Also, the pumps that supply lime slurry were found to be inadequate to deliver sufficient neutralization capacity during the stress testing of the plant in late April 2016, and so larger pumps and more redundant pumps were installed.

Sludge storage capacity has been changed out and also increased during the summer 2016. In the initial proposal for the IWTP the sludge bags were planned for a capacity of about 2,500 CY, based on the assumption of 550 GPM at the loading chemistry observed on August 8 – 13 of 2015, for 42 weeks of treatment, and on the assumption that the sludge would densify to 15% solids. Since that time it has been observed that the sludge does not densify to that level unless either the bags are stacked, or the bags are allowed to freeze and thaw. Because of these observations, and the need to continue treatment beyond September 2, 2016 (the 42nd week of post-demo plant operations) the lined area of the sludge bags has been increased, and the installed capacity of the bags online has been increased to more than 4,500 CY, with the capability to rapidly bring on at least 1,300 CY of additional sludge storage capacity.

7 UNKNOWNS OF THE SYSTEM AS DESIGNED:

The Mine Workings: The IWTP collects water from pipes that arise from the Gold King Mine #7 level adit. The Gold King Mine is connected hydrologically, by old workings, well known faults, drill holes and by porous ground to a very large mine pool within the Sunnyside workings, and from thence to the Mogul/Grand Mogul, Red and Bonita, and other underground workings. The extent of the connections between the Gold King and the Sunnyside are not exactly defined, and more importantly, these connections are under constant change. For example, the acidity level corresponding to a pH of 2 within the Sunnyside workings is sufficient to decrepitate crystalline rocks and convert minerals over time into clayey soup. While clay might act to seal some areas and block the flow, in other areas the rock-to-clay conversion process works to weaken zones that had structural integrity in the past, and can allow acid water to suddenly break through and surge from areas that previously had not flowed in decades, if ever.

The Mine Drainage composition: The source of water flowing from the Gold King adit is not constant. It is best viewed as a ratio of contributions from water entering the mine either as surface water infiltration or run-on into vent raises, collapsed stopes or other surface features and faults, or from groundwater arising from the increased recharge of acid water from the Sunnyside mine pool impounded behind 3 bulkhead concrete plugs that were installed from the mid-1990s through early 2000s. As these sources of water are fed by weather events, each source arises or enters within the mine as a unique condition that continuously varies throughout time. Furthermore, the mine itself is not static. Prior to placement of the soil berm at the opening of the mine, air freely entered the mine opening and likely maintained the ferrous | ferric ratio close to 90% ferric. After placement of the soil berm the ingress of oxygen was decreased, and the ferrous | ferric ratio would have trended toward ferrous ion predominance. These changes would have created follow-on effects on the amount of aluminum leached from the surrounding host rocks, and impacted the amount of leaching of sulfide minerals in the mine workings. After the events of August 2015 and the rehabilitation of the first couple hundred feet of the #7 adit, new capability for control of the geochemical regime (or boundary conditions) is being enabled for the mine tunnel with the alternative (of the owner) to allow the mine atmosphere to be similar to the conditions that would have existed prior to the soil berm closure, or to control the atmosphere.

Pond and Mine Adit sludge formation: If the pH is above about 2.8 the ambient oxygen will tend to cause formation of acidic ferric hydroxide sludge. These conditions are met throughout much of the year in both the adit and the upper Gladstone equalization ponds (north pond and south pond). Because of this sludge formation there is an unpredictable potential for sudden liquefaction of the sludge based on either hydraulic flow changes, or based on pH changes, or rock falls (or other sudden energy inputs) within the mine adit or the ponds. Each treatment clarifier is designed to handle 330 mg/L TSS at 900 GPM. This equates to 2.5 lbs of sludge per minute per clarifier. If acidified sludge enters the treatment system at a rate much faster than this design capacity, the plant can be temporarily overwhelmed, and treatment performance can suffer.

Because of all these very complex interactions, it is impossible to say with certainty that the Interim Water Treatment Plant is designed and constructed to handle all outcomes of mine water flow and composition that could arise from the Gold King adit. However, in the view of the designer of the IWTP, the plant as currently designed and operated can reliably remove 95% (or better) of the daily average loading of cadmium copper and zinc in the influent at flows up to 1,800 GPM, with the incoming composition similar to the average mine drainage composition observed since August 2015.

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8 REFERENCES:

Environmental Restoration LLC RFP GK8-77-WTP issued August 21, 2015.

Alexco Environmental Group US Inc BID submitted August 26, 2015 and amended in September 8 and -24, 2015. -

Alexco Environmental Group US Inc Updated proposal April 2016 to upgrade the treatment system. -

Personal Communications with Alexco, ER and EPA personnel. -

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Appendix B

Applicable or Relevant and Appropriate Requirements

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Preliminary Identification of Potential Federal and State Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered Information (TBCs)

Gladstone IWTP EE/CA, Bonita Peak Mining District (BMPD) Superfund Site

NOTE: Grey shading indicates environmental or facility siting laws statutes and regulations that are tentatively identified as "not ARARs" and excluded from further consideration in the EE/CA for the reasons stated in the comments column.

	Statute and Regulatory Citation	Preliminary ARAR Determination	Description	Comment	Chemical	Location	Action
			Federal ARARs				
1	National Historic Preservation Act (NHPA) and Implementing Regulations 54 United States Code (U.S.C.) § 300101 36 C.F.R. § 63 36 C.F.R. § 800	Potential ARAR	This statute and implementing regulations require federal agencies to take into account the effect of this response action upon any district, site, building, structure, or object that is included in or eligible for the National Register of Historic Places (generally, 50 years old or older). Federal agencies required to take into account their undertakings on historic properties and afford the Advisory Council on Historic Preservation or its designees a reasonable time to comment.	It is not anticipated that cultural resources eligible for the National Register of Historic Places would be found within the removal action area due to previous disturbances. In addition, the removal action alternatives contemplated do not involve intrusive activities.		✓	
2	Archaeological and Historic Preservation Act and Implementing Regulations 54 U.S.C. § 312501 *et seq.* 43 C.F.R. § 7	Not ARAR	This statute and implementing regulations establish requirements for the evaluation and preservation of historical and archaeological data, which may be destroyed through alteration of terrain as a result of a federal construction project or a federally licensed activity or program. The unauthorized removal of archaeological resources from public or Indian lands is prohibited without a permit and any archaeological investigations at a site must be conducted by a professional archaeologist.	To date, no such resources have been found at the removal action area. In addition, the removal action alternatives contemplated do not involve intrusive activities. If any are found, consultation with the State Historic Preservation Office (SHPO) and the NHPA will be addressed during removal design.		✓	
3	Historic Sites Act 54 U.S.C. § 320101.	Not ARAR	Requires federal agencies to consider the existence and location of potential and existing National Natural Landmarks to avoid undesirable impacts on such landmarks.	No National Natural Landmarks have been identified at the removal action area. In addition, the removal action alternatives contemplated do not involve intrusive activities.		✓	
4	Wild and Scenic River Act 16 U.S.C. §§1271 - 1287	Not ARAR	Establishes requirements applicable to water resource projects affecting wild, scenic, or recreational rivers within the National Wild and Scenic Rivers System, as well as rivers designated on the National Rivers Inventory to be studied for inclusion in the National System. Requires action to avoid adverse effects to the free-flowing characteristics or scenic, recreational, or fish and wildlife values of a Wild and Scenic River or Study River.	Cement Creek and the Animas River have not been designated as a wild and scenic river.		✓	

Preliminary Identification of Potential Federal and State Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered Information (TBCs)

Gladstone IWTP EE/CA, Bonita Peak Mining District (BMPD) Superfund Site

NOTE: Grey shading indicates environmental or facility siting laws statutes and regulations that are tentatively identified as "not ARARs" and excluded from further consideration in the EE/CA for the reasons stated in the comments column.

	Statute and Regulatory Citation	Preliminary ARAR Determination	Description	Comment	Chemical	Location	Action
			Federal ARARs				
5	Fish and Wildlife Coordination Act and Implementing Regulations 16 U.S.C. 662 *et seq*.,	Potentially Applicable	This statute and implementing regulations require coordination with federal and state agencies for federally funded projects to ensure that any modification of any stream or other water body affected by any action authorized or funded by the federal agency. The statute requires Federal agencies to take into consideration the effect that water-related projects would have upon fish and wildlife and then take action to prevent loss or damage to these resources.	The alternatives include potential discharges of treated or untreated water to Cement Creek. If the activities affect wildlife and/or non-game fish, federal agencies must first consult with the U.S. Fish and Wildlife Service and the Colorado Department of Natural Resources. Consultation is not required for on-site actions but is encouraged. The selected removal actions will be carried out in a manner to avoid adversely affecting wildlife and/or non-game fish.		✓	
6	Bald Eagle Protection Act 16 U.S.C. § 668 et seq.	Potentially Applicable	This requirement establishes a federal responsibility for protection of bald and golden eagles, and requires continued consultation with the appropriate program within the USFWS during removal design and removal construction to ensure that any cleanup of the facility does not unnecessarily adversely affect the bald and golden eagle.	Bald eagles have been identified in San Juan County, but not necessarily found at the removal action area. If bald eagles are identified within the removal areas, the selected removal actions will be carried out in a manner to avoid adversely affecting bald eagle.		✓	

Preliminary Identification of Potential Federal and State Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered Information (TBCs)

Gladstone IWTP EE/CA, Bonita Peak Mining District (BMPD) Superfund Site

NOTE: Grey shading indicates environmental or facility siting laws statutes and regulations that are tentatively identified as "not ARARs" and excluded from further consideration in the EE/CA for the reasons stated in the comments column.

	Statute and Regulatory Citation	Preliminary ARAR Determination	Description	Comment	Chemical	Location	Action
			Federal ARARs				
7	Endangered Species Act and Implementing Regulations, 16 U.S.C. §1531 50 C.F.R §1§7 and 402	Potentially Applicable	This statute and implementing regulations provide that federal activities not jeopardize the continued existence of any threatened or endangered species. Endangered Species Act, Section 7 requires consultation with the U.S. Fish and Wildlife Service to identify the possible presence of protected species and mitigate potential impacts on such species. Substantive compliance with the ESA means that the lead agency must identify whether a threatened or endangered species, or its critical habitat, will be affected by a proposed response action. If so, the agency must avoid the action or take appropriate mitigation measures so that the action does not affect the species or its critical habitat. If, at any point, the conclusion is reached that endangered species are not present or will not be affected, no further action is required.	Lynx (federally threatened mammal) and southwestern willow flycatcher (federally endangered bird) have been identified in San Juan County, but not necessarily found at the removal action area. If threatened or endangered species (T&E) are identified within the removal action area, the selected actions will be carried out in a manner to avoid adversely affecting those species.		✓	
8	Migratory Bird Treaty Act and Implementing Regulations, 16 U.S.C. § 703 *et seq.* 50 C.F.R. § 10.13	Potentially Applicable	This requirement establishes a federal responsibility for the protection of the international migratory bird resources and requires continued consultation with the U.S. Fish and Wildlife Service during removal design and removal construction to ensure that the cleanup of the site does not unnecessarily impact migratory birds.	The selected actions will be carried out in a manner to avoid adversely affecting migratory bird species, including individual birds or their nests.		✓	

Preliminary Identification of Potential Federal and State Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered Information (TBCs)

Gladstone IWTP EE/CA, Bonita Peak Mining District (BMPD) Superfund Site

NOTE: Grey shading indicates environmental or facility siting laws statutes and regulations that are tentatively identified as "not ARARs" and excluded from further consideration in the EE/CA for the reasons stated in the comments column.

	Statute and Regulatory Citation	Preliminary ARAR Determination	Description	Comment	Chemical	Location	Action
			Federal ARARs				
9	Solid Waste Disposal Facilities and Practices 40 C.F.R. § 257	Not ARAR	Establishes standards with which solid waste disposal must comply to avoid possible adverse effects on health or the environment. These criteria apply to any removal alternatives that require any type of solid waste disposal at the facility. The criteria do not apply to hazardous waste disposal that is subject to regulation under subtitle C of the Resource Conservation and Recovery Act (RCRA).	RCRA Subtitle D specifically regulates non-hazardous solid waste. The alternatives involve generation of non-hazardous solid waste (i.e. sludge) from IWTP operations, but do not involve disposal or open dumping within the period of evaluation for the removal action alternatives. In addition, the State of Colorado has a RCRA Subtitle D program that has been determined to be adequate and thus Colorado Code of Regulations pertaining to solid waste management is as stringent as Federal regulations.			✓
10	Floodplain Management Executive Order No. 11988.	Potential TBC	Requires federal agencies to take action to reduce the risk of the flood loss, to minimize the impact of flood on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains. Requires federal agencies to consider alternatives to avoid, to the extent possible, adverse effects and incompatible development in the floodplain. Design or modify its action in order to minimize potential harm to or within the floodplain.	The existing removal action infrastructure (e.g. the IWTP and associated ponds and pipelines from the Gold King Mine) are not known to be located in floodplains. None of the actions involve any construction activities within a floodplain. Additional research will be performed during the removal action to determine whether in fact this condition exists within removal action area.		✓	
11	Protection of Wetlands Executive Order No. 11990.	Potential TBC	Requires federal agencies to avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists.	The existing removal action infrastructure (e.g. the IWTP and associated ponds and pipelines from the Gold King Mine) are not located in known jurisdictional wetlands. Also the alternatives do not involve discharge of dredge or fill material into Cement Creek. Additional research will be performed during the removal action to determine whether in fact this condition exists within removal action area.		✓	✓

Preliminary Identification of Potential Federal and State Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered Information (TBCs)

Gladstone IWTP EE/CA, Bonita Peak Mining District (BMPD) Superfund Site

NOTE: Grey shading indicates environmental or facility siting laws statutes and regulations that are tentatively identified as "not ARARs" and excluded from further consideration in the EE/CA for the reasons stated in the comments column.

	Statute and Regulatory Citation	Preliminary ARAR Determination	Description	Comment	Chemical	Location	Action
			Federal ARARs				
12	Clean Water Act 33 U.S.C. § 1251 *et.seq*. 40 C.F.R. §§230, 231	Not ARAR	Requires federal agencies to avoid, to the extent possible adverse impacts associated with destruction or loss of the wetlands. Provides the guidelines to restore and maintain the chemical, physical, and biological integrity of waters of the United States through the control of the discharges of dredged or fill material.	The existing removal action infrastructure (e.g. the IWTP and associated ponds and pipelines from the Gold King Mine) are not located in known jurisdictional wetlands. Also the alternatives do not involve discharge of dredge or fill material into Cement Creek.		✓	✓
13	Colorado Non-Game, Endangered, or Threatened Species Act CRS 33-2-101	Potentially Applicable	Protects endangered or threatened species and preserves their habitats. Requires coordination with the Division of Wildlife if removal activities impact on state-listed endangered or threatened spices or their habitat.	Lynx, wolverine (state endangered mammals), and southwestern willow flycatcher (state endangered bird) were identified in San Juan County, but not necessarily found at the removal action area. If State-endangered species are identified within the removal action area, the selected actions will be carried out in a manner to avoid adversely affecting those species.		✓	✓
14	Classifications and Numeric Standards for San Juan and Dolores River Basins 5 CCR 1002-34	Potentially Applicable	Classification and numeric standards for the San Juan and Dolores River Basins, including tributaries and standing bodies of water. Classification identifies actual beneficial uses of water and allowable concentrations of various parameters.	Establishes numerical water quality standards for the contaminants of potential ecological concern (COPECs) in Cement Creek and the Animas River.	✓	✓	
15	Colorado Water Quality Control Act, and Colorado Discharge Permit System Regulations, CRS 25-8-101 *et seq.*, 5 CCR 1002 -61, Regulation No. 61	Potentially Applicable	Establishes program for permitting discharges of contaminants into waters of the United States within Colorado.	The substantive provisions of the Colorado Discharge Permit System (CPD) program are potentially applicable to point source discharge under the proposed removal activities (e.g. potential treated effluent discharges from the IWTP or from the collection pond at the Gold King Mine)			✓

Preliminary Identification of Potential Federal and State Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered Information (TBCs)

Gladstone IWTP EE/CA, Bonita Peak Mining District (BMPD) Superfund Site

NOTE: Grey shading indicates environmental or facility siting laws statutes and regulations that are tentatively identified as "not ARARs" and excluded from further consideration in the EE/CA for the reasons stated in the comments column.

	Statute and Regulatory Citation	Preliminary ARAR Determination	Description	Comment	Chemical	Location	Action
			Federal ARARs				
16	State Solid Waste Disposal Sites and Facilities Act and Implementing Regulations, CRS 30-20-100.5 *et seq.*, 6 CCR §1007-2 §§ 1, 2 and 9	Potentially Relevant and Appropriate	Section 2.1 and 2.2 establishes minimum standards and groundwater monitoring requirements for solid waste management facilities. Sections 9.1 and 9.2.1 establish general provisions and specific requirements for Type A waste impoundments.	The alternatives involve generation of non-hazardous solid waste (i.e. sludge) from IWTP operations. While the operations do not involve disposal or open dumping within the period of evaluation for the removal action alternatives (sludge is contained within geotextile bags), they do involve storage of IWTP sludge within a diked area for a period exceeding 30 days. Thus, the substantive requirements in Section 9.2.1 for a Type A waste impoundment are potentially relevant and appropriate to the removal action.			✓
17	Colorado Natural Areas CRS 33-33-101 *et seq.*	Potentially Applicable	The Colorado Natural Areas Program maintains a list of plant species of special concern for the State. Coordination with Division of Parks and Outdoor Recreation is recommended if activities will impact listed species.	If the removal action involves activities that impact species of special concerns, federal agencies will coordinate with Division of Parks and Outdoor Recreation to address substantive requirements to limit impacts.		✓	
18	Historic Places Register CRS 24-80.1-101–108	Not ARAR	The SHPO reviews potential impacts to historic places and structures	To date, no such resources have been found at the removal action area. In addition, the removal action alternatives contemplated do not involve intrusive activities. If any are found, consultation with SHPO will be addressed during removal design.		✓	

Appendix C
Analysis of Removal Action Alternatives

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Alternative RA1

Continue Operation of Existing Gladstone IWTP to Treat Gold King Mine Adit MIW Discharge

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Table C-1. Evaluation Summary for the Effectiveness Factors – Alternative RA1

Evaluation Factors for Effectiveness		Evaluation Summary
Overall Protection of Human Health and the Environment	Adequate protection of human health and the environment shall be evaluated for long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site	▪ The RAO would be addressed through continuing treatment of MIW from the Gold King Mine adit. ▪ Gold King adit MIW would continue to be delivered by gravity from the mine to the equalization ponds at the Gladstone IWTP, treated in the IWTP, and treated effluent discharged to Cement Creek. ▪ Current data indicates that the existing Gladstone IWTP removes most of the COPECs mass discharging from the Gold King adit, within the operational constraints of the Gladstone IWTP. Average removal rates of COPECs ranged from as low as 11.5% for dissolved silver, 52.1% for dissolved manganese, and the remaining seven COPECs were removed at an efficiency greater than 85%. Removal rates are shown in Table 4-2. ▪ TSS present or forming in the untreated Gold King adit MIW is removed in the equalization basins and Gladstone IWTP process and prevented from entering surface water, limiting the likelihood of an uncontrolled release of suspended solids as occurred in August 2015. ▪ A reduction of exposure risk to human and ecological receptors from MIW would occur from collection, treatment, and discharge of treated water. Reducing contaminants load is beneficial for reducing risks to human health and the environment. ▪ MIW collection, active treatment, and discharge to Cement Creek would reduce the mass of COPECs transported in Cement Creek. However, other untreated mine discharges and natural mineralization in the area would still contribute to the mass of COPECs transported in Cement Creek. ▪ Protection of human health and the environment is dependent on continued MIW treatment under designed capacities. ▪ Bi-weekly monitoring (influent and effluent) and regular PRSC would be performed to determine protectiveness of the action. ▪ There is uncertainty whether the RAO could be consistently met due to potential variability in flows and concentrations discharging from the Gold King adit due to the limited period of data evaluated.
Compliance with ARARs and Other Criteria, Advisories, and Guidance	Compliance with chemical-specific ARARs	▪ State of Colorado, Classifications and Numeric Standards for San Juan and Dolores River Basins, Regulation 34, establishes numerical water quality standards for the Animas River. Chemical specific ARARs for Cement Creek (COSJAF07) are currently designated for "Agriculture and Recreation E". The chronic standards that are listed for the COPECs are for the total fractions only as follows: ▪ As = 100 µg/L ▪ Be = 100 µg/L ▪ Cd = 10 µg/L ▪ Cu = 200 µg/L ▪ Pb = 100 µg/L ▪ Zn = 2,000 µg/L ▪ pH = 3.7-9.0 Based on the IWTP data, effluent concentrations after February 2016 met these chemical-specific ARARs for Cement Creek. It is anticipated that the effluent concentrations will continue to meet these chemical-specific ARARs to the extent practicable under RA1. ▪ There is uncertainty whether the ARARs could be consistently met due to variability in flows and concentrations discharging from the Gold King Mine adit.

Table C-1. Evaluation Summary for the Effectiveness Factors – Alternative RA1 (continued)

Evaluation Factors for Effectiveness		Evaluation Summary
Compliance with ARARs and Other Criteria, Advisories, and Guidance (continued)	Compliance with location-specific ARARs	▪ Location-specific ARARs for the remedy would be addressed during implementation of removal action. Activities under this alternative (pipe maintenance, pond maintenance, etc.) would be carried out in a manner that will comply with substantive requirements of ARARs that are identified in Appendix B to the extent practicable. ▪ Fish and Wildlife Coordination: The selected removal actions will be carried out in a manner to avoid adversely affecting wildlife and/or non-game fish. ▪ Bald Eagle Protection Act: Bald eagles have been identified in San Juan County, but not necessarily found at the removal action area. If bald eagles are identified within the removal areas, the selected removal actions will be carried out in a manner to avoid adversely affecting bald eagle. ▪ Endangered Species: Lynx (federally threatened mammal) and southwestern willow flycatcher (federally endangered bird) have been identified in San Juan County, but not necessarily found at the removal action area. If threatened or endangered species (T&E) are identified within the removal action area, the selected actions will be carried out in a manner to avoid adversely affecting those species. ▪ Migratory Bird Treaty Act: The selected actions will be carried out in a manner to avoid adversely affecting migratory bird species, including individual birds or their nests. ▪ Colorado Non-Game, Endangered, or Threatened Species: Lynx, wolverine (state endangered mammals), and southwestern willow flycatcher (state endangered bird) were identified in San Juan County, but not necessarily found at the removal action area. If State-endangered species are identified within the removal action area, the selected actions will be carried out in a manner to avoid adversely affecting those species. ▪ Colorado Natural Areas: If the removal action involves activities that impact species of special concerns, federal agencies will coordinate with Division of Parks and Outdoor Recreation to address substantive requirements to limit impacts.
	Compliance with action-specific ARARs	▪ Action-specific ARARs for the remedy would be addressed during implementation. ▪ Activities under this alternative (pipe maintenance, pond maintenance, etc.) would be carried out in a manner that will comply with substantive requirements of ARARs that are identified in Appendix B to the extent practicable. ▪ Colorado Water Quality Control Act, and Colorado Discharge Permit System Regulations: The substantive provisions of the Colorado Discharge Permit System (CPD) program are potentially applicable to point source discharge under the proposed removal activities (e.g. potential treated effluent discharges from the Gladstone IWTP or from the collection pond at the Gold King Mine). ▪ State Solid Waste Disposal Sites and Facilities Act and Implementing Regulations: The alternatives involve generation of non-hazardous solid waste (i.e. sludge) from Gladstone IWTP operations. While the operations do not involve disposal or open dumping within the period of evaluation for the removal action alternatives (sludge is contained within filter bags), they do involve storage of Gladstone IWTP sludge within a diked area for a period exceeding 30 days that will comply with substantive requirements listed in 6 CCR §1007-2 §§ 1, Section 9.2.1 for a Type A waste impoundment.

Table C-1. Evaluation Summary for the Effectiveness Factors – Alternative RA1 (continued)

Evaluation Factors for Effectiveness		Evaluation Summary
Long-Term Effectiveness and Permanence	Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the removal activities	▪ Long-term effectiveness and permanence is addressed through continuing treatment of MIW from the Gold King Mine adit. ▪ Current data indicates that the existing Gladstone IWTP removes most of the COPECs mass discharging from the Gold King adit, within the operational constraints of the Gladstone IWTP. Average removal rates of COPECs ranged from as low as 11.5% for dissolved silver, 52.1% for dissolved manganese, and the remaining seven COPECs were removed at an efficiency greater than 85%. Removal rates are shown in Table 4-2. ▪ TSS present or forming in the untreated Gold King adit MIW is removed in the equalization basins and Gladstone IWTP process and prevented from entering surface water, limiting the likelihood of an uncontrolled release of suspended solids as occurred in August 2015. ▪ A reduction of exposure risk to human and ecological receptors from MIW would occur from collection, treatment, and discharge of treated water. Reducing contaminant loads is beneficial for reducing risks to human health and the environment. ▪ MIW collection, active treatment, and discharge to Cement Creek would reduce the mass of COPECs transported in Cement Creek. However, other untreated mine discharges and natural mineralization in the area would still contribute to the mass of COPECs transported in Cement Creek. ▪ Sludge volume generation from the Gladstone IWTP is estimated to be about 6,000 CY/year. Sludge generation could change if modifications to the IWTP are made. There is sufficient capacity at the Gladstone IWTP under current generation rates to store approximately 1 year of sludge. Because the timeframe for the period of analysis is for 5 years, it is assumed that if IWTP operation continues, an additional interim management location for sludge would be identified by EPA and readied for use prior to mid-2017, so that sludge could be transported to this additional location for interim management. However, evaluation of long-term or permanent sludge disposal options is excluded from this EE/CA and is expected to be addressed in a future CERCLA response action evaluation, recognizing that sludge management and disposal may be a long-term BPMD site need. ▪ Residual risks would potentially remain until the sludge is disposed of at a permanent location because exposing sludge to acidic conditions in the future could liberate the sequestered COPECs. ▪ Protection of human health and the environment is dependent on continued MIW treatment under designed capacities. ▪ Bi-weekly monitoring (influent and effluent) and regular PRSC would be performed to determine protectiveness of the action. ▪ There is uncertainty whether the RAO could be consistently met due to potential variability in flows and concentrations discharging from the Gold King adit due to the limited period of data evaluated.

Table C-1. Evaluation Summary for the Effectiveness Factors – Alternative RA1 (continued)

Evaluation Factors for Effectiveness		Evaluation Summary
Long-Term Effectiveness and Permanence (continued)	Adequacy and reliability of controls that are used to manage treatment residuals and untreated waste remaining at the site	▪ Monitoring and PRSC of the Gladstone IWTP would be performed to evaluate long-term effectiveness and permanence of the remedy. ▪ PRSC activities would be periodically required to repair the Gladstone IWTP. Monitoring and maintenance of the Gladstone IWTP would be required for the 5-year period of evaluation. ▪ The equalization ponds and pipelines would need to be properly maintained. Equalization ponds may need to have sediment removed. Pipelines routing MIW from the Gold King Mine adit to the Gladstone IWTP may require flushing of sediments to function. ▪ Previous treatment residuals (sludge) will need to be disposed of in a permanent location. Until sludge is disposed of in a permanent location, the sludge drying area and interim sludge management area could be breached by high surface water flows, ice jams, or avalanches. Sludge is left uncontrolled, which could migrate to surface water and groundwater.
Reduction of Toxicity. Mobility or Volume through Treatment	The treatment processes, the alternative uses, and materials they will treat The amount of hazardous substances, pollutants, or contaminants that will be destroyed or treated The degree of expected reduction in toxicity, mobility, or volume of the waste due to treatment The degree to which the treatment is irreversible The type and quantity of residuals that will remain following treatment Whether the alternative will satisfy the preference for treatment	▪ The removal action is active treatment of MIW at the Gladstone IWTP. The lime neutralization process removes the COPECs from the water as solid metal hydroxides, and treated water flows to Cement Creek. ▪ Average load of COPECs mass removed are 992 lb/day. Loading rates are shown in Table 4-3. ▪ Each clarifier is designed to remove 330 mg/L TSS per 900 gpm. ▪ Treatment results in a reduction of toxicity and mobility of the metal contaminants by transferring them from the aqueous and mobile phase to a more geochemically stable, and less bioavailable solid phase. Metal treatment sludge are not as bioavailable due to the buffered conditions. ▪ The contaminants (metals) cannot be destroyed, only immobilized in a solid form. Lime treatment sludge containing the metals are expected to be chemically stable as stored at the IWTP. Certain COPECs could be remobilized (re-dissolved) out of the sludge under the right geochemical conditions (such as extremely high or low pH), but these are not expected to occur unintentionally. ▪ Sludge volume generation from the Gladstone IWTP is estimated to be about 6,000 CY/year. Sludge generation could change if modifications to the IWTP are made. There is sufficient capacity at the Gladstone IWTP under current generation rates to store approximately 1 year of sludge. Because the timeframe for the period of analysis is for 5 years, it is assumed that if IWTP operation continues, an additional interim management location for sludge would be identified by EPA and readied for use prior to mid-2017, so that sludge could be transported to this additional location for interim management. However, evaluation of long-term or permanent sludge disposal options is excluded from this EE/CA and is expected to be addressed in a future CERCLA response action evaluation, recognizing that sludge management and disposal may be a long-term BPMD site need. ▪ Until sludge is disposed of in a permanent location, the onsite sludge drying area and interim sludge management area could be breached by high surface water flows, ice jams, or avalanches. ▪ This alternative would satisfy the statutory preference for treatment as a principal element of the removal action.

Table C-1. Evaluation Summary for the Effectiveness Factors – Alternative RA1 (continued)

Evaluation Factors for Effectiveness		Evaluation Summary
Short-Term Effectiveness	Short-term risks that might be posed to the community during implementation of an alternative	▪ There would be minor impacts to the community under this alternative, as truck traffic would only be required to transport treatment materials (reagents or other chemicals) to the Gladstone IWTP. In addition, the Gladstone IWTP is in a remote location away from the town of Silverton. ▪ Short-term risks posed to the community during implementation of the alternative relate to trespassers within the areas of the Gold King Mine and the Gladstone IWTP. ▪ The road to the IWTP is also used to access the base of the Silverton Mountain ski area (small resort for expert skiers); however, lime deliveries would be limited after the onset of winter, allowing for about 150 days of lime storage onsite, lessening the likelihood of IWTP truck traffic interfering with skier traffic. ▪ After capacity at the existing sludge drying area is exhausted, there will be additional periodic truck traffic for transport of sludge to the new the interim sludge management area.
	Potential impacts on workers during removal action and the effectiveness and reliability of protective measures	▪ The Gladstone IWTP has been constructed and is operational. No additional major construction is anticipated under this alternative. ▪ Workers performing monitoring and site PRSC activities would potentially be exposed to MIW and treatment plant reagents or residuals. ▪ Safety measures such as use of PPE would protect workers during PRSC activities. ▪ The transport of treatment materials (reagents or other chemicals) for PRSC activities would pose short-term risks to workers from hauling traffic. ▪ Other potential impacts could be from safety hazards during removal implementation, such as slips and falls, mechanical hazards, high altitude, and weather.
	Potential adverse environmental impacts from implementation of an alternative and the reliability of mitigation measures in preventing or reducing the potential impacts	▪ As the Gladstone IWTP has been constructed already, there would minimal impacts to the environment from the continued operation of the Gladstone IWTP. ▪ The equalization ponds and pipelines would need to be properly maintained. Equalization ponds may need to have sediment removed. Pipelines routing MIW from the Gold King Mine adit to the Gladstone IWTP may require flushing of sediments to function. ▪ Management of sludge generated from the Gladstone IWTP during treatment would be required. Available areas to manage the sludge are currently limited to the immediate area near the Gladstone IWTP. If IWTP operation continues, an additional interim management location for sludge would be identified by EPA and readied for use prior to mid-2017, so that sludge could be transported to this additional location for interim management. The interim sludge management areas are not intended to be the permanent disposal locations for treatment residuals. ▪ After capacity at the existing sludge drying area is exhausted, there will be additional periodic truck traffic for transport of sludge to the new the interim sludge management area. ▪ Until sludge is disposed of in a permanent location, the onsite sludge drying area and the new interim sludge management area could be breached by high surface water flows, ice jams, or avalanches. ▪ There could be impacts to the environment during the implementation of the removal action due to the use of hauling equipment. Use of fuel efficient and low emission equipment could reduce environmental impacts.
	Time until protection is achieved	▪ The Gladstone IWTP is already constructed and operational. However, there is some uncertainty whether the RAO could be consistently met given variability in flows and concentrations.

Table C-2. Implementability Evaluation Summary – Alternative RA1

Evaluation Factors for Implementability		Evaluation Summary
Technical feasibility	Technical difficulties and unknowns associated with the construction and operation of a technology	▪ The Gladstone IWTP has already been constructed and is operational. Winter operations at the Gladstone IWTP are challenging, making equipment and treatment material deliveries temporarily unavailable.
	Reliability of the technology, focusing on technical problems that will lead to schedule delays	▪ Lime neutralization is a proven, effective technology for removing metals from MIW. ▪ Sufficient lime must be stored at the Gladstone IWTP for continuous operation throughout the winter months. Gladstone IWTP operations could be shut down due to inclement weather which could affect highways for treatment material deliveries, cause power outages (which can be mitigated temporarily with onsite generators), or prevent personnel from accessing the plant.
	Potential future removal action, difficulty to implement PRSC measures or operation and maintenance (O&M) or future removal actions	▪ Future activities may be required under this removal action alternative because MIW will be a continuous problem at the site. The size of the influent storage ponds is geographically limited, leaving only a few hours filling time before the ponds are overtopped. There is limited area onsite for sludge storage.
	Ability to monitor the effectiveness of the alternative	▪ Inspection and monitoring of the Gold King Mine adit, Gladstone IWTP, influent storage ponds, and sludge storage area is relatively straightforward and can be implemented using available materials, equipment, and labor resources. However, monitoring could become difficult during winter storm events.
Administrative feasibility	Evaluate alternative for compliance with the statutory limits which requires the alternative to remain under $2 million or completed within a 12-month limit	▪ This is a Fund-financed removal action; thus the statutory limit of $2,000,000 and 12-month duration limit applies. However, the continued response action is appropriate and consistent with the remedial action to be taken. It is anticipated that Alternative RA1 would qualify for an exemption of the statutory limit.
	Evaluate whether alternative will require off-site permits or other factors including easements, right-of-way agreements, or zoning variances	▪ The removal action would be performed within the boundary of the Bonita Peak Mining District Superfund Site; thus, no off-site permits would be required. ▪ An agreement is in place with a private property owner for siting of the Gladstone IWTP at the current location. However, that agreement would need to be extended for at least 5 years beyond December 2016. ▪ An agreement for an additional interim sludge management location would also need to be reached prior to mid-2017 so that sludge can be transported to this location for interim management.
Availability of services and materials	Availability of adequate offsite treatment, storage capacity, and disposal capacity and services	▪ This alternative does not require offsite treatment, storage, and disposal services. Thus, this criterion is not applicable. ▪ Disposal of treatment residuals (sludge) from the Gladstone IWTP will require a permanent disposal location (evaluation excluded from this EE/CA).
	Availability of personnel and technology to maintain the removal schedule	▪ Labor, equipment, materials, and technical specialists for monitoring and PRSC of the Gladstone IWTP are currently available and should continue to be available. ▪ Treatment materials must be hauled in by semi-truck over high mountain roads from a significant distance. ▪ Gladstone IWTP operations could be shut down due to inclement weather which could affect highways for treatment material deliveries, cause power outages (which can be mitigated temporarily with onsite generators), or prevent personnel from accessing the plant.
	Availability of services and materials (i.e. laboratory testing capacity, turnaround for chemical analyses, adequate supplies and equipment for on-site activities, or installation of extra utilities)	
	Availability of prospective technologies	

Table C-2. Implementability Evaluation Summary – Alternative RA1 (continued)

Evaluation Factors for Implementability		Evaluation Summary
State (Support Agency) Acceptance	State concerns will be considered in determining the recommended alternative in the EE/CA and in the final selection of the alternative in the Action Memorandum	▪ This criterion is not directly evaluated in this EE/CA. For detailed explanation please refer to Section 4.5.
Community Acceptance	Acceptance from the community will be considered in determining a recommendation for the EE/CA and in the final selection of the alternative in the Action Memorandum	▪ This criterion is not directly evaluated in this EE/CA. For detailed explanation please refer to Section 4.6.

Table C-3. Cost Evaluation Summary – Alternative RA1

Evaluation Factors for Cost	Approximate Cost (Dollars)
Total capital cost	$348,000
Total annual PRSC cost	$8,529,000
Total cost (excluding present value discounting)	$8,877,000
Total present value cost	$7,326,000

Note: Total costs are for the assumed period of analysis (5 years). Costs are rounded to the nearest $1,000.

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Alternative RA2

Suspend Operation of Existing Gladstone IWTP to Treat the Gold King Mine Adit MIW Discharge

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Table C-4. Evaluation Summary for the Effectiveness Factors – Alternative RA2

Evaluation Factors for Effectiveness		Evaluation Summary
Overall Protection of Human Health and the Environment	Adequate protection of human health and the environment shall be evaluated for long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site	▪ Previous actions such as the stabilization of the adit and the Gladstone IWTP would remain. ▪ Alternative RA2 entails suspension of treatment operation at the existing Gladstone IWTP ▪ The Gladstone IWTP and the associated infrastructure would remain in place should a future decision be made to restart water treatment. To preserve the Gladstone IWTP infrastructure, the acidic MIW discharge from the adit would be routed back to the creek and not through the conveyances to the IWTP. ▪ Hydrated lime already onsite in the silos would be consumed and not left in storage prior to suspension of operation to prevent solidification of the chemical. ▪ Generated sludge will be allowed to consolidate and will be maintained in a stable state on site, pending a future evaluation of sludge disposal options. ▪ MIW from the Gold King Mine adit would no longer be treated at the Gladstone IWTP. MIW would be safely routed instead to the North Fork of Cement Creek as was done prior to the release. Because MIW will not be routed for treatment, any TSS released, either chronically or in a sudden event, will not be controlled. There is potential for precipitates forming within the mine portal to build up and be released unexpectedly. ▪ Untreated MIW will flow into Cement Creek which will increase the mass of COPECs in Cement Creek to approximately pre-release levels, increasing the exposure risk to human and ecological receptors. Because concentrations and flow rates discharging from the adit have been observed to vary since the release, water discharged from the Gold King adit may be of worse quality than prior to the release, resulting in even higher mass of COPECs released to surface water, perhaps significantly worsening risks to aquatic receptors. ▪ The ability for this alternative to be protective of human health and the environment and meet the RAO is highly uncertain.
Compliance with ARARs and Other Criteria, Advisories, and Guidance	Compliance with chemical-specific ARARs	▪ State of Colorado, Classifications and Numeric Standards for San Juan and Dolores River Basins, Regulation 34, establishes numerical water quality standards for the Animas River. Chemical specific ARARs for Cement Creek (COSJAF07) are currently designated for "Agriculture and Recreation E". The chronic standards that are listed for the COPECs are for the total fractions only as follows: ▪ As = 100 µg/L ▪ Be = 100 µg/L ▪ Cd = 10 µg/L ▪ Cu = 200 µg/L ▪ Pb = 100 µg/L ▪ Zn = 2,000 µg/L ▪ pH = 3.7-9.0 ▪ Alternative RA2 fails to be compliant with chemical-specific ARARs for Cement Creek since treatment at the Gladstone IWTP would stop. MIW from the Gold King mine would flow back to the North Fork of Cement Creek untreated. Available water quality data for the untreated Gold King Mine adit MIW indicate concentrations far exceed the chemical-specific ARARs for Cement Creek and would not be expected to be met in the future without additional action. Thus, this criterion is not met.

Table C-4. Evaluation Summary for the Effectiveness Factors – Alternative RA2 (continued)

Evaluation Factors for Effectiveness		Evaluation Summary
Compliance with ARARs and Other Criteria, Advisories, and Guidance (continued)	Compliance with location-specific ARARs	▪ Location-specific ARARs for the remedy would be addressed during implementation. ▪ Activities under this alternative (suspension of Gladstone IWTP) would be carried out in a manner that will comply with substantive requirements of ARARs that are identified in Appendix B to the extent practicable. ▪ Fish and Wildlife Coordination: The selected removal actions will be carried out in a manner to avoid adversely affecting wildlife and/or non-game fish. ▪ Bald Eagle Protection Act: Bald eagles have been identified in San Juan County, but not necessarily found at the removal action area. If bald eagles are identified within the removal areas, the selected removal actions will be carried out in a manner to avoid adversely affecting bald eagle. ▪ Endangered Species: Lynx (federally threatened mammal) and southwestern willow flycatcher (federally endangered bird) have been identified in San Juan County, but not necessarily found at the removal action area. If threatened or endangered species (T&E) are identified within the removal action area, the selected actions will be carried out in a manner to avoid adversely affecting those species. ▪ Migratory Bird Treaty Act: The selected actions will be carried out in a manner to avoid adversely affecting migratory bird species, including individual birds or their nests. ▪ Colorado Non-Game, Endangered, or Threatened Species: Lynx, wolverine (state endangered mammals), and southwestern willow flycatcher (state endangered bird) were identified in San Juan County, but not necessarily found at the removal action area. If State-endangered species are identified within the removal action area, the selected actions will be carried out in a manner to avoid adversely affecting those species. ▪ Colorado Natural Areas: If the removal action involves activities that impact species of special concerns, federal agencies will coordinate with Division of Parks and Outdoor Recreation to address substantive requirements to limit impacts.
	Compliance with action-specific ARARs	▪ Action-specific ARARs for the remedy would be addressed during implementation. ▪ Activities under this alternative (suspension of Gladstone IWTP) would be carried out in a manner that will comply with substantive requirements of ARARs that are identified in Appendix B to the extent practicable. ▪ Colorado Non-Game, Endangered, or Threatened Species: Lynx, wolverine (state endangered mammals), and southwestern willow flycatcher (state endangered bird) were identified in San Juan County, but not necessarily found at the removal action area. If State-endangered species are identified within the removal action area, the selected actions will be carried out in a manner to avoid adversely affecting those species.

Table C-4. Evaluation Summary for the Effectiveness Factors – Alternative RA2 (continued)

Evaluation Factors for Effectiveness		Evaluation Summary
Compliance with ARARs and Other Criteria, Advisories, and Guidance (continued)	Compliance with action-specific ARARs	▪ State Solid Waste Disposal Sites and Facilities Act and Implementing Regulations: The alternatives involve generation of non-hazardous solid waste (i.e. sludge) from Gladstone IWTP operations. While the operations do not involve disposal or open dumping within the period of evaluation for the removal action alternatives (sludge is contained within filter bags), they do involve storage of Gladstone IWTP sludge within a diked area for a period exceeding 30 days that will comply with substantive requirements listed in 6 CCR §1007-2 §§ 1, Section 9.2.1 for a Type A waste impoundment.
Long-Term Effectiveness and Permanence	Magnitude of residual risk remaining from untreated waste or treatment residuals remaining at the conclusion of the removal activities	▪ MIW from the Gold King Mine Level 7 would no longer be treated at the Gladstone IWTP. No further removal action would be undertaken to treat MIW. ▪ MIW would be left uncontrolled except as partially mitigated during previous removal activities. Unaddressed MIW substantially contributes to metals mass loading of Cement Creek and the Animas River. For example, the average mass of COPECs removed in the Gladstone IWTP would cease, and mass loads entering Cement Creek would increase back up to 992 lb/day. Loading rates are shown in Table 4-3. ▪ Because concentrations and flow rates discharging from the adit have been observed to vary since the release, water discharged from the Gold King adit may be of worse quality than prior to the release, resulting in even higher mass of COPECs released to surface water, perhaps significantly worsening risks to aquatic receptors. The Gladstone IWTP would not be in use to mitigate the effects of potentially higher mass loads of COPECs if they occur. ▪ Untreated MIW would once again flow into the North Fork of Cement Creek which could increase exposure risk to human and ecological receptors. ▪ TSS present or forming in the untreated Gold King adit portal could be released chronically or in a sudden, uncontrolled release. ▪ Generation of treatment residuals (sludge) will stop Residual risks would potentially remain until the sludge is disposed of at a permanent location because exposing sludge to acidic conditions in the future could liberate the sequestered COPECs. ▪ Quarterly monitoring of the piping or channels used to divert the Gold King adit discharge around the mine dump would be performed to determine the protectiveness of the action. ▪ It is highly uncertain that the RAO would not be met as acidic MIW would remain untreated.
	Adequacy and reliability of controls that are used to manage treatment residuals and untreated waste remaining at the site	▪ Generation of treatment residuals (sludge) will stop. ▪ Previous treatment residuals (sludge) will need to be disposed of in a permanent location. Until sludge is disposed of in a permanent location, the sludge drying area could be breached by high surface water flows, ice jams, or avalanches. Sludge is left uncontrolled, which could migrate to surface water and groundwater. ▪ PRSC activities (sediment cleanout) would be periodically required to ensure conveyance structures routing MIW from the Gold King Mine adit to the North Fork Cement Creek continue to function.

Table C-4. Evaluation Summary for the Effectiveness Factors – Alternative RA2 (continued)

Evaluation Factors for Effectiveness		Evaluation Summary
Reduction of Toxicity. Mobility or Volume through Treatment	The treatment processes, the alternative uses, and materials they will treat	▪ This alternative would stop treatment of MIW. Thus, there would be no reduction of toxicity, mobility, or volume of contamination through treatment. ▪ The contaminants (metals) cannot be destroyed, only immobilized in a solid form. Lime treatment sludge containing the metals is expected to be chemically stable as stored at the IWTP. Certain COPECs could be remobilized (re-dissolved) out of the sludge under the right geochemical conditions (such as extremely high or low pH), but these are not expected to occur unintentionally. ▪ Until sludge is disposed of in a permanent location, the onsite sludge drying area could be breached by extremely high surface water flows, ice jams, or avalanches. ▪ The statutory preference for treatment as a principal element of the removal action would not be met.
	The amount of hazardous substances, pollutants, or contaminants that will be destroyed or treated	
	The degree of expected reduction in toxicity, mobility, or volume of the waste due to treatment	
	The degree to which the treatment is irreversible	
	The type and quantity of residuals that will remain following treatment	
	Whether the alternative will satisfy the preference for treatment	
Short-Term Effectiveness	Short-term risks that might be posed to the community during implementation of an alternative	▪ Work area restrictions (such as exclusion zones) would be implemented during suspension of the Gladstone IWTP to reduce short-term exposure risks to the community. ▪ There would be minor impacts to the community under this alternative, as truck traffic would only be required temporarily as workers suspend the Gladstone IWTP. In addition, the Gladstone IWTP is in a remote location away from the town of Silverton. ▪ The road to the IWTP is also used to access the base of the Silverton Mountain ski area (small resort for expert skiers); however, truck traffic would only be required temporarily as workers suspend the Gladstone IWTP, lessening the likelihood of IWTP truck traffic interfering with skier traffic. ▪ Short-term risks posed to the community during implementation of the alternative relate to trespassers within the areas of the Gold King Mine and the Gladstone IWTP.
	Potential impacts on workers during removal action and the effectiveness and reliability of protective measures	▪ Workers performing suspension of the Gladstone IWTP would potentially be exposed to MIW and treatment plant materials or residuals that poses unacceptable risks. Exposure risks could increase due to suspension activities related to mothballing of pipelines, clarifiers, and other Gladstone IWTP equipment. ▪ Safety measures such as use of PPE would protect workers during suspension of the Gladstone IWTP. ▪ Other potential impacts could be from safety hazards during suspension of the Gladstone IWTP, such as slips and falls, mechanical hazards, high altitude, and weather.
	Potential adverse environmental impacts from implementation of an alternative and the reliability of mitigation measures in preventing or reducing the potential impacts	▪ PRSC activities (sediment cleanout) would be periodically required to ensure conveyance structures routing MIW from the Gold King Mine adit to the North Fork Cement Creek continue to function. ▪ Previous treatment residuals (sludge) will need to be disposed of in a permanent location. Until sludge is disposed of in a permanent location, the sludge drying area could be breached by high surface water flows, ice jams, or avalanches.
	Time until protection is achieved	▪ The Gladstone IWTP would be suspended and no further removal action would be undertaken to address MIW. Thus, protection would not be achieved under this alternative.

Table C-5. Implementability Evaluation Summary – Alternative RA2

Evaluation Factors for Implementability		Evaluation Summary
Technical feasibility	Technical difficulties and unknowns associated with the construction and operation of a technology	▪ Suspension of the Gladstone IWTP could be conducted; however, considerations would need to be taken to ensure Gladstone IWTP infrastructure is not damaged ▪ The settling ponds and pipes should be drained, electrical service disconnected, and remaining lime onsite should be consumed to prevent it from solidifying. ▪ Suspension of the Gladstone IWTP may be difficult; especially with regards to the mothballing the pipes and equalization ponds. These would remain in-place and be exposed to weather conditions. ▪ Disposal of treatment residuals (sludge) from the Gladstone IWTP would require a permanent disposal location (evaluation excluded from this EE/CA).
	Reliability of the technology, focusing on technical problems that will lead to schedule delays	▪ Schedule delays may result from unexpected difficulties in mothballing Gladstone IWTP equipment.
	Potential future removal action, difficulty to implement PRSC measures or operation and maintenance (O&M) or future removal actions	▪ Future activities may be required under this removal action alternative because MIW will be a continuous problem at the site. The ease of restart of the Gladstone IWTP may be impeded from equipment which has not operated in some time or damaged due to natural causes (weather).
	Ability to monitor the effectiveness of the alternative	▪ Inspection and monitoring of the Gold King Mine adit is relatively straightforward and can be implemented using available materials, equipment, and labor resources. However, monitoring could become difficult during winter storm events.
Administrative feasibility	Evaluate alternative for compliance with the statutory limits which requires the alternative to remain under $2 million or completed within a 12-month limit	▪ This is a Fund-financed removal action; thus the statutory limit of $2,000,000 and 12-month duration limit applies. However, the continued response action is appropriate and consistent with the remedial action to be taken. It is anticipated that Alternative RA2 would qualify for an exemption (schedule) of the statutory limit.
	Evaluate whether alternative will require off-site permits or other factors including easements, right-of-way agreements, or zoning variances	▪ No offsite removal activities would be conducted under this alternative. ▪ An agreement is in place with a private property owner for siting of the Gladstone IWTP at the current location. However, that agreement would need to be extended for at least 5 years beyond December 2016.
Availability of services and materials)	Availability of adequate offsite treatment, storage capacity, and disposal capacity and services	▪ This alternative would not require offsite treatment, storage, and disposal services. Thus, this criterion is not applicable. ▪ Disposal of treatment residuals (sludge) at the Gladstone IWTP would require a permanent disposal location (evaluation excluded from this EE/CA).
	Availability of personnel and technology to maintain the removal schedule	▪ Labor, equipment, materials, and technical specialists for suspension of the Gladstone IWTP and monitoring of the Gold King Mine adit should be available.
	Availability of services and materials (i.e. laboratory testing capacity, turnaround for chemical analyses, adequate supplies and equipment for on-site activities, or installation of extra utilities)	
	Availability of prospective technologies	

Table C-5. Implementability Evaluation Summary – Alternative RA2 (continued)

Evaluation Factors for Implementability		Evaluation Summary
State (Support Agency) Acceptance	State concerns will be considered in determining the recommended alternative in the EE/CA and in the final selection of the alternative in the Action Memorandum	▪ This criterion is not directly evaluated in this EE/CA. For detailed explanation please refer Section 4.5.
Community Acceptance	Acceptance from the community will be considered in determining a recommendation for the EE/CA and in the final selection of the alternative in the Action Memorandum	▪ This criterion is not directly evaluated in this EE/CA. For detailed explanation please refer Section 4.6.

Table C-6. Cost Evaluation Summary – Alternative RA2

Evaluation Factors for Cost	Approximate Cost (Dollars)
Total capital cost	$104,000
Total annual PRSC cost	$35,000
Total cost (excluding present value discounting)	$139,000
Total present value cost	$126,000

Note: Total costs are for the assumed period of analysis (5 years). Costs are rounded to the nearest $1,000

Appendix D

Data

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Client: Weston Solutions, Inc.
Project/Site: Gold King Mine - Region 8 (T/S)

TestAmerica Job ID: 680-128719-1

Client Sample ID: GST_SLUDGE_080916
Date Collected: 08/09/16 13:30
Date Received: 08/13/16 09:39

Lab Sample ID: 680-128719-3
Matrix: Solid
Percent Solids: 11.2

Method: 6020A - Metals (ICP/MS)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Antimony	3.8	J	7.5	0.75	mg/Kg	☼	08/15/16 11:57	08/16/16 04:17	1
Gold	3.7	U	37	3.7	mg/Kg	☼	08/18/16 08:02	08/19/16 19:47	20
Arsenic	140		2.2	0.75	mg/Kg	☼	08/15/16 11:57	08/16/16 04:17	1
Barium	22		3.7	0.45	mg/Kg	☼	08/15/16 11:57	08/16/16 04:17	1
Beryllium	9.5		0.37	0.11	mg/Kg	☼	08/15/16 11:57	08/16/16 04:17	1
Cadmium	120		0.37	0.11	mg/Kg	☼	08/15/16 11:57	08/16/16 04:17	1
Chromium	18	B	7.5	0.82	mg/Kg	☼	08/15/16 11:57	08/16/16 04:17	1
Cobalt	120		0.37	0.075	mg/Kg	☼	08/15/16 11:57	08/16/16 04:17	1
Copper	9100	B	3.7	0.97	mg/Kg	☼	08/15/16 11:57	08/16/16 04:17	1
Lead	110		1.5	0.37	mg/Kg	☼	08/15/16 11:57	08/16/16 12:56	1
Manganese	17000	B	150	18	mg/Kg	☼	08/15/16 11:57	08/16/16 13:17	20
Molybdenum	8.5		7.5	0.60	mg/Kg	☼	08/15/16 11:57	08/16/16 04:17	1
Nickel	83		7.5	1.9	mg/Kg	☼	08/15/16 11:57	08/16/16 04:17	1
Selenium	26		3.7	0.75	mg/Kg	☼	08/15/16 11:57	08/16/16 04:17	1
Silver	0.48	J	0.75	0.075	mg/Kg	☼	08/15/16 11:57	08/16/16 04:17	1
Thallium	0.37	U	0.75	0.37	mg/Kg	☼	08/15/16 11:57	08/16/16 04:17	1
Vanadium	66		3.7	2.0	mg/Kg	☼	08/15/16 11:57	08/16/16 04:17	1
Zinc	35000		300	150	mg/Kg	☼	08/15/16 11:57	08/16/16 13:17	20

Method: 6020A - Metals (ICP/MS) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Silver	0.010	U	0.010	0.010	mg/L		08/18/16 11:50	08/19/16 13:51	1
Arsenic	0.030	U	0.030	0.030	mg/L		08/18/16 11:50	08/19/16 13:51	1
Chromium	0.050	U	0.050	0.050	mg/L		08/18/16 11:50	08/19/16 13:51	1
Copper	1.5		0.050	0.050	mg/L		08/18/16 11:50	08/19/16 13:51	1
Cadmium	0.30		0.0050	0.0050	mg/L		08/18/16 11:50	08/19/16 13:51	1
Cobalt	0.41		0.0050	0.0050	mg/L		08/18/16 11:50	08/19/16 13:51	1
Barium	0.054		0.050	0.050	mg/L		08/18/16 11:50	08/19/16 13:51	1
Beryllium	0.0050	U	0.0050	0.0050	mg/L		08/18/16 11:50	08/19/16 13:51	1
Manganese	75		0.050	0.050	mg/L		08/18/16 11:50	08/19/16 13:51	1
Molybdenum	0.050	U	0.050	0.050	mg/L		08/18/16 11:50	08/19/16 13:51	1
Nickel	0.17		0.050	0.050	mg/L		08/18/16 11:50	08/19/16 13:51	1
Lead	0.025	U	0.025	0.025	mg/L		08/18/16 11:50	08/19/16 13:51	1
Antimony	0.050	U	0.050	0.050	mg/L		08/18/16 11:50	08/19/16 13:51	1
Selenium	0.025	U	0.025	0.025	mg/L		08/18/16 11:50	08/19/16 13:51	1
Thallium	0.011		0.010	0.010	mg/L		08/18/16 11:50	08/19/16 13:51	1
Vanadium	0.10	U	0.10	0.10	mg/L		08/18/16 11:50	08/19/16 13:51	1
Zinc	71		20	20	mg/L		08/18/16 11:50	08/19/16 13:51	1

Method: 7470A - Mercury (CVAA) - TCLP

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.020	U	0.020	0.020	mg/L		08/18/16 09:38	08/18/16 16:44	1

Method: 7471A - Mercury (CVAA)

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Mercury	0.069	U	0.17	0.069	mg/Kg	☼	08/15/16 12:38	08/15/16 20:14	1

Analytical Results

Site:	A8K9
Lab:	TestAmerica Savannah
Sample Number:	GST_SLUDGE_041216
Sampling Location:	GST_SLUDGE
Matrix:	Solid
Units:	mg/L
Date Sampled:	4/12/2016
Date Analyzed:	4/20/2016 17:20

Parameter	Analysis	Result_Units	Result	Flag	MDL	MDL Units
Aluminum	6010C Metals (ICP)	mg/L	4.3		2	mg/L
Calcium	6010C Metals (ICP)	mg/L	92		5	mg/L
Iron	6010C Metals (ICP)	mg/L	1	U	1	mg/L
Magnesium	6010C Metals (ICP)	mg/L	19		5	mg/L
Potassium	6010C Metals (ICP)	mg/L	10	U	10	mg/L
Antimony	6020A Metals (ICP/MS)	mg/L	0.05	U	0.05	mg/L
Arsenic	6020A Metals (ICP/MS)	mg/L	0.03	U	0.03	mg/L
Barium	6020A Metals (ICP/MS)	mg/L	0.05	U	0.05	mg/L
Beryllium	6020A Metals (ICP/MS)	mg/L	0.007		0.005	mg/L
Cadmium	6020A Metals (ICP/MS)	mg/L	0.31		0.005	mg/L
Chromium	6020A Metals (ICP/MS)	mg/L	0.05	U	0.05	mg/L
Cobalt	6020A Metals (ICP/MS)	mg/L	0.37		0.005	mg/L
Copper	6020A Metals (ICP/MS)	mg/L	11		0.05	mg/L
Lead	6020A Metals (ICP/MS)	mg/L	0.025	U	0.025	mg/L
Manganese	6020A Metals (ICP/MS)	mg/L	80		0.05	mg/L
Molybdenum	6020A Metals (ICP/MS)	mg/L	0.05	U	0.05	mg/L
Nickel	6020A Metals (ICP/MS)	mg/L	0.17		0.05	mg/L
Selenium	6020A Metals (ICP/MS)	mg/L	0.025	U	0.025	mg/L
Silver	6020A Metals (ICP/MS)	mg/L	0.01	UJ	0.01	mg/L
Thallium	6020A Metals (ICP/MS)	mg/L	0.01	U	0.01	mg/L
Vanadium	6020A Metals (ICP/MS)	mg/L	0.1	U	0.1	mg/L
Zinc	6020A Metals (ICP/MS)	mg/L	99		20	mg/L
Mercury	7470A Mercury (CVAA)	mg/L	0.02	U	0.02	mg/L

DATA VALIDATION REPORT

Gold King Mine Follow-Up Monitoring

SAMPLE DELIVERY GROUP: 680-124126-1

Prepared by

MEC^X
12269 East Vassar Drive
Aurora, CO 80014

I. INTRODUCTION

Task Order Title:	Gold King Mine Follow-Up Monitoring
Project No.:	20408.012.001.0285.00
Sample Delivery Group:	680-124126-1
EPA Project Manager:	Steve Merritt
Weston Project Manager:	Mark Blanchard
TDD No.:	0001/1510-02
Matrix:	Solid/Water
QC Level:	Stage 2A
No. of Samples:	8
No. of Reanalyses/Dilutions:	0
Laboratory:	TestAmerica - Denver

Table 1. Sample Identification

Location ID	*Lab Sample Name*	*Matrix Type*	*Collection Date*	*Method*
GST_SLUDGE_041216	680-124126-8	Solid	4/12/16 2:00 PM	6010C, 6020A, 7471A
GSTI	680-124126-4	Water	4/12/16 1:00 PM	200.7, 200.8, 245.1
GSTI_C_TEST_638	680-124126-3	Water	4/12/16 1:30 PM	200.7, 200.8, 245.1
GSTI_C_TEST_746	680-124126-7	Water	4/12/16 2:10 PM	200.7, 200.8, 245.1
GSTI_C_TEST_961	680-124126-5	Water	4/12/16 2:35 PM	200.7, 200.8, 245.1
GSTO_TEST_638	680-124126-6	Water	4/12/16 1:45 PM	200.7, 200.8, 245.1
GSTO_TEST_746	680-124126-2	Water	4/12/16 2:15 PM	200.7, 200.8, 245.1
GSTO_TEST_961	680-124126-1	Water	4/12/16 2:30 PM	200.7, 200.8, 245.1

II. Sample Management

Anomalies regarding sample management are noted below. The samples were received within the temperature limits of 4°C ±2°C. The samples were received intact, on ice, and properly preserved. The chains-of-custody (COCs) were appropriately signed and dated by field and laboratory personnel. The presence or absence of custody seals on the cooler was not specifically noted. Sample GST_SLUDGE_041216 was a solid sludge which was first prepared according to the TCLP leachate procedure SW-846 Method 1311. The sample results are reported in liquid units of mg/L for all analytes.

The following issues were noted:

- Corrections made to the COC were made by overwriting the original entry. The corrections were not initialed or dated.
- The COCs did not list CLP sample IDs, and none were provided. The laboratory logged the samples per the location IDs on the COCs.

- The presence or absence of sample tags was not noted in the case narrative, and sample tags were not listed on the COCs.

Data Qualifier Reference Table

Qualifier	Organics	Inorganics
U	The analyte was analyzed for, but was not detected above the reported sample quantitation limit. The associated value is the quantitation limit or the estimated detection limit for dioxins or PCB congeners.	The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit. The associated value is the sample detection limit or the quantitation limit for perchlorate only.
UB	The analyte was detected in the sample and in either the associated laboratory blank or field blank. If detected below the reporting limit (RL) the analyte result was reported as non-detected at the RL due to blank contamination. If detected above the RL, the analyte result was reported as non-detected at the reported result due to blank contamination.	The analyte was detected in the sample and in either the associated laboratory blank or field blank. If detected below the reporting limit (RL) the analyte result was reported as non-detected at the RL due to blank contamination. If detected above the RL, the analyte result was reported as non-detected at the reported result due to blank contamination.
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
J+	Not applicable	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample, and may have a potential positive bias.
J-	Not applicable	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample, and may have a potential negative bias.

Qualifier	Organics	Inorganics
UJ	The analyte was not deemed above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.	The material was analyzed for, but was not detected. The associated value is an estimate and may be inaccurate or imprecise.
UJB	The analyte was detected in the sample and in either the associated laboratory blank or field blank; the analyte result was reported as non-detected at either the RL or the reported result. The reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.	The analyte was detected in the sample and in either the associated laboratory blank or field blank; the analyte result was reported as non-detected at either the RL or the reported result. The reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification."	Not applicable.
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.	Not applicable.
R	The data are unusable. The sample results are rejected due to serious deficiencies in the ability to analyze the sample and to meet quality control criteria. The presence or absence of the analyte cannot be verified.	The data are unusable. The sample results are rejected due to serious deficiencies in the ability to analyze the sample and to meet quality control criteria. The presence or absence of the analyte cannot be verified.

Qualification Code Reference Table

Qualifier	Organics	Inorganics
H	Holding times were exceeded.	Holding times were exceeded.
S	Surrogate recovery was outside QC limits.	The sequence or number of standards used for the calibration was incorrect
C	Calibration %RSD or %D was noncompliant.	Correlation coefficient is <0.995 or calibration was noncompliant.
R	Calibration RRF was <0.05.	%R for calibration is not within control limits.
B	Presumed contamination as indicated by the preparation (method) blank results.	Presumed contamination as indicated by the preparation (method) or calibration blank results.
L	Laboratory Blank Spike/Blank Spike Duplicate %R was not within control limits.	Laboratory Control Sample %R was not within control limits.
L1	LCS/LCSD RPD was outside control limits.	LCS/LCSD RPD was outside control limits.
Q	MS/MSD recovery was poor.	MS recovery was poor.
Q1	MS/MSD RPD was outside control limits.	MS/MSD RPD was outside control limits.
E	Not applicable.	Duplicates showed poor agreement.
I	Internal standard performance was unsatisfactory.	ICP ICS results were unsatisfactory.
A	Not applicable.	ICP Serial Dilution %D were not within control limits.
M	Tuning (BFB or DFTPP) was noncompliant.	ICPMS tune was not compliant.
T	Presumed contamination as indicated by the trip blank results.	Not applicable.
+	False positive – reported compound was not present.	Not applicable.
-	False negative – compound was present but not reported.	Not applicable.
F	Presumed contamination as indicated by the FB or ER results.	Presumed contamination as indicated by the FB or ER results.
F1	Field duplicate results were outside the control limit.	Field duplicate results were outside the control limit.
$	Reported result or other information was incorrect.	Reported result or other information was incorrect.

Qualifier	Organics	Inorganics
?	TIC identity or reported retention time has been changed.	Not applicable.
D	The analysis with this flag should not be used because another more technically sound analysis is available.	The analysis with this flag should not be used because another more technically sound analysis is available.
P	Instrument performance for pesticides was poor.	Post Digestion Spike recovery was not within control limits.
*II, *III	Unusual problems found with the data that have been described in Section II, "Sample Management," or Section III, "Method Analyses." The number following the asterisk (*) will indicate the report section where a description of the problem can be found.	Unusual problems found with the data that have been described in Section II, "Sample Management," or Section III, "Method Analyses." The number following the asterisk (*) will indicate the report section where a description of the problem can be found.

III. Method Analyses

A. Contract Laboratory Program Statement of Work for Inorganic Superfund Methods, 200.7, 200.8, 245.1, 6010C, 6020A, 7470A — Metals and Mercury

Reviewed By: M. Cherny
Date Reviewed: May 6, 2016

The samples listed in Table 1 for these analyses were validated based on the guidelines outlined in the *Quality Assurance Project Plan for U.S. EPA Region 8 CERCLA Site Assessment, Sampling and Analysis Plan/Quality Assurance Project Plan for Gold King Mine Release, Silverton, San Juan County, Colorado* (2015), *United States Environmental Protection Agency Contract Laboratory Program Statement of Work for Inorganic Superfund Methods, EPA Methods 200.7, 200.8, 245.1*, 6010C, 6020A and 7470A and the *National Functional Guidelines for Inorganic Superfund Data Review* (2010).

- Holding Times: The analytical holding times, 28 days for mercury and six months for the remaining metals, were met.

- Analytical Method Blanks: There were no detects in the method blanks above the method detection limits (MDLs).

- Laboratory Control Samples (LCS): The recoveries were within the laboratory control limits of 85-115% for waters, 75-125% for 6020A, and 80-120% for the 6010C and 7470A analytes.

- Laboratory Duplicates: Laboratory duplicate analyses were not performed on a sample from this SDG. Method precision was evaluated based on matrix spike/matrix spike duplicate results.

- Matrix Spike/Matrix Spike Duplicate (MS/MSD): MS/MSD analyses were performed on the samples below. Results were not assessed when the native concentration was more than 4× the spike amount. Potassium detects below were qualified as estimated with a potential high bias (J+), and the silver nondetect was qualified as estimated (UJ).

Parent Sample	Analyte and recoveries	Sample(s) qualified
GSTI_C_TEST_746	Total potassium (126% / 128%)	All water samples
GSTO_TEST_961	Total and dissolved mercury (acceptable)	None
GST_SLUDGE_041216	Total silver (50% / 53%)	GST_SLUDGE_041216

The remaining recoveries were within the laboratory control limits of 75-125% for the 200.7, 6010C and 6020A analytes; 80-120% for the 7470A mercury and within 70-130% for aqueous mercury and the 200.8 analytes. The RPDs were ≤20%. Method accuracy for dissolved 200.7 and 200.8 metals was evaluated based on the LCS results.

- Post Digestion Spike (PDS): There were no PDS analyses performed on a sample in this SDG.

- Serial Dilution: Serial dilution analyses were not performed.

- Field QC Samples: MEC^X evaluated field quality control (QC) samples, and if necessary, qualified based on method blanks and other laboratory QC results affecting the usability of the field QC data. MEC^X used the remaining detects to evaluate the associated site samples. Findings associated with field QC samples are summarized below:

    - Field Blanks and Equipment Rinsates: Field blank or equipment blank samples were not identified for this SDG.

    - Field Duplicates: There were no field duplicate samples identified for this SDG.

Validated Sample Result Forms: 680-124126-1

Analysis Method 200.7 Rev 4.4

Sample Name GSTO_TEST_961 **Matrix Type:** Water

Lab Sample Name: 680-124126-1 **Sample Date:** 4/12/2016 2:30:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Aluminum	T	7429-90-5	170	200	24	ug/L	J	J	
Aluminum, Dissolved	D	7429-90-5	110	200	24	ug/L	J	J	
Calcium	T	7440-70-2	420000	500	25	ug/L			
Calcium, Dissolved	D	7440-70-2	410000	500	25	ug/L			
Iron	T	7439-89-6	340	50	17	ug/L			
Iron, Dissolved	D	7439-89-6	25	50	17	ug/L	J	J	
Magnesium	T	7439-95-4	15000	500	33	ug/L			
Magnesium, Dissolved	D	7439-95-4	14000	500	33	ug/L			
Potassium	T	7440-09-7	1800	1000	17	ug/L		J+	Q
Potassium, Dissolved	D	7440-09-7	1800	1000	17	ug/L			
Sodium	T	7440-23-5	4600	1000	480	ug/L			
Sodium, Dissolved	D	7440-23-5	4600	1000	480	ug/L			

Sample Name GSTO_TEST_746 **Matrix Type:** Water

Lab Sample Name: 680-124126-2 **Sample Date:** 4/12/2016 2:15:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Aluminum	T	7429-90-5	170	200	24	ug/L	J	J	
Calcium	T	7440-70-2	420000	500	25	ug/L			
Iron	T	7439-89-6	300	50	17	ug/L			
Magnesium	T	7439-95-4	14000	500	33	ug/L			
Potassium	T	7440-09-7	1800	1000	17	ug/L		J+	Q
Sodium	T	7440-23-5	4700	1000	480	ug/L			

Sample Name GSTI_C_TEST_638 **Matrix Type:** Water

Lab Sample Name: 680-124126-3 **Sample Date:** 4/12/2016 1:30:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Aluminum	T	7429-90-5	7700	200	24	ug/L			
Aluminum, Dissolved	D	7429-90-5	140	200	24	ug/L	J	J	
Calcium	T	7440-70-2	420000	500	25	ug/L			
Calcium, Dissolved	D	7440-70-2	410000	500	25	ug/L			
Iron	T	7439-89-6	37000	50	17	ug/L			
Iron, Dissolved	D	7439-89-6	200	50	17	ug/L			

Analysis Method *200.7 Rev 4.4*

Magnesium	T	7439-95-4	16000	500	33	ug/L			
Magnesium, Dissolved	D	7439-95-4	14000	500	33	ug/L			
Potassium	T	7440-09-7	1800	1000	17	ug/L		J+	Q
Potassium, Dissolved	D	7440-09-7	1800	1000	17	ug/L			
Sodium	T	7440-23-5	2700	1000	480	ug/L			
Sodium, Dissolved	D	7440-23-5	4600	1000	480	ug/L			

Sample Name GSTI **Matrix Type:** Water

Lab Sample Name: 680-124126-4 **Sample Date:** 4/12/2016 1:00:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Aluminum	T	7429-90-5	13000	200	24	ug/L			
Aluminum, Dissolved	D	7429-90-5	4700	200	24	ug/L			
Calcium	T	7440-70-2	360000	500	25	ug/L			
Calcium, Dissolved	D	7440-70-2	360000	500	25	ug/L			
Iron	T	7439-89-6	52000	50	17	ug/L			
Iron, Dissolved	D	7439-89-6	36000	50	17	ug/L			
Magnesium	T	7439-95-4	16000	500	33	ug/L			
Magnesium, Dissolved	D	7439-95-4	16000	500	33	ug/L			
Potassium	T	7440-09-7	1800	1000	17	ug/L		J+	Q
Potassium, Dissolved	D	7440-09-7	1800	1000	17	ug/L			
Sodium	T	7440-23-5	2600	1000	480	ug/L			
Sodium, Dissolved	D	7440-23-5	2500	1000	480	ug/L			

Sample Name GSTI_C_TEST_961 **Matrix Type:** Water

Lab Sample Name: 680-124126-5 **Sample Date:** 4/12/2016 2:35:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Aluminum	T	7429-90-5	6000	200	24	ug/L			
Aluminum, Dissolved	D	7429-90-5	200	200	24	ug/L			
Calcium	T	7440-70-2	420000	500	25	ug/L			
Calcium, Dissolved	D	7440-70-2	410000	500	25	ug/L			
Iron	T	7439-89-6	35000	50	17	ug/L			
Iron, Dissolved	D	7439-89-6	850	50	17	ug/L			
Magnesium	T	7439-95-4	16000	500	33	ug/L			
Magnesium, Dissolved	D	7439-95-4	14000	500	33	ug/L			
Potassium	T	7440-09-7	1900	1000	17	ug/L		J+	Q
Potassium, Dissolved	D	7440-09-7	1800	1000	17	ug/L			
Sodium	T	7440-23-5	2700	1000	480	ug/L			
Sodium, Dissolved	D	7440-23-5	4500	1000	480	ug/L			

Analysis Method 200.7 Rev 4.4

Sample Name GSTO_TEST_638 **Matrix Type:** Water

Lab Sample Name: 680-124126-6 **Sample Date:** 4/12/2016 1:45:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Aluminum	T	7429-90-5	190	200	24	ug/L	J	J	
Aluminum, Dissolved	D	7429-90-5	100	200	24	ug/L	J	J	
Calcium	T	7440-70-2	420000	500	25	ug/L			
Calcium, Dissolved	D	7440-70-2	420000	500	25	ug/L			
Iron	T	7439-89-6	410	50	17	ug/L			
Iron, Dissolved	D	7439-89-6	17	50	17	ug/L	U	U	
Magnesium	T	7439-95-4	14000	500	33	ug/L			
Magnesium, Dissolved	D	7439-95-4	14000	500	33	ug/L			
Potassium	T	7440-09-7	1800	1000	17	ug/L		J+	Q
Potassium, Dissolved	D	7440-09-7	1800	1000	17	ug/L			
Sodium	T	7440-23-5	4600	1000	480	ug/L			
Sodium, Dissolved	D	7440-23-5	4700	1000	480	ug/L			

Sample Name GSTI_C_TEST_746 **Matrix Type:** Water

Lab Sample Name: 680-124126-7 **Sample Date:** 4/12/2016 2:10:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Aluminum	T	7429-90-5	6400	200	24	ug/L			
Calcium	T	7440-70-2	420000	500	25	ug/L			
Iron	T	7439-89-6	36000	50	17	ug/L			
Magnesium	T	7439-95-4	16000	500	33	ug/L			
Potassium	T	7440-09-7	1800	1000	17	ug/L	F1	J+	Q
Sodium	T	7440-23-5	2800	1000	480	ug/L			

Analysis Method 200.8

Sample Name GSTO_TEST_961 **Matrix Type:** Water

Lab Sample Name: 680-124126-1 **Sample Date:** 4/12/2016 2:30:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Antimony	T	7440-36-0	0.4	1	0.4	ug/L	U	U	
Antimony, Dissolved	D	7440-36-0	0.4	1	0.4	ug/L	U	U	
Arsenic	T	7440-38-2	0.37	1	0.37	ug/L	U	U	
Arsenic, Dissolved	D	7440-38-2	0.37	1	0.37	ug/L	U	U	
Barium	T	7440-39-3	8.5	2	0.14	ug/L			
Barium, Dissolved	D	7440-39-3	8.7	2	0.14	ug/L			
Beryllium	T	7440-41-7	0.15	0.4	0.15	ug/L	U	U	
Beryllium, Dissolved	D	7440-41-7	0.15	0.4	0.15	ug/L	U	U	

Analysis Method 200.8

Cadmium	T	7440-43-9	4.4	0.5	0.043	ug/L		
Cadmium, Dissolved	D	7440-43-9	4.1	0.5	0.043	ug/L		
Chromium	T	7440-47-3	1	2	1	ug/L	U	U
Chromium, Dissolved	D	7440-47-3	1	2	1	ug/L	U	U
Cobalt	T	7440-48-4	11	0.4	0.12	ug/L		
Cobalt, Dissolved	D	7440-48-4	11	0.4	0.12	ug/L		
Copper	T	7440-50-8	22	1	0.5	ug/L		
Copper, Dissolved	D	7440-50-8	2.2	1	0.5	ug/L		
Lead	T	7439-92-1	0.06	0.3	0.06	ug/L	U	U
Lead, Dissolved	D	7439-92-1	0.2	0.3	0.06	ug/L	J	J
Manganese	T	7439-96-5	13000	2.5	1.2	ug/L	E	
Manganese, Dissolved	D	7439-96-5	13000	2.5	1.2	ug/L	E	
Molybdenum	T	7439-98-7	1.2	1	0.45	ug/L		
Molybdenum, Dissolved	D	7439-98-7	1	1	0.45	ug/L		
Nickel	T	7440-02-0	14	1	0.4	ug/L		
Nickel, Dissolved	D	7440-02-0	14	1	0.4	ug/L		
Selenium	T	7782-49-2	0.58	2	0.58	ug/L	U	U
Selenium, Dissolved	D	7782-49-2	0.58	2	0.58	ug/L	U	U
Silver	T	7440-22-4	0.1	1	0.1	ug/L	U	U
Silver, Dissolved	D	7440-22-4	0.1	1	0.1	ug/L	U	U
Thallium	T	7440-28-0	0.13	0.2	0.1	ug/L	J	J
Thallium, Dissolved	D	7440-28-0	0.12	0.2	0.1	ug/L	J	J
Vanadium	T	7440-62-2	0.3	1	0.3	ug/L	U	U
Vanadium, Dissolved	D	7440-62-2	0.3	1	0.3	ug/L	U	U
Zinc	T	7440-66-6	230	20	2.8	ug/L		
Zinc, Dissolved	D	7440-66-6	130	20	2.8	ug/L		

Sample Name GSTO_TEST_746 **Matrix Type:** Water

Lab Sample Name: 680-124126-2 **Sample Date:** 4/12/2016 2:15:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Antimony	T	7440-36-0	0.4	1	0.4	ug/L	U	U	
Arsenic	T	7440-38-2	0.37	1	0.37	ug/L	U	U	
Barium	T	7440-39-3	8.4	2	0.14	ug/L			
Beryllium	T	7440-41-7	0.15	0.4	0.15	ug/L	U	U	
Cadmium	T	7440-43-9	4.6	0.5	0.043	ug/L			
Chromium	T	7440-47-3	1	2	1	ug/L	U	U	
Cobalt	T	7440-48-4	11	0.4	0.12	ug/L			
Copper	T	7440-50-8	20	1	0.5	ug/L			
Lead	T	7439-92-1	0.06	0.3	0.06	ug/L	U	U	
Manganese	T	7439-96-5	14000	2.5	1.2	ug/L	E		

Analysis Method 200.8

Molybdenum	T	7439-98-7	1.2	1	0.45	ug/L		
Nickel	T	7440-02-0	14	1	0.4	ug/L		
Selenium	T	7782-49-2	0.58	2	0.58	ug/L	U	U
Silver	T	7440-22-4	0.1	1	0.1	ug/L	U	U
Thallium	T	7440-28-0	0.13	0.2	0.1	ug/L	J	J
Vanadium	T	7440-62-2	0.3	1	0.3	ug/L	U	U
Zinc	T	7440-66-6	240	20	2.8	ug/L		

Sample Name GSTI_C_TEST_638 **Matrix Type:** Water

Lab Sample Name: 680-124126-3 **Sample Date:** 4/12/2016 1:30:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Antimony	T	7440-36-0	0.75	1	0.4	ug/L	J	J	
Antimony, Dissolved	D	7440-36-0	0.4	1	0.4	ug/L	U	U	
Arsenic	T	7440-38-2	6.9	1	0.37	ug/L			
Arsenic, Dissolved	D	7440-38-2	0.37	1	0.37	ug/L	U	U	
Barium	T	7440-39-3	10	2	0.14	ug/L			
Barium, Dissolved	D	7440-39-3	8.4	2	0.14	ug/L			
Beryllium	T	7440-41-7	3	0.4	0.15	ug/L			
Beryllium, Dissolved	D	7440-41-7	0.15	0.4	0.15	ug/L	U	U	
Cadmium	T	7440-43-9	34	0.5	0.043	ug/L			
Cadmium, Dissolved	D	7440-43-9	4.1	0.5	0.043	ug/L			
Chromium	T	7440-47-3	1.2	2	1	ug/L	J	J	
Chromium, Dissolved	D	7440-47-3	1	2	1	ug/L	U	U	
Cobalt	T	7440-48-4	50	0.4	0.12	ug/L			
Cobalt, Dissolved	D	7440-48-4	9.8	0.4	0.12	ug/L			
Copper	T	7440-50-8	2200	1	0.5	ug/L			
Copper, Dissolved	D	7440-50-8	13	1	0.5	ug/L			
Lead	T	7439-92-1	8.4	0.3	0.06	ug/L			
Lead, Dissolved	D	7439-92-1	0.18	0.3	0.06	ug/L	J	J	
Manganese	T	7439-96-5	19000	2.5	1.2	ug/L	E		
Manganese, Dissolved	D	7439-96-5	13000	2.5	1.2	ug/L	E		
Molybdenum	T	7439-98-7	1.9	1	0.45	ug/L			
Molybdenum, Dissolved	D	7439-98-7	1.2	1	0.45	ug/L			
Nickel	T	7440-02-0	35	1	0.4	ug/L			
Nickel, Dissolved	D	7440-02-0	15	1	0.4	ug/L			
Selenium	T	7782-49-2	0.58	2	0.58	ug/L	U	U	
Selenium, Dissolved	D	7782-49-2	0.58	2	0.58	ug/L	U	U	
Silver	T	7440-22-4	0.1	1	0.1	ug/L	U	U	
Silver, Dissolved	D	7440-22-4	0.1	1	0.1	ug/L	U	U	
Thallium	T	7440-28-0	0.14	0.2	0.1	ug/L	J	J	

Analysis Method 200.8

Thallium, Dissolved	D	7440-28-0	0.12	0.2	0.1	ug/L	J	J
Vanadium	T	7440-62-2	7.2	1	0.3	ug/L		
Vanadium, Dissolved	D	7440-62-2	0.3	1	0.3	ug/L	U	U
Zinc	T	7440-66-6	10000	20	2.8	ug/L	E	
Zinc, Dissolved	D	7440-66-6	160	20	2.8	ug/L		

Sample Name GSTI **Matrix Type:** Water

Lab Sample Name: 680-124126-4 **Sample Date:** 4/12/2016 1:00:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Antimony	T	7440-36-0	1.4	1	0.4	ug/L			
Antimony, Dissolved	D	7440-36-0	0.42	1	0.4	ug/L	J	J	
Arsenic	T	7440-38-2	17	1	0.37	ug/L			
Arsenic, Dissolved	D	7440-38-2	1.5	1	0.37	ug/L			
Barium	T	7440-39-3	9.6	2	0.14	ug/L			
Barium, Dissolved	D	7440-39-3	9.3	2	0.14	ug/L			
Beryllium	T	7440-41-7	5	0.4	0.15	ug/L			
Beryllium, Dissolved	D	7440-41-7	2.5	0.4	0.15	ug/L			
Cadmium	T	7440-43-9	36	0.5	0.043	ug/L			
Cadmium, Dissolved	D	7440-43-9	37	0.5	0.043	ug/L			
Chromium	T	7440-47-3	1.8	2	1	ug/L	J	J	
Chromium, Dissolved	D	7440-47-3	1	2	1	ug/L	U	U	
Cobalt	T	7440-48-4	54	0.4	0.12	ug/L			
Cobalt, Dissolved	D	7440-48-4	53	0.4	0.12	ug/L			
Copper	T	7440-50-8	2900	1	0.5	ug/L			
Copper, Dissolved	D	7440-50-8	2100	1	0.5	ug/L			
Lead	T	7439-92-1	19	0.3	0.06	ug/L			
Lead, Dissolved	D	7439-92-1	0.89	0.3	0.06	ug/L			
Manganese	T	7439-96-5	20000	2.5	1.2	ug/L	E		
Manganese, Dissolved	D	7439-96-5	20000	2.5	1.2	ug/L	E		
Molybdenum	T	7439-98-7	3	1	0.45	ug/L			
Molybdenum, Dissolved	D	7439-98-7	0.72	1	0.45	ug/L	J	J	
Nickel	T	7440-02-0	36	1	0.4	ug/L			
Nickel, Dissolved	D	7440-02-0	36	1	0.4	ug/L			
Selenium	T	7782-49-2	0.61	2	0.58	ug/L	J	J	
Selenium, Dissolved	D	7782-49-2	0.58	2	0.58	ug/L	U	U	
Silver	T	7440-22-4	0.1	1	0.1	ug/L	U	U	
Silver, Dissolved	D	7440-22-4	0.1	1	0.1	ug/L	U	U	
Thallium	T	7440-28-0	0.15	0.2	0.1	ug/L	J	J	
Thallium, Dissolved	D	7440-28-0	0.14	0.2	0.1	ug/L	J	J	
Vanadium	T	7440-62-2	13	1	0.3	ug/L			

Analysis Method 200.8

Vanadium, Dissolved	D	7440-62-2	0.3	1	0.3	ug/L	U	U
Zinc	T	7440-66-6	11000	20	2.8	ug/L	E	
Zinc, Dissolved	D	7440-66-6	11000	20	2.8	ug/L	E	

Sample Name GSTI_C_TEST_961 **Matrix Type:** Water

Lab Sample Name: 680-124126-5 **Sample Date:** 4/12/2016 2:35:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Antimony	T	7440-36-0	0.51	1	0.4	ug/L	J	J	
Antimony, Dissolved	D	7440-36-0	0.4	1	0.4	ug/L	U	U	
Arsenic	T	7440-38-2	3.5	1	0.37	ug/L			
Arsenic, Dissolved	D	7440-38-2	0.37	1	0.37	ug/L	U	U	
Barium	T	7440-39-3	9.8	2	0.14	ug/L			
Barium, Dissolved	D	7440-39-3	8.9	2	0.14	ug/L			
Beryllium	T	7440-41-7	2.7	0.4	0.15	ug/L			
Beryllium, Dissolved	D	7440-41-7	0.15	0.4	0.15	ug/L	U	U	
Cadmium	T	7440-43-9	34	0.5	0.043	ug/L			
Cadmium, Dissolved	D	7440-43-9	7.2	0.5	0.043	ug/L			
Chromium	T	7440-47-3	1	2	1	ug/L	U	U	
Chromium, Dissolved	D	7440-47-3	1	2	1	ug/L	U	U	
Cobalt	T	7440-48-4	50	0.4	0.12	ug/L			
Cobalt, Dissolved	D	7440-48-4	16	0.4	0.12	ug/L			
Copper	T	7440-50-8	2100	1	0.5	ug/L			
Copper, Dissolved	D	7440-50-8	55	1	0.5	ug/L			
Lead	T	7439-92-1	4.9	0.3	0.06	ug/L			
Lead, Dissolved	D	7439-92-1	0.21	0.3	0.06	ug/L	J	J	
Manganese	T	7439-96-5	19000	2.5	1.2	ug/L	E		
Manganese, Dissolved	D	7439-96-5	14000	2.5	1.2	ug/L	E		
Molybdenum	T	7439-98-7	1.3	1	0.45	ug/L			
Molybdenum, Dissolved	D	7439-98-7	0.94	1	0.45	ug/L	J	J	
Nickel	T	7440-02-0	35	1	0.4	ug/L			
Nickel, Dissolved	D	7440-02-0	18	1	0.4	ug/L			
Selenium	T	7782-49-2	0.58	2	0.58	ug/L	U	U	
Selenium, Dissolved	D	7782-49-2	0.58	2	0.58	ug/L	U	U	
Silver	T	7440-22-4	0.1	1	0.1	ug/L	U	U	
Silver, Dissolved	D	7440-22-4	0.1	1	0.1	ug/L	U	U	
Thallium	T	7440-28-0	0.14	0.2	0.1	ug/L	J	J	
Thallium, Dissolved	D	7440-28-0	0.12	0.2	0.1	ug/L	J	J	
Vanadium	T	7440-62-2	4.5	1	0.3	ug/L			
Vanadium, Dissolved	D	7440-62-2	0.3	1	0.3	ug/L	U	U	
Zinc	T	7440-66-6	10000	20	2.8	ug/L	E		

Analysis Method 200.8

Zinc, Dissolved	D		7440-66-6	580	20	2.8	ug/L			

Sample Name GSTO_TEST_638 **Matrix Type:** Water

Lab Sample Name: 680-124126-6 **Sample Date:** 4/12/2016 1:45:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Antimony	T	7440-36-0	0.4	1	0.4	ug/L	U	U	
Antimony, Dissolved	D	7440-36-0	0.4	1	0.4	ug/L	U	U	
Arsenic	T	7440-38-2	0.37	1	0.37	ug/L	U	U	
Arsenic, Dissolved	D	7440-38-2	0.37	1	0.37	ug/L	U	U	
Barium	T	7440-39-3	8.4	2	0.14	ug/L			
Barium, Dissolved	D	7440-39-3	8.2	2	0.14	ug/L			
Beryllium	T	7440-41-7	0.15	0.4	0.15	ug/L	U	U	
Beryllium, Dissolved	D	7440-41-7	0.15	0.4	0.15	ug/L	U	U	
Cadmium	T	7440-43-9	5.8	0.5	0.043	ug/L			
Cadmium, Dissolved	D	7440-43-9	5.4	0.5	0.043	ug/L			
Chromium	T	7440-47-3	1	2	1	ug/L	U	U	
Chromium, Dissolved	D	7440-47-3	1	2	1	ug/L	U	U	
Cobalt	T	7440-48-4	14	0.4	0.12	ug/L			
Cobalt, Dissolved	D	7440-48-4	13	0.4	0.12	ug/L			
Copper	T	7440-50-8	25	1	0.5	ug/L			
Copper, Dissolved	D	7440-50-8	1.5	1	0.5	ug/L			
Lead	T	7439-92-1	0.17	0.3	0.06	ug/L	J	J	
Lead, Dissolved	D	7439-92-1	0.073	0.3	0.06	ug/L	J	J	
Manganese	T	7439-96-5	14000	2.5	1.2	ug/L	E		
Manganese, Dissolved	D	7439-96-5	14000	2.5	1.2	ug/L	E		
Molybdenum	T	7439-98-7	1.4	1	0.45	ug/L			
Molybdenum, Dissolved	D	7439-98-7	1.3	1	0.45	ug/L			
Nickel	T	7440-02-0	16	1	0.4	ug/L			
Nickel, Dissolved	D	7440-02-0	16	1	0.4	ug/L			
Selenium	T	7782-49-2	0.58	2	0.58	ug/L	U	U	
Selenium, Dissolved	D	7782-49-2	0.58	2	0.58	ug/L	U	U	
Silver	T	7440-22-4	0.1	1	0.1	ug/L	U	U	
Silver, Dissolved	D	7440-22-4	0.1	1	0.1	ug/L	U	U	
Thallium	T	7440-28-0	0.12	0.2	0.1	ug/L	J	J	
Thallium, Dissolved	D	7440-28-0	0.12	0.2	0.1	ug/L	J	J	
Vanadium	T	7440-62-2	0.3	1	0.3	ug/L	U	U	
Vanadium, Dissolved	D	7440-62-2	0.3	1	0.3	ug/L	U	U	
Zinc	T	7440-66-6	370	20	2.8	ug/L			
Zinc, Dissolved	D	7440-66-6	260	20	2.8	ug/L			

Analysis Method 200.8

Sample Name GSTI_C_TEST_746 **Matrix Type:** Water

Lab Sample Name: 680-124126-7 **Sample Date:** 4/12/2016 2:10:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Antimony	T	7440-36-0	0.58	1	0.4	ug/L	J	J	
Arsenic	T	7440-38-2	4.4	1	0.37	ug/L			
Barium	T	7440-39-3	9.5	2	0.14	ug/L			
Beryllium	T	7440-41-7	2.8	0.4	0.15	ug/L			
Cadmium	T	7440-43-9	34	0.5	0.043	ug/L			
Chromium	T	7440-47-3	1	2	1	ug/L	U	U	
Cobalt	T	7440-48-4	50	0.4	0.12	ug/L			
Copper	T	7440-50-8	2100	1	0.5	ug/L			
Lead	T	7439-92-1	5.6	0.3	0.06	ug/L			
Manganese	T	7439-96-5	19000	2.5	1.2	ug/L	E		
Molybdenum	T	7439-98-7	1.5	1	0.45	ug/L			
Nickel	T	7440-02-0	35	1	0.4	ug/L			
Selenium	T	7782-49-2	0.58	2	0.58	ug/L	U	U	
Silver	T	7440-22-4	0.1	1	0.1	ug/L	U	U	
Thallium	T	7440-28-0	0.14	0.2	0.1	ug/L	J	J	
Vanadium	T	7440-62-2	4.9	1	0.3	ug/L			
Zinc	T	7440-66-6	9900	20	2.8	ug/L	E		

Analysis Method 245.1

Sample Name GSTO_TEST_961 **Matrix Type:** Water

Lab Sample Name: 680-124126-1 **Sample Date:** 4/12/2016 2:30:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Mercury	T	7439-97-6	0.08	0.2	0.08	ug/L	U	U	
Mercury, Dissolved	D	7439-97-6	0.08	0.2	0.08	ug/L	U	U	

Sample Name GSTO_TEST_746 **Matrix Type:** Water

Lab Sample Name: 680-124126-2 **Sample Date:** 4/12/2016 2:15:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Mercury	T	7439-97-6	0.08	0.2	0.08	ug/L	U	U	

Sample Name GSTI_C_TEST_638 **Matrix Type:** Water

Lab Sample Name: 680-124126-3 **Sample Date:** 4/12/2016 1:30:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Mercury	T	7439-97-6	0.08	0.2	0.08	ug/L	U	U	
Mercury, Dissolved	D	7439-97-6	0.08	0.2	0.08	ug/L	U	U	

Analysis Method 245.1

Sample Name GSTI **Matrix Type:** Water

Lab Sample Name: 680-124126-4 **Sample Date:** 4/12/2016 1:00:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Mercury	T	7439-97-6	0.08	0.2	0.08	ug/L	U	U	
Mercury, Dissolved	D	7439-97-6	0.08	0.2	0.08	ug/L	U	U	

Sample Name GSTI_C_TEST_961 **Matrix Type:** Water

Lab Sample Name: 680-124126-5 **Sample Date:** 4/12/2016 2:35:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Mercury	T	7439-97-6	0.08	0.2	0.08	ug/L	U	U	
Mercury, Dissolved	D	7439-97-6	0.08	0.2	0.08	ug/L	U	U	

Sample Name GSTO_TEST_638 **Matrix Type:** Water

Lab Sample Name: 680-124126-6 **Sample Date:** 4/12/2016 1:45:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Mercury	T	7439-97-6	0.08	0.2	0.08	ug/L	U	U	
Mercury, Dissolved	D	7439-97-6	0.08	0.2	0.08	ug/L	U	U	

Sample Name GSTI_C_TEST_746 **Matrix Type:** Water

Lab Sample Name: 680-124126-7 **Sample Date:** 4/12/2016 2:10:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Mercury	T	7439-97-6	0.08	0.2	0.08	ug/L	U	U	

Analysis Method 6010C

Sample Name GST_SLUDGE_041216 **Matrix Type:** Solid

Lab Sample Name: 680-124126-8 **Sample Date:** 4/12/2016 2:00:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Aluminum	T	7429-90-5	4.3	2	2	mg/L			
Calcium	T	7440-70-2	92	5	5	mg/L			
Iron	T	7439-89-6	1	1	1	mg/L	U	U	
Magnesium	T	7439-95-4	19	5	5	mg/L			
Potassium	T	7440-09-7	10	10	10	mg/L	U	U	

Analysis Method 6020A

Sample Name GST_SLUDGE_041216 **Matrix Type:** Solid

Lab Sample Name: 680-124126-8 **Sample Date:** 4/12/2016 2:00:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Antimony	T	7440-36-0	0.05	0.05	0.05	mg/L	U	U	
Arsenic	T	7440-38-2	0.03	0.03	0.03	mg/L	U	U	
Barium	T	7440-39-3	0.05	0.05	0.05	mg/L	U	U	
Beryllium	T	7440-41-7	0.007	0.005	0.005	mg/L			
Cadmium	T	7440-43-9	0.31	0.005	0.005	mg/L			
Chromium	T	7440-47-3	0.05	0.05	0.05	mg/L	U	U	
Cobalt	T	7440-48-4	0.37	0.005	0.005	mg/L			
Copper	T	7440-50-8	11	0.05	0.05	mg/L			
Lead	T	7439-92-1	0.025	0.025	0.025	mg/L	U	U	
Manganese	T	7439-96-5	80	0.05	0.05	mg/L			
Molybdenum	T	7439-98-7	0.05	0.05	0.05	mg/L	U	U	
Nickel	T	7440-02-0	0.17	0.05	0.05	mg/L			
Selenium	T	7782-49-2	0.025	0.025	0.025	mg/L	U	U	
Silver	T	7440-22-4	0.01	0.01	0.01	mg/L	U F1	UJ	Q
Thallium	T	7440-28-0	0.01	0.01	0.01	mg/L	U	U	
Vanadium	T	7440-62-2	0.1	0.1	0.1	mg/L	U	U	
Zinc	T	7440-66-6	99	20	20	mg/L			

Analysis Method 7470A

Sample Name GST_SLUDGE_041216 **Matrix Type:** Solid

Lab Sample Name: 680-124126-8 **Sample Date:** 4/12/2016 2:00:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Mercury	T	7439-97-6	0.02	0.02	0.02	mg/L	U	U	

DATA VALIDATION REPORT

Gold King Mine Follow-Up Monitoring

SAMPLE DELIVERY GROUP: 680-128719-1

Prepared by

MEC^X
12269 East Vassar Drive
Aurora, CO 80014

I. INTRODUCTION

Task Order Title:	Gold King Mine Follow-Up Monitoring
Project No.:	20408.012.001.0285.00
Sample Delivery Group:	680-128719-1
EPA Project Manager:	Steve Merritt
Weston Project Manager:	Mark Blanchard
TDD No.:	0001/1510-02
Matrix:	Soil/Sludge/Water
QC Level:	Stage 2A
No. of Samples:	11
No. of Reanalyses/Dilutions:	0
Laboratory:	TestAmerica - Denver

Table 1. Sample Identification

Location ID	*Lab Sample Name*	*Matrix Type*	*Collection Date*	*Method*
BH_WD_081916	680-128719-2	Soil	8/9/16 11:20 AM	6020A, 7471A
CC03D_081016_0958	680-128719-5	Water	8/10/16 9:58 AM	200.7, 200.8, 245.1, 2540 D
CC18_081016_1023	680-128719-4	Water	8/10/16 10:23 AM	200.7, 200.8, 245.1, 2540 D
GST_SLUDGE_080916	680-128719-3	Sludge	8/9/16 1:30 PM	6020A, 6020A TCLP, 7470A, 7471A
GST_SLUDGE_DUP_080916	680-128719-11	Sludge	8/9/16 1:30 PM	6020A, 6020A TCLP, 7470A, 7471A
GSTC_081016_1105	680-128719-9	Water	8/10/16 11:05 AM	200.7, 200.8, 245.1, 2540 D
GSTI_081016_1013	680-128719-6	Water	8/10/16 10:13 AM	200.7, 200.8, 245.1, 2540 D
GSTI_DUP_081016_1013	680-128719-7	Water	8/10/16 10:13 AM	200.7, 200.8, 245.1, 2540 D
GSTO_081016_1118	680-128719-10	Water	8/10/16 11:18 AM	200.7, 200.8, 245.1, 2540 D
GSTPO_081016_1056	680-128719-8	Water	8/10/16 10:56 AM	200.7, 200.8, 245.1, 2540 D
OXY_WD_080916	680-128719-1	Soil	8/9/16 11:00 AM	6020A, 7471A

II. Sample Management

Anomalies regarding sample management are noted below. The samples were received within the temperature limits of 4°C ±2°C. The samples were received intact, on ice, and properly preserved. The chains-of-custody (COCs) were appropriately signed and dated by field and laboratory personnel. The presence or absence of custody seals on the cooler was not specifically noted.

The following issues were noted:

- Corrections made to the original COC were made by overwriting the original entry. The corrections were not initialed or dated.

Data Qualifier Reference Table

Qualifier	Organics	Inorganics
U	The analyte was analyzed for, but was not detected above the reported sample quantitation limit. The associated value is the quantitation limit or the estimated detection limit for dioxins or PCB congeners.	The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit. The associated value is the sample detection limit or the quantitation limit for perchlorate only.
UB	The analyte was detected in the sample and in either the associated laboratory blank or field blank. If detected below the reporting limit (RL) the analyte result was reported as non-detected at the RL due to blank contamination. If detected above the RL, the analyte result was reported as non-detected at the reported result due to blank contamination.	The analyte was detected in the sample and in either the associated laboratory blank or field blank. If detected below the reporting limit (RL) the analyte result was reported as non-detected at the RL due to blank contamination. If detected above the RL, the analyte result was reported as non-detected at the reported result due to blank contamination.
J	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
J+	Not applicable	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample, and may have a potential positive bias.
J-	Not applicable	The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample, and may have a potential negative bias.

Qualifier	Organics	Inorganics
UJ	The analyte was not deemed above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.	The material was analyzed for, but was not detected. The associated value is an estimate and may be inaccurate or imprecise.
UJB	The analyte was detected in the sample and in either the associated laboratory blank or field blank; the analyte result was reported as non-detected at either the RL or the reported result. The reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.	The analyte was detected in the sample and in either the associated laboratory blank or field blank; the analyte result was reported as non-detected at either the RL or the reported result. The reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification."	Not applicable.
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.	Not applicable.
R	The data are unusable. The sample results are rejected due to serious deficiencies in the ability to analyze the sample and to meet quality control criteria. The presence or absence of the analyte cannot be verified.	The data are unusable. The sample results are rejected due to serious deficiencies in the ability to analyze the sample and to meet quality control criteria. The presence or absence of the analyte cannot be verified.

Qualification Code Reference Table

Qualifier	Organics	Inorganics
H	Holding times were exceeded.	Holding times were exceeded.
S	Surrogate recovery was outside QC limits.	The sequence or number of standards used for the calibration was incorrect
C	Calibration %RSD or %D was noncompliant.	Correlation coefficient is <0.995 or calibration was noncompliant.
R	Calibration RRF was <0.05.	%R for calibration is not within control limits.
B	Presumed contamination as indicated by the preparation (method) blank results.	Presumed contamination as indicated by the preparation (method) or calibration blank results.
L	Laboratory Blank Spike/Blank Spike Duplicate %R was not within control limits.	Laboratory Control Sample %R was not within control limits.
L1	LCS/LCSD RPD was outside control limits.	LCS/LCSD RPD was outside control limits.
Q	MS/MSD recovery was poor.	MS recovery was poor.
Q1	MS/MSD RPD was outside control limits.	MS/MSD RPD was outside control limits.
E	Not applicable.	Duplicates showed poor agreement.
I	Internal standard performance was unsatisfactory.	ICP ICS results were unsatisfactory.
A	Not applicable.	ICP Serial Dilution %D were not within control limits.
M	Tuning (BFB or DFTPP) was noncompliant.	ICPMS tune was not compliant.
T	Presumed contamination as indicated by the trip blank results.	Not applicable.
+	False positive – reported compound was not present.	Not applicable.
-	False negative – compound was present but not reported.	Not applicable.
F	Presumed contamination as indicated by the FB or ER results.	Presumed contamination as indicated by the FB or ER results.
F1	Field duplicate results were outside the control limit.	Field duplicate results were outside the control limit.
$	Reported result or other information was incorrect.	Reported result or other information was incorrect.

Qualifier	Organics	Inorganics
?	TIC identity or reported retention time has been changed.	Not applicable.
D	The analysis with this flag should not be used because another more technically sound analysis is available.	The analysis with this flag should not be used because another more technically sound analysis is available.
P	Instrument performance for pesticides was poor.	Post Digestion Spike recovery was not within control limits.
*II, *III	Unusual problems found with the data that have been described in Section II, "Sample Management," or Section III, "Method Analyses." The number following the asterisk (*) will indicate the report section where a description of the problem can be found.	Unusual problems found with the data that have been described in Section II, "Sample Management," or Section III, "Method Analyses." The number following the asterisk (*) will indicate the report section where a description of the problem can be found.

III. Method Analyses

A. Contract Laboratory Program Statement of Work for Inorganic Superfund Methods, 200.7, 200.8, 245.1, 6020A, 7470A, 7471A—Metals and Mercury

Reviewed By: M. Hilchey
Date Reviewed: August 31, 2016

The samples listed in Table 1 for these analyses were validated based on the guidelines outlined in the *Quality Assurance Project Plan for U.S. EPA Region 8 CERCLA Site Assessment, Sampling and Analysis Plan/Quality Assurance Project Plan for Gold King Mine Release, Silverton, San Juan County, Colorado* (2015), *United States Environmental Protection Agency Contract Laboratory Program Statement of Work for Inorganic Superfund Methods, Program Statement of Work for Inorganic Superfund Methods, EPA Methods 200.7, 200.8, 245.1*, *6020A, 7470A and 7471A,* and the *National Functional Guidelines for Inorganic Superfund Data Review* (2010).

- Holding Times: The analytical holding times, 28 days for mercury, and six months for the remaining metals, were met.

- Analytical Method Blanks: No target analytes were reported in the method blanks with concentrations sufficient to qualify site sample results except as noted in the table below. All associated detected sample results that were less than the reporting limit (RL) were qualified as nondetected (UB). All associated detected sample results that were greater than RL and <5x the blank concentration were qualified as estimated with high bias (J+).

analyte	MB concentration	Affected samples
total selenium	1.22µg/L	GSTI_081016_1013, GSTI_DUP_081016_1013, GSTPO_081016_1056, GSTC_081016_1105,
dissolved selenium	1.22µg/L	GSTI_081016_1013, GSTI_DUP_081016_1013, GSTPO_081016_1056

- Laboratory Control Samples (LCS): The recoveries were within the laboratory control limits of 75-125% for method 6020A; 80-120% for methods 6020A (gold only), 7470A and 7471A; and 85-115% for methods 200.7, 200.8 and 245.1.

- Laboratory Duplicates: Laboratory duplicate analyses were not performed on a sample from this SDG.

- Matrix Spike/Matrix Spike Duplicate (MS/MSD): MS/MSD analyses were performed on the samples below from this SDG. For the remaining analyses, MS/MSD analyses were not performed on a sample from this SDG and were not assessed.

Parent Sample	Analysis
GSTO_081016_1118	200.7, 200.8, 245.1
CC18_081016_1023	245.1
GST_SLUDGE_081016	6020A (gold only)
OXY_WD_080916	6020A, 7471A

Results were not assessed when the native concentration was more than 4× the spike amount. The recoveries were within the laboratory control limits of 75-125% for methods 200.7 and 6020A, 70-130% for methods 200.8 and 245.1, and 80-120% for method 7471A except as noted in the table below. All associated detected sample results were qualified as estimated (J+). The RPDs were ≤20% for all target analytes except antimony (66%). Affected results for antimony were qualified as estimated (J).

Analyte	MS/MSD %R	Affected samples
cadmium	267%/355%	OXY_WD_080916, BH_WD_081916
barium	160%/161%	
molybdenum	131%/126%	
vanadium	189%/146%	
antimony	359%	
mercury	194%/165%	

- Post Digestion Spike (PDS): PDS analyses were not performed.

- Serial Dilution: Serial dilution analyses were not performed.

- Field QC Samples: MEC^X evaluated field quality control (QC) samples, and if necessary, qualified based on method blanks and other laboratory QC results affecting the usability of the field QC data. MEC^X used the remaining detects to evaluate the associated site samples. Findings associated with field QC samples are summarized below:

    - Field Blanks and Equipment Rinsates: Field blank or equipment blank samples were not identified for this SDG.

    - Field Duplicates: Samples GSTI_081016_1013 and GSTI_DUP_081016_1013, and samples GSTO_SLUDGE_080916 and GSTO_SLUDGE_DUP_080916 were identified as field duplicate pairs for this SDG. All RPDs met the reasonable control limits of ≤30% for aqueous samples and ≤50% for solid samples, and less than ±

the reporting limit (RL) for results 5X RL with the following exceptions. RPDs for lead (58%), TCLP barium (difference >RL), and TCLP thallium (difference >RL) failed to meet acceptance limits for the solid samples. Associated results for samples GSTO_SLUDGE_080916 and GSTO_SLUDGE_DUP_080916 were qualified as estimated (UJ for nondetects and J for detects).

B. VARIOUS EPA METHODS—General Chemistry

Reviewed By: M. Hilchey
Date Reviewed: August 31, 2016

The samples listed in Table 1 for these analyses were validated based on the guidelines outlined in the *Quality Assurance Project Plan for U.S. EPA Region 8 CERCLA Site Assessment, Sampling and Analysis Plan/Quality Assurance Project Plan for Gold King Mine Release, Silverton, San Juan County, Colorado* (2015), *United States Environmental Protection Agency Contract Laboratory Program Statement of Work for Inorganic Superfund Methods, Standard Methods for the Examination of Water and Wastewater 2540D,* and the *National Functional Guidelines for Superfund Inorganic Data Review* (2010).

- Holding Times: Total suspended solids (TSS) was analyzed within the required holding time of 7 days.
- Analytical Method Blanks: There were no detects in the method blank.
- Laboratory Control Samples LCS/LCSD recoveries were within the laboratory control limits of 80-120%, and RPD was within the QAPP control limit of ≤20%.
- Laboratory Duplicates Laboratory duplicate analysis was performed on sample CC03D_081016_0958. The RPD was within the QAPP control limit of ≤20%.
- Matrix Spike/Matrix Spike Duplicate (MS/MSD): MS/MSD analyses were not performed.
- Field QC Samples: MEC^X evaluated field quality control (QC) samples, and if necessary, qualified based on method blanks and other laboratory QC results affecting the usability of the field QC data. MEC^X used the remaining detects to evaluate the associated site samples. Findings associated with field QC samples are summarized below:
    - Field Blanks and Equipment Rinsates: This SDG had no identified field blank or equipment rinsate samples.

- Field Duplicates: Samples GSTI_081016_1013 and GSTI_DUP_081016_1013 were identified as a field duplicate pair for this SDG. The RPD met the reasonable control limit of ≤30% for aqueous samples.

Validated Sample Result Forms: 680-128719-1

Analysis Method 200.7 Metals (ICP)

Sample Name GSTO_081016_1118 **Matrix Type:** Water

Lab Sample Name: 680-128719-10 **Sample Date:** 8/10/2016 11:18:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Aluminum	T	7429-90-5	840	200	24	ug/L			
Aluminum, Dissolved	D	7429-90-5	580	200	24	ug/L			
Calcium	T	7440-70-2	530000	500	25	ug/L			
Calcium, Dissolved	D	7440-70-2	540000	500	25	ug/L			
Iron	T	7439-89-6	870	50	17	ug/L			
Iron, Dissolved	D	7439-89-6	17	50	17	ug/L	J	J	
Magnesium	T	7439-95-4	18000	500	33	ug/L			
Magnesium, Dissolved	D	7439-95-4	18000	500	33	ug/L			
Potassium	T	7440-09-7	2700	1000	17	ug/L			
Potassium, Dissolved	D	7440-09-7	2700	1000	17	ug/L			
Sodium	T	7440-23-5	4900	1000	480	ug/L			
Sodium, Dissolved	D	7440-23-5	4800	1000	480	ug/L			

Sample Name CC18_081016_1023 **Matrix Type:** Water

Lab Sample Name: 680-128719-4 **Sample Date:** 8/10/2016 10:23:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Aluminum	T	7429-90-5	3300	200	24	ug/L			
Aluminum, Dissolved	D	7429-90-5	3100	200	24	ug/L			
Calcium	T	7440-70-2	160000	500	25	ug/L			
Calcium, Dissolved	D	7440-70-2	160000	500	25	ug/L			
Iron	T	7439-89-6	18000	50	17	ug/L			
Iron, Dissolved	D	7439-89-6	18000	50	17	ug/L			
Magnesium	T	7439-95-4	11000	500	33	ug/L			
Magnesium, Dissolved	D	7439-95-4	11000	500	33	ug/L			
Potassium	T	7440-09-7	920	1000	17	ug/L	J	J	
Potassium, Dissolved	D	7440-09-7	920	1000	17	ug/L	J	J	
Sodium	T	7440-23-5	3000	1000	480	ug/L			
Sodium, Dissolved	D	7440-23-5	2900	1000	480	ug/L			

Analysis Method 200.7 Metals (ICP)

Sample Name CC03D_081016_0958 **Matrix Type:** Water

Lab Sample Name: 680-128719-5 **Sample Date:** 8/10/2016 9:58:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Aluminum	T	7429-90-5	3800	200	24	ug/L			
Aluminum, Dissolved	D	7429-90-5	1400	200	24	ug/L			
Calcium	T	7440-70-2	440000	5000	250	ug/L			
Calcium, Dissolved	D	7440-70-2	440000	5000	250	ug/L			
Iron	T	7439-89-6	86000	50	17	ug/L			
Iron, Dissolved	D	7439-89-6	84000	50	17	ug/L			
Magnesium	T	7439-95-4	25000	5000	330	ug/L			
Magnesium, Dissolved	D	7439-95-4	26000	5000	330	ug/L			
Potassium	T	7440-09-7	2100	1000	17	ug/L			
Potassium, Dissolved	D	7440-09-7	2100	1000	17	ug/L			
Sodium	T	7440-23-5	6500	1000	480	ug/L			
Sodium, Dissolved	D	7440-23-5	6600	1000	480	ug/L			

Sample Name GSTI_081016_1013 Matrix Type: Water

Lab Sample Name: 680-128719-6 **Sample Date:** 8/10/2016 10:13:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Aluminum	T	7429-90-5	37000	200	24	ug/L			
Aluminum, Dissolved	D	7429-90-5	33000	200	24	ug/L			
Calcium	T	7440-70-2	330000	500	25	ug/L			
Calcium, Dissolved	D	7440-70-2	340000	500	25	ug/L			
Iron	T	7439-89-6	190000	50	17	ug/L			
Iron, Dissolved	D	7439-89-6	84000	50	17	ug/L			
Magnesium	T	7439-95-4	23000	500	33	ug/L			
Magnesium, Dissolved	D	7439-95-4	23000	500	33	ug/L			
Potassium	T	7440-09-7	2900	1000	17	ug/L			
Potassium, Dissolved	D	7440-09-7	2600	1000	17	ug/L			
Sodium	T	7440-23-5	1600	1000	480	ug/L			
Sodium, Dissolved	D	7440-23-5	1600	1000	480	ug/L			

Sample Name GSTI_DUP_081016_1013 **Matrix Type:** Water

Lab Sample Name: 680-128719-7 **Sample Date:** 8/10/2016 10:13:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Aluminum	T	7429-90-5	36000	200	24	ug/L			

Analysis Method 200.7 Metals (ICP)

Aluminum, Dissolved	D	7429-90-5	33000	200	24	ug/L				
Calcium	T	7440-70-2	340000	500	25	ug/L				
Calcium, Dissolved	D	7440-70-2	340000	500	25	ug/L				
Iron	T	7439-89-6	190000	50	17	ug/L				
Iron, Dissolved	D	7439-89-6	84000	50	17	ug/L				
Magnesium	T	7439-95-4	23000	500	33	ug/L				
Magnesium, Dissolved	D	7439-95-4	23000	500	33	ug/L				
Potassium	T	7440-09-7	3100	1000	17	ug/L				
Potassium, Dissolved	D	7440-09-7	2600	1000	17	ug/L				
Sodium	T	7440-23-5	1600	1000	480	ug/L				
Sodium, Dissolved	D	7440-23-5	1600	1000	480	ug/L				

Sample Name GSTPO_081016_1056 **Matrix Type:** Water

Lab Sample Name: 680-128719-8 **Sample Date:** 8/10/2016 10:56:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Aluminum	T	7429-90-5	35000	200	24	ug/L			
Aluminum, Dissolved	D	7429-90-5	35000	200	24	ug/L			
Calcium	T	7440-70-2	340000	500	25	ug/L			
Calcium, Dissolved	D	7440-70-2	350000	500	25	ug/L			
Iron	T	7439-89-6	120000	50	17	ug/L			
Iron, Dissolved	D	7439-89-6	98000	50	17	ug/L			
Magnesium	T	7439-95-4	23000	500	33	ug/L			
Magnesium, Dissolved	D	7439-95-4	24000	500	33	ug/L			
Potassium	T	7440-09-7	2800	1000	17	ug/L			
Potassium, Dissolved	D	7440-09-7	2800	1000	17	ug/L			
Sodium	T	7440-23-5	1600	1000	480	ug/L			
Sodium, Dissolved	D	7440-23-5	1800	1000	480	ug/L			

Sample Name GSTC_081016_1105 **Matrix Type:** Water

Lab Sample Name: 680-128719-9 **Sample Date:** 8/10/2016 11:05:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Aluminum	T	7429-90-5	43000	200	24	ug/L			
Aluminum, Dissolved	D	7429-90-5	2800	200	24	ug/L			
Calcium	T	7440-70-2	610000	5000	250	ug/L			
Calcium, Dissolved	D	7440-70-2	540000	500	25	ug/L			
Iron	T	7439-89-6	150000	50	17	ug/L			
Iron, Dissolved	D	7439-89-6	4700	50	17	ug/L			
Magnesium	T	7439-95-4	28000	5000	330	ug/L			

Analysis Method 200.7 Metals (ICP)

Magnesium, Dissolved	D	7439-95-4	18000	500	33	ug/L		
Potassium	T	7440-09-7	2700	1000	17	ug/L		
Potassium, Dissolved	D	7440-09-7	2700	1000	17	ug/L		
Sodium	T	7440-23-5	880	1000	480	ug/L	J	J
Sodium, Dissolved	D	7440-23-5	4800	1000	480	ug/L		

Analysis Method 200.8 Metals (ICP/MS)

Sample Name GSTO_081016_1118 **Matrix Type:** Water

Lab Sample Name: 680-128719-10 **Sample Date:** 8/10/2016 11:18:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Antimony	T	7440-36-0	0.4	1	0.4	ug/L	J	J	
Antimony, Dissolved	D	7440-36-0	0.55	1	0.4	ug/L	J	J	
Arsenic	T	7440-38-2	0.37	1	0.37	ug/L	U	U	
Arsenic, Dissolved	D	7440-38-2	0.37	1	0.37	ug/L	U	U	
Barium	T	7440-39-3	7.3	2	0.14	ug/L			
Barium, Dissolved	D	7440-39-3	7.4	2	0.14	ug/L			
Beryllium	T	7440-41-7	0.15	0.4	0.15	ug/L	U	U	
Beryllium, Dissolved	D	7440-41-7	0.15	0.4	0.15	ug/L	U	U	
Cadmium	T	7440-43-9	3.3	0.5	0.043	ug/L			
Cadmium, Dissolved	D	7440-43-9	2.7	0.5	0.043	ug/L			
Chromium	T	7440-47-3	1	2	1	ug/L	U	U	
Chromium, Dissolved	D	7440-47-3	1	2	1	ug/L	U	U	
Cobalt	T	7440-48-4	4.3	0.4	0.12	ug/L			
Cobalt, Dissolved	D	7440-48-4	3.8	0.4	0.12	ug/L			
Copper	T	7440-50-8	50	5	0.5	ug/L			
Copper, Dissolved	D	7440-50-8	1.7	5	0.5	ug/L	J	J	
Lead	T	7439-92-1	0.43	0.3	0.06	ug/L			
Lead, Dissolved	D	7439-92-1	0.078	0.3	0.06	ug/L	J	J	
Manganese	T	7439-96-5	7900	25	12	ug/L			
Manganese, Dissolved	D	7439-96-5	7900	25	12	ug/L			
Molybdenum	T	7439-98-7	2.5	1	0.45	ug/L			
Molybdenum, Dissolved	D	7439-98-7	2.4	1	0.45	ug/L			
Nickel	T	7440-02-0	6.4	5	0.4	ug/L			
Nickel, Dissolved	D	7440-02-0	6.4	5	0.4	ug/L			
Selenium	T	7782-49-2	0.58	2	0.58	ug/L	U	U	
Selenium, Dissolved	D	7782-49-2	0.58	2	0.58	ug/L	U	U	
Silver	T	7440-22-4	0.1	1	0.1	ug/L	U	U	
Silver, Dissolved	D	7440-22-4	0.1	1	0.1	ug/L	U	U	
Thallium	T	7440-28-0	0.27	0.2	0.1	ug/L			

Analysis Method 200.8 Metals (ICP/MS)

Thallium, Dissolved	D	7440-28-0	0.27	0.2	0.1	ug/L		
Vanadium	T	7440-62-2	0.51	1	0.3	ug/L	J	J
Vanadium, Dissolved	D	7440-62-2	0.33	1	0.3	ug/L	J	J
Zinc	T	7440-66-6	240	20	2.8	ug/L		
Zinc, Dissolved	D	7440-66-6	61	20	2.8	ug/L		

Sample Name CC18_081016_1023 **Matrix Type:** Water

Lab Sample Name: 680-128719-4 **Sample Date:** 8/10/2016 10:23:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Antimony	T	7440-36-0	0.4	1	0.4	ug/L	U	U	
Antimony, Dissolved	D	7440-36-0	0.4	1	0.4	ug/L	U	U	
Arsenic	T	7440-38-2	0.37	1	0.37	ug/L	U	U	
Arsenic, Dissolved	D	7440-38-2	0.37	1	0.37	ug/L	U	U	
Barium	T	7440-39-3	20	2	0.14	ug/L			
Barium, Dissolved	D	7440-39-3	21	2	0.14	ug/L			
Beryllium	T	7440-41-7	1.8	0.4	0.15	ug/L			
Beryllium, Dissolved	D	7440-41-7	1.9	0.4	0.15	ug/L			
Cadmium	T	7440-43-9	12	0.5	0.043	ug/L			
Cadmium, Dissolved	D	7440-43-9	13	0.5	0.043	ug/L			
Chromium	T	7440-47-3	1	2	1	ug/L	U	U	
Chromium, Dissolved	D	7440-47-3	1	2	1	ug/L	U	U	
Cobalt	T	7440-48-4	31	0.4	0.12	ug/L			
Cobalt, Dissolved	D	7440-48-4	31	0.4	0.12	ug/L			
Copper	T	7440-50-8	100	5	0.5	ug/L			
Copper, Dissolved	D	7440-50-8	100	5	0.5	ug/L			
Lead	T	7439-92-1	19	0.3	0.06	ug/L			
Lead, Dissolved	D	7439-92-1	18	0.3	0.06	ug/L			
Manganese	T	7439-96-5	11000	25	12	ug/L			
Manganese, Dissolved	D	7439-96-5	11000	25	12	ug/L			
Molybdenum	T	7439-98-7	0.45	1	0.45	ug/L	U	U	
Molybdenum, Dissolved	D	7439-98-7	0.45	1	0.45	ug/L	U	U	
Nickel	T	7440-02-0	19	5	0.4	ug/L			
Nickel, Dissolved	D	7440-02-0	20	5	0.4	ug/L			
Selenium	T	7782-49-2	0.58	2	0.58	ug/L	U ^	U	
Selenium, Dissolved	D	7782-49-2	0.58	2	0.58	ug/L	U ^	U	
Silver	T	7440-22-4	0.1	1	0.1	ug/L	U	U	
Silver, Dissolved	D	7440-22-4	0.1	1	0.1	ug/L	U	U	
Thallium	T	7440-28-0	0.1	0.2	0.1	ug/L	U	U	
Thallium, Dissolved	D	7440-28-0	0.1	0.2	0.1	ug/L	U	U	
Vanadium	T	7440-62-2	0.43	1	0.3	ug/L	J	J	

Analysis Method 200.8 Metals (ICP/MS)

Vanadium, Dissolved	D	7440-62-2	0.3	1	0.3	ug/L	U	U
Zinc	T	7440-66-6	5200	200	28	ug/L		
Zinc, Dissolved	D	7440-66-6	5300	200	28	ug/L		

Sample Name CC03D_081016_0958 **Matrix Type:** Water

Lab Sample Name: 680-128719-5 **Sample Date:** 8/10/2016 9:58:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Antimony	T	7440-36-0	0.4	1	0.4	ug/L	U	U	
Antimony, Dissolved	D	7440-36-0	0.4	1	0.4	ug/L	U	U	
Arsenic	T	7440-38-2	1.8	1	0.37	ug/L			
Arsenic, Dissolved	D	7440-38-2	1.2	1	0.37	ug/L			
Barium	T	7440-39-3	13	2	0.14	ug/L			
Barium, Dissolved	D	7440-39-3	13	2	0.14	ug/L			
Beryllium	T	7440-41-7	6.5	0.4	0.15	ug/L			
Beryllium, Dissolved	D	7440-41-7	5	0.4	0.15	ug/L			
Cadmium	T	7440-43-9	25	0.5	0.043	ug/L			
Cadmium, Dissolved	D	7440-43-9	24	0.5	0.043	ug/L			
Chromium	T	7440-47-3	1	2	1	ug/L	U	U	
Chromium, Dissolved	D	7440-47-3	1	2	1	ug/L	U	U	
Cobalt	T	7440-48-4	100	0.4	0.12	ug/L			
Cobalt, Dissolved	D	7440-48-4	100	0.4	0.12	ug/L			
Copper	T	7440-50-8	7.7	5	0.5	ug/L			
Copper, Dissolved	D	7440-50-8	3.6	5	0.5	ug/L	J	J	
Lead	T	7439-92-1	69	0.3	0.06	ug/L			
Lead, Dissolved	D	7439-92-1	7.2	0.3	0.06	ug/L			
Manganese	T	7439-96-5	32000	50	24	ug/L			
Manganese, Dissolved	D	7439-96-5	31000	50	24	ug/L			
Molybdenum	T	7439-98-7	0.47	1	0.45	ug/L	J	J	
Molybdenum, Dissolved	D	7439-98-7	0.47	1	0.45	ug/L	J	J	
Nickel	T	7440-02-0	53	5	0.4	ug/L			
Nickel, Dissolved	D	7440-02-0	52	5	0.4	ug/L			
Selenium	T	7782-49-2	0.58	2	0.58	ug/L	U	U	
Selenium, Dissolved	D	7782-49-2	0.58	2	0.58	ug/L	U	U	
Silver	T	7440-22-4	0.1	1	0.1	ug/L	U	U	
Silver, Dissolved	D	7440-22-4	0.1	1	0.1	ug/L	U	U	
Thallium	T	7440-28-0	0.11	0.2	0.1	ug/L	J	J	
Thallium, Dissolved	D	7440-28-0	0.11	0.2	0.1	ug/L	J	J	
Vanadium	T	7440-62-2	0.8	1	0.3	ug/L	J	J	
Vanadium, Dissolved	D	7440-62-2	0.31	1	0.3	ug/L	J	J	
Zinc	T	7440-66-6	13000	400	56	ug/L			

Analysis Method 200.8 Metals (ICP/MS)

Zinc, Dissolved	D		7440-66-6	13000	400	56	ug/L			

Sample Name GSTI_081016_1013 **Matrix Type:** Water

Lab Sample Name: 680-128719-6 **Sample Date:** 8/10/2016 10:13:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Antimony	T	7440-36-0	9.9	20	8	ug/L	J	J	
Antimony, Dissolved	D	7440-36-0	0.76	1	0.4	ug/L	J	J	
Arsenic	T	7440-38-2	130	1	0.37	ug/L			
Arsenic, Dissolved	D	7440-38-2	6.5	1	0.37	ug/L			
Barium	T	7440-39-3	21	40	2.8	ug/L	J	J	
Barium, Dissolved	D	7440-39-3	8.6	2	0.14	ug/L			
Beryllium	T	7440-41-7	9.5	0.4	0.15	ug/L			
Beryllium, Dissolved	D	7440-41-7	9.1	0.4	0.15	ug/L			
Cadmium	T	7440-43-9	93	10	0.86	ug/L			
Cadmium, Dissolved	D	7440-43-9	80	0.5	0.043	ug/L			
Chromium	T	7440-47-3	12	2	1	ug/L			
Chromium, Dissolved	D	7440-47-3	3.8	2	1	ug/L			
Cobalt	T	7440-48-4	96	0.4	0.12	ug/L			
Cobalt, Dissolved	D	7440-48-4	97	0.4	0.12	ug/L			
Copper	T	7440-50-8	11000	100	10	ug/L			
Copper, Dissolved	D	7440-50-8	9300	100	10	ug/L			
Lead	T	7439-92-1	100	6	1.2	ug/L			
Lead, Dissolved	D	7439-92-1	33	0.3	0.06	ug/L			
Manganese	T	7439-96-5	26000	50	24	ug/L			
Manganese, Dissolved	D	7439-96-5	26000	50	24	ug/L			
Molybdenum	T	7439-98-7	15	20	9	ug/L	J	J	
Molybdenum, Dissolved	D	7439-98-7	9	20	9	ug/L	U	U	
Nickel	T	7440-02-0	59	5	0.4	ug/L			
Nickel, Dissolved	D	7440-02-0	60	5	0.4	ug/L			
Selenium	T	7782-49-2	3.3	2	0.58	ug/L	B ^	J+	B
Selenium, Dissolved	D	7782-49-2	1.5	2	0.58	ug/L	J B ^	UB	B
Silver	T	7440-22-4	2	20	2	ug/L	U	U	
Silver, Dissolved	D	7440-22-4	0.1	1	0.1	ug/L	U	U	
Thallium	T	7440-28-0	2	4	2	ug/L	U	U	
Thallium, Dissolved	D	7440-28-0	0.36	0.2	0.1	ug/L			
Vanadium	T	7440-62-2	76	1	0.3	ug/L			
Vanadium, Dissolv	D	7440-62-2	2.9	1	0.3	ug/L			
Zinc	T	7440-66-6	25000	400	56	ug/L			
Zinc, Dissolved	D	7440-66-6	25000	400	56	ug/L			

Analysis Method 200.8 Metals (ICP/MS)

Sample Name GSTI_DUP_081016_1013 **Matrix Type:** Water

Lab Sample Name: 680-128719-7 **Sample Date:** 8/10/2016 10:13:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Antimony	T	7440-36-0	9.8	20	8	ug/L	J	J	
Antimony, Dissolved	D	7440-36-0	0.7	1	0.4	ug/L	J	J	
Arsenic	T	7440-38-2	120	1	0.37	ug/L			
Arsenic, Dissolved	D	7440-38-2	6.4	1	0.37	ug/L			
Barium	T	7440-39-3	19	40	2.8	ug/L	J	J	
Barium, Dissolved	D	7440-39-3	8.8	2	0.14	ug/L			
Beryllium	T	7440-41-7	9.3	0.4	0.15	ug/L			
Beryllium, Dissolved	D	7440-41-7	9	0.4	0.15	ug/L			
Cadmium	T	7440-43-9	94	10	0.86	ug/L			
Cadmium, Dissolved	D	7440-43-9	80	0.5	0.043	ug/L			
Chromium	T	7440-47-3	12	2	1	ug/L			
Chromium, Dissolved	D	7440-47-3	3.8	2	1	ug/L			
Cobalt	T	7440-48-4	94	0.4	0.12	ug/L			
Cobalt, Dissolved	D	7440-48-4	95	0.4	0.12	ug/L			
Copper	T	7440-50-8	10000	100	10	ug/L			
Copper, Dissolved	D	7440-50-8	9100	100	10	ug/L			
Lead	T	7439-92-1	94	6	1.2	ug/L			
Lead, Dissolved	D	7439-92-1	33	0.3	0.06	ug/L			
Manganese	T	7439-96-5	26000	50	24	ug/L			
Manganese, Dissolved	D	7439-96-5	26000	50	24	ug/L			
Molybdenum	T	7439-98-7	15	20	9	ug/L	J	J	
Molybdenum, Dissolved	D	7439-98-7	9	20	9	ug/L	U	U	
Nickel	T	7440-02-0	58	5	0.4	ug/L			
Nickel, Dissolved	D	7440-02-0	58	5	0.4	ug/L			
Selenium	T	7782-49-2	3.3	2	0.58	ug/L	B ^	J+	B
Selenium, Dissolved	D	7782-49-2	1.3	2	0.58	ug/L	J B ^	UB	B
Silver	T	7440-22-4	2	20	2	ug/L	U	U	
Silver, Dissolved	D	7440-22-4	0.1	1	0.1	ug/L	U	U	
Thallium	T	7440-28-0	2	4	2	ug/L	U	U	
Thallium, Dissolved	D	7440-28-0	0.35	0.2	0.1	ug/L			
Vanadium	T	7440-62-2	73	1	0.3	ug/L			
Vanadium, Dissolved	D	7440-62-2	2.9	1	0.3	ug/L			
Zinc	T	7440-66-6	25000	400	56	ug/L			
Zinc, Dissolved	D	7440-66-6	25000	400	56	ug/L			

Analysis Method 200.8 Metals (ICP/MS)

Sample Name GSTPO_081016_1056 **Matrix Type:** Water

Lab Sample Name: 680-128719-8 **Sample Date:** 8/10/2016 10:56:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Antimony	T	7440-36-0	3.8	1	0.4	ug/L			
Antimony, Dissolved	D	7440-36-0	2	1	0.4	ug/L			
Arsenic	T	7440-38-2	52	1	0.37	ug/L			
Arsenic, Dissolved	D	7440-38-2	24	1	0.37	ug/L			
Barium	T	7440-39-3	13	2	0.14	ug/L			
Barium, Dissolved	D	7440-39-3	10	2	0.14	ug/L			
Beryllium	T	7440-41-7	9	0.4	0.15	ug/L			
Beryllium, Dissolved	D	7440-41-7	9.3	0.4	0.15	ug/L			
Cadmium	T	7440-43-9	77	0.5	0.043	ug/L			
Cadmium, Dissolved	D	7440-43-9	80	0.5	0.043	ug/L			
Chromium	T	7440-47-3	6.4	2	1	ug/L			
Chromium, Dissolved	D	7440-47-3	4.9	2	1	ug/L			
Cobalt	T	7440-48-4	96	0.4	0.12	ug/L			
Cobalt, Dissolved	D	7440-48-4	99	0.4	0.12	ug/L			
Copper	T	7440-50-8	8700	100	10	ug/L			
Copper, Dissolved	D	7440-50-8	8900	100	10	ug/L			
Lead	T	7439-92-1	55	0.3	0.06	ug/L			
Lead, Dissolved	D	7439-92-1	38	0.3	0.06	ug/L			
Manganese	T	7439-96-5	26000	50	24	ug/L			
Manganese, Dissolved	D	7439-96-5	27000	50	24	ug/L			
Molybdenum	T	7439-98-7	9	20	9	ug/L	U	U	
Molybdenum, Dissolved	D	7439-98-7	9	20	9	ug/L	U	U	
Nickel	T	7440-02-0	59	5	0.4	ug/L			
Nickel, Dissolved	D	7440-02-0	60	5	0.4	ug/L			
Selenium	T	7782-49-2	2.1	2	0.58	ug/L	B	J+	B
Selenium, Dissolved	D	7782-49-2	1.6	2	0.58	ug/L	J B	UB	B
Silver	T	7440-22-4	0.16	1	0.1	ug/L	J	J	
Silver, Dissolved	D	7440-22-4	0.1	1	0.1	ug/L	U	U	
Thallium	T	7440-28-0	0.31	0.2	0.1	ug/L			
Thallium, Dissolved	D	7440-28-0	0.34	0.2	0.1	ug/L			
Vanadium	T	7440-62-2	31	1	0.3	ug/L			
Vanadium, Dissolved	D	7440-62-2	14	1	0.3	ug/L			
Zinc	T	7440-66-6	25000	400	56	ug/L			
Zinc, Dissolved	D	7440-66-6	26000	400	56	ug/L			

Analysis Method 200.8 Metals (ICP/MS)

Sample Name GSTC_081016_1105 **Matrix Type:** Water

Lab Sample Name: 680-128719-9 **Sample Date:** 8/10/2016 11:05:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Antimony	T	7440-36-0	5.3	1	0.4	ug/L			
Antimony, Dissolved	D	7440-36-0	0.83	1	0.4	ug/L	J	J	
Arsenic	T	7440-38-2	79	1	0.37	ug/L			
Arsenic, Dissolved	D	7440-38-2	2	1	0.37	ug/L			
Barium	T	7440-39-3	12	2	0.14	ug/L			
Barium, Dissolved	D	7440-39-3	7.2	2	0.14	ug/L			
Beryllium	T	7440-41-7	11	0.4	0.15	ug/L			
Beryllium, Dissolved	D	7440-41-7	0.36	0.4	0.15	ug/L	J	J	
Cadmium	T	7440-43-9	88	0.5	0.043	ug/L			
Cadmium, Dissolved	D	7440-43-9	4.3	0.5	0.043	ug/L			
Chromium	T	7440-47-3	11	2	1	ug/L			
Chromium, Dissolved	D	7440-47-3	1	2	1	ug/L	U	U	
Cobalt	T	7440-48-4	120	0.4	0.12	ug/L			
Cobalt, Dissolved	D	7440-48-4	5.3	0.4	0.12	ug/L			
Copper	T	7440-50-8	10000	50	5	ug/L			
Copper, Dissolved	D	7440-50-8	310	5	0.5	ug/L			
Lead	T	7439-92-1	67	3	0.6	ug/L			
Lead, Dissolved	D	7439-92-1	2.1	0.3	0.06	ug/L			
Manganese	T	7439-96-5	30000	25	12	ug/L			
Manganese, Dissolved	D	7439-96-5	5200	25	12	ug/L			
Molybdenum	T	7439-98-7	7.3	10	4.5	ug/L	J	J	
Molybdenum, Dissolved	D	7439-98-7	2.7	1	0.45	ug/L			
Nickel	T	7440-02-0	76	5	0.4	ug/L			
Nickel, Dissolved	D	7440-02-0	6.7	5	0.4	ug/L			
Selenium	T	7782-49-2	2.8	2	0.58	ug/L	B	J+	B
Selenium, Dissolved	D	7782-49-2	0.58	2	0.58	ug/L	U	U	
Silver	T	7440-22-4	0.15	1	0.1	ug/L	J	J	
Silver, Dissolved	D	7440-22-4	0.1	1	0.1	ug/L	U	U	
Thallium	T	7440-28-0	1	2	1	ug/L	U	U	
Thallium, Dissolved	D	7440-28-0	0.26	0.2	0.1	ug/L			
Vanadium	T	7440-62-2	58	1	0.3	ug/L			
Vanadium, Dissolved	D	7440-62-2	1.9	1	0.3	ug/L			
Zinc	T	7440-66-6	30000	200	28	ug/L			
Zinc, Dissolved	D	7440-66-6	930	20	2.8	ug/L			

Analysis Method 245.1 Mercury (CVAA)

Sample Name GSTO_081016_1118 **Matrix Type:** Water

Lab Sample Name: 680-128719-10 **Sample Date:** 8/10/2016 11:18:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Mercury	T	7439-97-6	0.08	0.2	0.08	ug/L	U	U	
Mercury, Dissolved	D	7439-97-6	0.08	0.2	0.08	ug/L	U	U	

Sample Name CC18_081016_1023 **Matrix Type:** Water

Lab Sample Name: 680-128719-4 **Sample Date:** 8/10/2016 10:23:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Mercury	T	7439-97-6	0.08	0.2	0.08	ug/L	U	U	
Mercury, Dissolved	D	7439-97-6	0.08	0.2	0.08	ug/L	U	U	

Sample Name CC03D_081016_0958 **Matrix Type:** Water

Lab Sample Name: 680-128719-5 **Sample Date:** 8/10/2016 9:58:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Mercury	T	7439-97-6	0.08	0.2	0.08	ug/L	U	U	
Mercury, Dissolved	D	7439-97-6	0.08	0.2	0.08	ug/L	U	U	

Sample Name GSTI_081016_1013 **Matrix Type:** Water

Lab Sample Name: 680-128719-6 **Sample Date:** 8/10/2016 10:13:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Mercury	T	7439-97-6	0.08	0.2	0.08	ug/L	U	U	
Mercury, Dissolved	D	7439-97-6	0.08	0.2	0.08	ug/L	U	U	

Sample Name GSTI_DUP_081016_1013 **Matrix Type:** Water

Lab Sample Name: 680-128719-7 **Sample Date:** 8/10/2016 10:13:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Mercury	T	7439-97-6	0.08	0.2	0.08	ug/L	U	U	
Mercury, Dissolved	D	7439-97-6	0.08	0.2	0.08	ug/L	U	U	

Sample Name GSTPO_081016_1056 **Matrix Type:** Water

Lab Sample Name: 680-128719-8 **Sample Date:** 8/10/2016 10:56:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Mercury	T	7439-97-6	0.08	0.2	0.08	ug/L	U	U	
Mercury, Dissolved	D	7439-97-6	0.08	0.2	0.08	ug/L	U	U	

Analysis Method 245.1 Mercury (CVAA)

Sample Name GSTC_081016_1105 **Matrix Type:** Water

Lab Sample Name: 680-128719-9 **Sample Date:** 8/10/2016 11:05:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Mercury	T	7439-97-6	0.08	0.2	0.08	ug/L	U	U	
Mercury, Dissolved	D	7439-97-6	0.08	0.2	0.08	ug/L	U	U	

Analysis Method 2540D Total Suspended Solids

Sample Name GSTO_081016_1118 **Matrix Type:** Water

Lab Sample Name: 680-128719-10 **Sample Date:** 8/10/2016 11:18:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Total Suspended Solids	T	STL00161	6.8	4	4	mg/L			

Sample Name CC18_081016_1023 **Matrix Type:** Water

Lab Sample Name: 680-128719-4 **Sample Date:** 8/10/2016 10:23:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Total Suspended Solids	T	STL00161	26	4	4	mg/L			

Sample Name CC03D_081016_0958 **Matrix Type:** Water

Lab Sample Name: 680-128719-5 **Sample Date:** 8/10/2016 9:58:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Total Suspended Solids	T	STL00161	90	10	10	mg/L			

Sample Name GSTI_081016_1013 **Matrix Type:** Water

Lab Sample Name: 680-128719-6 **Sample Date:** 8/10/2016 10:13:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Total Suspended Solids	T	STL00161	460	33	33	mg/L			

Sample Name GSTI_DUP_081016_1013 **Matrix Type:** Water

Lab Sample Name: 680-128719-7 **Sample Date:** 8/10/2016 10:13:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Total Suspended Solids	T	STL00161	430	25	25	mg/L			

Analysis Method 2540D Total Suspended Solids

Sample Name GSTPO_081016_1056 **Matrix Type:** Water

Lab Sample Name: 680-128719-8 **Sample Date:** 8/10/2016 10:56:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Total Suspended Solids	T	STL00161	250	17	17	mg/L			

Sample Name GSTC_081016_1105 **Matrix Type:** Water

Lab Sample Name: 680-128719-9 **Sample Date:** 8/10/2016 11:05:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Total Suspended Solids	T	STL00161	830	50	50	mg/L			

Analysis Method 6020A Metals (ICP/MS)

Sample Name OXY_WD_080916 **Matrix Type:** Solid

Lab Sample Name: 680-128719-1 **Sample Date:** 8/9/2016 11:00:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Antimony	T	7440-36-0	7.3	0.9	0.09	mg/Kg	F1 F2	J+	Q,Q1
Arsenic	T	7440-38-2	8.6	0.27	0.09	mg/Kg			
Barium	T	7440-39-3	27	0.45	0.054	mg/Kg	F1	J+	Q
Beryllium	T	7440-41-7	0.12	0.045	0.013	mg/Kg			
Cadmium	T	7440-43-9	10	0.045	0.013	mg/Kg	F1	J+	Q
Chromium	T	7440-47-3	2.1	0.9	0.099	mg/Kg	B		
Cobalt	T	7440-48-4	0.6	0.045	0.009	mg/Kg			
Copper	T	7440-50-8	130	0.45	0.12	mg/Kg	B F2		
Lead	T	7439-92-1	4200	18	4.5	mg/Kg	F2		
Manganese	T	7439-96-5	670	0.9	0.11	mg/Kg	B F2		
Molybdenum	T	7439-98-7	15	0.9	0.072	mg/Kg	F1	J+	Q
Nickel	T	7440-02-0	0.86	0.9	0.23	mg/Kg	J	J	
Selenium	T	7782-49-2	6.7	0.45	0.09	mg/Kg			
Silver	T	7440-22-4	20	0.09	0.009	mg/Kg	F2		
Thallium	T	7440-28-0	0.45	0.09	0.045	mg/Kg			
Vanadium	T	7440-62-2	15	0.45	0.24	mg/Kg	F1	J+	Q
Zinc	T	7440-66-6	2100	180	90	mg/Kg	F2		

Sample Name GST_SLUDGE_DUP_080916 **Matrix Type:** Solid

Lab Sample Name: 680-128719-11 **Sample Date:** 8/9/2016 1:30:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Antimony	T	7440-36-0	4.2	8	0.8	mg/Kg	J	J	
Arsenic	T	7440-38-2	150	2.4	0.8	mg/Kg			

Analysis Method 6020A Metals (ICP/MS)

Barium	T	7440-39-3	36	4	0.48	mg/Kg			
Beryllium	T	7440-41-7	10	0.4	0.12	mg/Kg			
Cadmium	T	7440-43-9	120	0.4	0.12	mg/Kg			
Chromium	T	7440-47-3	19	8	0.88	mg/Kg	B		
Cobalt	T	7440-48-4	130	0.4	0.08	mg/Kg			
Copper	T	7440-50-8	9300	4	1	mg/Kg	B		
Gold	T	7440-57-5	4.5	45	4.5	mg/Kg	U	U	
Lead	T	7439-92-1	200	1.6	0.4	mg/Kg		J	F1
Manganese	T	7439-96-5	18000	160	19	mg/Kg	B		
Molybdenum	T	7439-98-7	9.1	8	0.64	mg/Kg			
Nickel	T	7440-02-0	86	8	2.1	mg/Kg			
Selenium	T	7782-49-2	28	4	0.8	mg/Kg			
Silver	T	7440-22-4	1.1	0.8	0.08	mg/Kg			
Thallium	T	7440-28-0	0.4	0.8	0.4	mg/Kg	U	U	
Vanadium	T	7440-62-2	68	4	2.2	mg/Kg			
Zinc	T	7440-66-6	36000	320	160	mg/Kg			

Sample Name BH_WD_081916 **Matrix** Type: Solid

Lab Sample Name: 680-128719-2 **Sample Date**: 8/9/2016 11:20:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Antimony	T	7440-36-0	7.1	0.95	0.095	mg/Kg		J+	Q,Q1
Arsenic	T	7440-38-2	68	0.28	0.095	mg/Kg			
Barium	T	7440-39-3	85	0.47	0.057	mg/Kg		J+	Q
Beryllium	T	7440-41-7	2.3	0.047	0.014	mg/Kg			
Cadmium	T	7440-43-9	10	0.047	0.014	mg/Kg		J+	Q
Chromium	T	7440-47-3	13	0.95	0.1	mg/Kg	B		
Cobalt	T	7440-48-4	5.1	0.047	0.0095	mg/Kg			
Copper	T	7440-50-8	200	0.47	0.12	mg/Kg	B		
Lead	T	7439-92-1	1900	3.8	0.95	mg/Kg			
Manganese	T	7439-96-5	2100	19	2.3	mg/Kg	B		
Molybdenum	T	7439-98-7	33	0.95	0.076	mg/Kg		J+	Q
Nickel	T	7440-02-0	3.6	0.95	0.25	mg/Kg			
Selenium	T	7782-49-2	3.8	0.47	0.095	mg/Kg			
Silver	T	7440-22-4	7.8	0.095	0.0095	mg/Kg			
Thallium	T	7440-28-0	1	0.095	0.047	mg/Kg			
Vanadium	T	7440-62-2	59	0.47	0.26	mg/Kg		J+	Q
Zinc	T	7440-66-6	2600	38	19	mg/Kg			

Sample Name GST_SLUDGE_080916 **Matrix Type:** Solid

Lab Sample Name: 680-128719-3 **Sample Date:** 8/9/2016 1:30:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes

Analysis Method 6020A Metals (ICP/MS)

Antimony	T	7440-36-0	3.8	7.5	0.75	mg/Kg	J	J	
Arsenic	T	7440-38-2	140	2.2	0.75	mg/Kg			
Barium	T	7440-39-3	22	3.7	0.45	mg/Kg			
Beryllium	T	7440-41-7	9.5	0.37	0.11	mg/Kg			
Cadmium	T	7440-43-9	120	0.37	0.11	mg/Kg			
Chromium	T	7440-47-3	18	7.5	0.82	mg/Kg	B		
Cobalt	T	7440-48-4	120	0.37	0.075	mg/Kg			
Copper	T	7440-50-8	9100	3.7	0.97	mg/Kg	B		
Gold	T	7440-57-5	3.7	37	3.7	mg/Kg	U	U	
Lead	T	7439-92-1	110	1.5	0.37	mg/Kg		J	F1
Manganese	T	7439-96-5	17000	150	18	mg/Kg	B		
Molybdenum	T	7439-98-7	8.5	7.5	0.6	mg/Kg			
Nickel	T	7440-02-0	83	7.5	1.9	mg/Kg			
Selenium	T	7782-49-2	26	3.7	0.75	mg/Kg			
Silver	T	7440-22-4	0.48	0.75	0.075	mg/Kg	J	J	
Thallium	T	7440-28-0	0.37	0.75	0.37	mg/Kg	U	U	
Vanadium	T	7440-62-2	66	3.7	2	mg/Kg			
Zinc	T	7440-66-6	35000	300	150	mg/Kg			

Analysis Method 6020A Metals (ICP/MS)-TCLP

Sample Name GST_SLUDGE_DUP_080916 **Matrix Type:** Solid

Lab Sample Name: 680-128719-11 **Sample Date:** 8/9/2016 1:30:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Antimony	T	7440-36-0	0.05	0.05	0.05	mg/L	U	U	
Arsenic	T	7440-38-2	0.03	0.03	0.03	mg/L	U	U	
Barium	T	7440-39-3	0.05	0.05	0.05	mg/L	U	UJ	F1
Beryllium	T	7440-41-7	0.005	0.005	0.005	mg/L	U	U	
Cadmium	T	7440-43-9	0.29	0.005	0.005	mg/L			
Chromium	T	7440-47-3	0.05	0.05	0.05	mg/L	U	U	
Cobalt	T	7440-48-4	0.42	0.005	0.005	mg/L			
Copper	T	7440-50-8	1.3	0.05	0.05	mg/L			
Lead	T	7439-92-1	0.025	0.025	0.025	mg/L	U	U	
Manganese	T	7439-96-5	77	0.05	0.05	mg/L			
Mercury	T	7439-97-6	0.02	0.02	0.02	mg/L	U	U	
Molybdenum	T	7439-98-7	0.05	0.05	0.05	mg/L	U	U	
Nickel	T	7440-02-0	0.17	0.05	0.05	mg/L			
Selenium	T	7782-49-2	0.025	0.025	0.025	mg/L	U	U	
Silver	T	7440-22-4	0.01	0.01	0.01	mg/L	U	U	
Thallium	T	7440-28-0	0.01	0.01	0.01	mg/L	U	UJ	F1
Vanadium	T	7440-62-2	0.1	0.1	0.1	mg/L	U	U	
Zinc	T	7440-66-6	68	20	20	mg/L			

Analysis Method 6020A Metals (ICP/MS)-TCLP

Sample Name GST_SLUDGE_080916 **Matrix Type:** Solid

Lab Sample Name: 680-128719-3 **Sample Date:** 8/9/2016 1:30:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Antimony	T	7440-36-0	0.05	0.05	0.05	mg/L	U	U	
Arsenic	T	7440-38-2	0.03	0.03	0.03	mg/L	U	U	
Barium	T	7440-39-3	0.054	0.05	0.05	mg/L		J	F1
Beryllium	T	7440-41-7	0.005	0.005	0.005	mg/L	U	U	
Cadmium	T	7440-43-9	0.3	0.005	0.005	mg/L			
Chromium	T	7440-47-3	0.05	0.05	0.05	mg/L	U	U	
Cobalt	T	7440-48-4	0.41	0.005	0.005	mg/L			
Copper	T	7440-50-8	1.5	0.05	0.05	mg/L			
Lead	T	7439-92-1	0.025	0.025	0.025	mg/L	U	U	
Manganese	T	7439-96-5	75	0.05	0.05	mg/L			
Mercury	T	7439-97-6	0.02	0.02	0.02	mg/L	U	U	
Molybdenum	T	7439-98-7	0.05	0.05	0.05	mg/L	U	U	
Nickel	T	7440-02-0	0.17	0.05	0.05	mg/L			
Selenium	T	7782-49-2	0.025	0.025	0.025	mg/L	U	U	
Silver	T	7440-22-4	0.01	0.01	0.01	mg/L	U	U	
Thallium	T	7440-28-0	0.011	0.01	0.01	mg/L		J	F1
Vanadium	T	7440-62-2	0.1	0.1	0.1	mg/L	U	U	
Zinc	T	7440-66-6	71	20	20	mg/L			

Analysis Method 7471A Mercury (CVAA)

Sample Name OXY_WD_080916 **Matrix Type:** Solid

Lab Sample Name: 680-128719-1 **Sample Date:** 8/9/2016 11:00:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Mercury	T	7439-97-6	0.16	0.019	0.0076	mg/Kg	F1	J+	Q

Sample Name GST_SLUDGE_DUP_080916 **Matrix Type:** Solid

Lab Sample Name: 680-128719-11 **Sample Date:** 8/9/2016 1:30:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Mercury	T	7439-97-6	0.074	0.18	0.071	mg/Kg	J	J	

Sample Name BH_WD_081916 **Matrix Type:** Solid

Lab Sample Name: 680-128719-2 **Sample Date:** 8/9/2016 11:20:00 AM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Mercury	T	7439-97-6	0.0087	0.022	0.0087	mg/Kg	U	U	

Analysis Method 7471A Mercury (CVAA)

Sample Name GST_SLUDGE_080916 **Matrix Type:** Solid

Lab Sample Name: 680-128719-3 **Sample Date:** 8/9/2016 1:30:00 PM

Analyte	Total/Dissolved	CAS No	Result Value	Reporting Limit	MDL	Result Units	Lab Qualifier	Validation Qualifier	Validation Notes
Mercury	T	7439-97-6	0.069	0.17	0.069	mg/Kg	U	U	

Appendix E

Cost

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The cost spreadsheets included in this appendix were developed in accordance with EPA 540-R-00-002 (OSWER 9355.0-75) July 2000.

These costs should be used to compare alternative relative costs. Costs for project management, removal action planning, and construction management were determined as percentages of capital cost per the guidance. Costs for these work items may not reflect costs for implementation. These costs are determined based on specific client requirements during implementation.

TABLE CS-ALT

ALTERNATIVE COST SUMMARY

Site: Gladstone Interim Water Treatment Plant
Bonita Peak Mining District Superfund Site
Location: San Juan County, Colorado
Phase: Engineering Evaluation / Cost Analysis
Year: 2016

Alternative		Total Capital Cost	Total PRSC Cost	Total Non-Discounted Cost	Present Value Cost
RA1	Continue Operation of Existing Gladstone IWTP to Treat Gold King Mine Adit MIW Discharge	$348,000	$8,529,000	$8,877,000	$7,326,000
RA2	Suspend Operation of Existing Gladstone IWTP to Treat Gold King Mine Adit MIW Discharge	$104,000	$35,000	$139,000	$126,000

PRSC - Post-Removal Site Control

Notes:

1 - Capital costs, annual costs, and periodic costs are presented on Tables CS-RA1 through CS-RA2
2 - Present value analysis for each remedial alternative are provided on Tables PV-RA1 through PV-RA2
3 - The non-discounted total cost demonstrates the impact of a discount rate on the total present value cost and the relative amount of future annual expenditures. Non-discounted costs are presented for comparison purposes only and should not be used in place of present value costs in the CERCLA remedy selection process.
4 - Costs presented are expected to have an accuracy between -30% to +50% of actual costs, based on the scope presented. They are prepared solely to facilitate relative comparisons between alternatives for EE/CA evaluation purposes.

Present Value and Cost Estimate Summary

Alternative RA1

TABLE PV-RA1

PRESENT VALUE ANALYSIS

Alternative RA1

Continue Operation of Existing Gladstone IWTP to Treat Gold King Mine Adit MIW Discharge

Site: Gladstone Interim Water Treatment Plant
Bonita Peak Mining District Superfund Site
Location: San Juan County, Colorado
Phase: Engineering Evaluation / Cost Analysis
Base Year: 2016

Year[1]	Capital Costs[2]	Annual PRSC Costs	Total Annual Expenditure[3]	Discount Factor (7.0%)	Present Value[4]
0	$0	$0	$0	1.0000	$0
1	$348,000	$1,753,000	$2,101,000	0.9346	$1,963,595
2	$0	$1,694,000	$1,694,000	0.8734	$1,479,540
3	$0	$1,694,000	$1,694,000	0.8163	$1,382,812
4	$0	$1,694,000	$1,694,000	0.7629	$1,292,353
5	$0	$1,694,000	$1,694,000	0.7130	$1,207,822
TOTALS:	$348,000	$8,529,000	$8,877,000		$7,326,122
TOTAL PRESENT VALUE OF ALTERNATIVE RA1 [5]					**$7,326,000**

Notes:

[1] Estimated removal timeframes (5 years from intiation of the NTCRA) are discussed within the EE/CA report. As a simplifying assumption, it is assumed that NTCRA initiation would occur in 2017 (Year 1).

[2] Capital costs, for purposes of this analysis, are assumed to be distributed as indicated on Table CS-RA1.

[3] Total annual expenditure is the total cost per year with no discounting.

[4] Present value is the total cost per year including a 7.0% discount factor for that year. See Table PV-ADRFT for details.

[5] Total present value is rounded to the nearest $1,000. Inflation and depreciation are excluded from the present value cost.

Costs presented for this alternative are expected to have an accuracy between -30% to +50% of actual costs, based on the scope presented.

The cost estimates are prepared solely to facilitate relative comparisons between alternatives for EE/CA evaluation purposes.

TABLE CS-RA1

Alternative **RA1**

Continue Operation of Existing Gladstone IWTP to Treat Gold King Mine Adit MIW Discharge

COST ESTIMATE SUMMARY

Site: Gladstone Interim Water Treatment Plant
Bonita Peak Mining District Superfund Site
Location: San Juan County, Colorado
Phase: Engineering Evaluation / Cost Analysis
Base Year: 2016
Date: November 2016

Description: Alternative RA1 entails utilizing the existing Gladstone IWTP and associated MIW collection and conveyance infrastructure (built or modified during the emergency removal action) to continue treatment of the MIW from the Gold King Mine adit. No further significant improvements or expansions to the Gladstone IWTP or to the Gold King Mine adit and MIW collection and conveyance system would be done. Under this alternative, treatment of Gold King Mine adit MIW and PRSC would continue, as has been ongoing since the Gladstone IWTP was brought online in October 2015. This alternative would produce treated effluent, which would be discharged to Cement Creek. Because space for sludge management is limited to 1 year of accumulation at the Gladstone IWTP, dried sludge would be transported to an additional interim sludge management area. For the purposes of the EE/CA cost estimate, it is assumed this annual sludge volume is hauled off every year to a location up to 12 miles away.

CAPITAL COSTS: (Assumed to be Incurred During Year 1)

DESCRIPTION	WORKSHEET	QTY	UNIT(S)	UNIT COST	TOTAL	NOTES
Interim Sludge Management Area Construction	CW1-7	1	LS	$218,046	$218,046	
SUBTOTAL					$218,046	
Contingency (Scope and Bid)		20%			$43,609	10% Scope, 10% Bid (Low end of the recommended range in EPA 540-R-00-002).
SUBTOTAL					$261,655	
Project Management		8%			$20,932	Percentage from Exhibit 5-8 in EPA 540-R-00-002 was used.
Removal Action Planning		15%			$39,248	Percentage from Exhibit 5-8 in EPA 540-R-00-002 was used, based on recommended percentages for Remedial Design
Construction Management		10%			$26,166	Percentage from Exhibit 5-8 in EPA 540-R-00-002 was used.
TOTAL					$348,001	
TOTAL CAPITAL COST					**$348,000**	Total capital cost is rounded to the nearest $1,000.

ANNUAL POST-REMOVAL SITE CONTROLS (PRSC) (Assumed to be Incurred During Year 1)

DESCRIPTION	WORKSHEET	QTY	UNIT(S)	UNIT COST	TOTAL	NOTES
Snow Removal	CW1-1	1	LS	$22,500	$22,500	
Equalization Pond Cleaning	CW1-2	1	LS	$40,000	$40,000	
Sludge Removal and Liner Replacement	CW1-3	1	LS	$250,000	$250,000	
Annual Operation of Interim Water Treatment Plant	CW1-4	1	YR	$924,000	$924,000	
Transport and Placement of Sludge at Interim Storage Location	CW1-5	12,000	LCY	$7	$88,657	
SUBTOTAL					$1,325,157	
Contingency (Scope and Bid)		15%			$198,774	5% Scope, 10% Bid (Low end of the recommended range in EPA 540-R-00-002).
SUBTOTAL					$1,523,931	
Project Management		5%			$76,197	Low end of the recommended range in EPA 540-R-00-002 was used.
Technical Support		10%			$152,393	Low end of the recommended range in EPA 540-R-00-002 was used.
TOTAL					$1,752,521	
TOTAL ANNUAL PRSC COST					**$1,753,000**	Total annual PRSC cost is rounded to the nearest $1,000.

TABLE CS-RA1

Alternative **RA1**
Continue Operation of Existing Gladstone IWTP to Treat Gold King Mine Adit MIW Discharge

COST ESTIMATE SUMMARY

Site: Gladstone Interim Water Treatment Plant
Bonita Peak Mining District Superfund Site
Location: San Juan County, Colorado
Phase: Engineering Evaluation / Cost Analysis
Base Year: 2016
Date: November 2016

Description: Alternative RA1 entails utilizing the existing Gladstone IWTP and associated MIW collection and conveyance infrastructure (built or modified during the emergency removal action) to continue treatment of the MIW from the Gold King Mine adit. No further significant improvements or expansions to the Gladstone IWTP or to the Gold King Mine adit and MIW collection and conveyance system would be done. Under this alternative, treatment of Gold King Mine adit MIW and PRSC would continue, as has been ongoing since the Gladstone IWTP was brought online in October 2015. This alternative would produce treated effluent, which would be discharged to Cement Creek. Because space for sludge management is limited to 1 year of accumulation at the Gladstone IWTP, dried sludge would be transported to an additional interim sludge management area. For the purposes of the EE/CA cost estimate, it is assumed this annual sludge volume is hauled off every year to a location up to 12 miles away.

ANNUAL POST-REMOVAL SITE CONTROLS (PRSC) (Assumed to be Incurred During Years 2 through 5)

DESCRIPTION	WORKSHEET	QTY	UNIT(S)	UNIT COST	TOTAL	NOTES
Snow Removal	CW1-1	1	LS	$22,500	$22,500	
Equalization Pond Cleaning	CW1-2	1	LS	$40,000	$40,000	
Sludge Removal and Liner Replacement	CW1-3	1	LS	$250,000	$250,000	
Annual Operation of Interim Water Treatment Plant	CW1-4	1	YR	$924,000	$924,000	
Transport and Placement of Sludge at Interim Storage Location	CW1-6	6,000	LCY	$7	$44,328	
SUBTOTAL					$1,280,828	
Contingency (Scope and Bid)		15%			$192,124	5% Scope, 10% Bid (Low end of the recommended range in EPA 540-R-00-002).
SUBTOTAL					$1,472,952	
Project Management		5%			$73,648	Low end of the recommended range in EPA 540-R-00-002 was used.
Technical Support		10%			$147,295	Low end of the recommended range in EPA 540-R-00-002 was used.
TOTAL					$1,693,895	
TOTAL ANNUAL PRSC COST					**$1,694,000**	Total annual PRSC cost is rounded to the nearest $1,000.

Notes:

Percentages used for contingency and professional/technical services costs are based on guidance from Section 5.0 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000.
Costs presented for this alternative are expected to have an accuracy between -30% to +50% of actual costs, based on the scope presented. They are prepared solely to facilitate relative comparisons between alternatives for EE/CA evaluation purposes.

Abbreviations:

CY Cubic Yard
EA Each
LS Lump Sum
QTY Quantity
YR Year

Present Value and Cost Estimate Summary

Alternative RA2

TABLE PV-RA2

PRESENT VALUE ANALYSIS

Alternative RA2

Suspend Operation of Existing Gladstone IWTP to Treat Gold King Mine Adit MIW Discharge

Site: Gladstone Interim Water Treatment Plant
Bonita Peak Mining District Superfund Site
Location: San Juan County, Colorado
Phase: Engineering Evaluation / Cost Analysis
Base Year: 2016

Year[1]	Capital Costs[2]	Annual PRSC Costs	Total Annual Expenditure[3]	Discount Factor (7.0%)	Present Value[4]
0	$0	$0	$0	1.0000	$0
1	$104,000	$7,000	$111,000	0.9346	$103,741
2	$0	$7,000	$7,000	0.8734	$6,114
3	$0	$7,000	$7,000	0.8163	$5,714
4	$0	$7,000	$7,000	0.7629	$5,340
5	$0	$7,000	$7,000	0.7130	$4,991
TOTALS:	$104,000	$35,000	$139,000		$125,900
TOTAL PRESENT VALUE OF ALTERNATIVE RA2 [5]					**$126,000**

Notes:

[1] Estimated removal timeframes (5 years from intiation of the NTCRA) are discussed within the EE/CA report. As a simplifying assumption, it is assumed that NTCRA initiation would occur in 2017 (Year 1).

[2] Capital costs, for purposes of this analysis, are assumed to be distributed as indicated on Table CS-RA2.

[3] Total annual expenditure is the total cost per year with no discounting.

[4] Present value is the total cost per year including a 7.0% discount factor for that year. See Table PV-ADRFT for details.

[5] Total present value is rounded to the nearest $1,000. Inflation and depreciation are excluded from the present value cost.

Costs presented for this alternative are expected to have an accuracy between -30% to +50% of actual costs, based on the scope presented.

The cost estimates are prepared solely to facilitate relative comparisons between alternatives for EE/CA evaluation purposes.

TABLE CS-RA2

Alternative **RA2**
Suspend Operation of Existing Gladstone IWTP to Treat Gold King Mine Adit MIW Discharge

COST ESTIMATE SUMMARY

Site: Gladstone Interim Water Treatment Plant
Bonita Peak Mining District Superfund Site
Location: San Juan County, Colorado
Phase: Engineering Evaluation / Cost Analysis
Base Year: 2016
Date: November 2016

Description: Alternative RA2 entails suspension of treatment operations at the existing Gladstone IWTP, pending evaluation of broader potential water treatment needs. Under this alternative, water treatment of Gold King Mine adit MIW would be suspended. Discharge from the stabilized adit of the Gold King Mine would be routed around the mine dump and allowed to discharge into the North Fork of Cement Creek untreated, as was occurring prior to construction of the IWTP. Suspension of water treatment activities means that the IWTP would not be dismantled. It would be shut down to allow for a potential restart of treatment operations in the future. This would include expected shutdown activities such as winterization (draining of pipes and tanks), discontinuing electrical service and other utilities, securing of equipment, and consumption of remaining water treatment reagents that cannot be stored for the long term. Any solids accumulated in the equalization ponds would be removed and consolidated with the other IWTP sludge. It is assumed that the sludge generated at the IWTP would remain stored on site in the sludge drying area. It is assumed that the piping or channels used to divert the Gold King Mine adit discharge around the mine dump and to North Fork of Cement Creek would be inspected quarterly to ensure these diversion features are not clogging and are continuing to function properly.

CAPITAL COSTS: (Assumed to be Incurred During Year 1)

DESCRIPTION	WORKSHEET	QTY	UNIT(S)	UNIT COST	TOTAL	NOTES
Shutdown and Mothballing of Gladstone Interim Water Treatment Plant	CW2-1	1	LS	$37,852	$37,852	
Demobilization of Lime Storage Silo	CW2-2	1	LS	$1,815	$1,815	Assumes that the storage silo currently used for lime storage will be demobilized off-site following shutdown
Equalization Pond Cleaning	CW2-4	1	LS	$20,000	$20,000	Assumes equalization pond cleaning following suspension of water treatment activities.
SUBTOTAL					$59,667	
Contingency (Scope and Bid)		20%			$11,933	10% Scope, 10% Bid (Low end of the recommended range in EPA 540-R-00-002).
SUBTOTAL					$71,600	
Project Management		10%			$7,160	Percentage from Exhibit 5-8 in EPA 540-R-00-002 was used.
Removal Action Planning		20%			$14,320	Percentage from Exhibit 5-8 in EPA 540-R-00-002 was used, based on recommended percentages for Remedial Design
Construction Management		15%			$10,740	Percentage from Exhibit 5-8 in EPA 540-R-00-002 was used.
TOTAL					$103,820	
TOTAL CAPITAL COST					**$104,000**	Total capital cost is rounded to the nearest $1,000.

ANNUAL POST-REMOVAL SITE CONTROLS (PRSC) (Assumed to be Incurred During Years 1 through 5)

DESCRIPTION	WORKSHEET	QTY	UNIT(S)	UNIT COST	TOTAL	NOTES
Inspection of Diversion Features	CW2-3	1	LS	$4,960	$4,960	Assumes quarterly inspections of diversion features
SUBTOTAL					$4,960	
Contingency (Scope and Bid)		15%			$744	5% Scope, 10% Bid (Low end of the recommended range in EPA 540-R-00-002).
SUBTOTAL					$5,704	
Project Management		5%			$285	Low end of the recommended range in EPA 540-R-00-002 was used.
Technical Support		10%			$570	Low end of the recommended range in EPA 540-R-00-002 was used.
TOTAL					$6,559	
TOTAL ANNUAL PRSC COST					**$7,000**	Total annual PRSC cost is rounded to the nearest $1,000.

Notes:

Percentages used for contingency and professional/technical services costs are based on guidance from Section 5.0 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000.
Costs presented for this alternative are expected to have an accuracy between -30% to +50% of actual costs, based on the scope presented. They are prepared solely to facilitate relative comparisons between alternatives for EE/CA evaluation purposes.

Abbreviations:

EA Each
LS Lump Sum
QTY Quantity
YR Year

Cost Worksheets

Alternative RA1

TABLE CW1-1

Alternative RA1
Capital Cost Sub-Element
Snow Removal

Cost Worksheet: **CW1-1**

COST WORKSHEET

Site: Gladstone Interim Water Treatment Plant
Bonita Peak Mining District Superfund Site
Location: San Juan County, Colorado
Phase: Engineering Evaluation / Cost Analysis
Base Year: 2016

Prepared By: JN **Date:** 10/5/2016

Checked By: EB **Date:** 10/10/2016

Work Statement:
This sub-element involves snow removal at the Gladstone IWTP. Asssumes snow removal services would be required for six months each year. Costs are based on previously incurred costs for the site.

Cost Analysis:
Cost for Snow Removal (Lump Sum)

COST DATABASE CODE	DESCRIPTION	QTY	UNIT(S)	HPF	LABOR	ADJ LABOR	EQUIP	ADJ EQUIP	MATL	OTHER	UNMOD UC	UNMOD LIC	PC OH	PC PF	BUR LIC	COST SOURCE CITATION	COMMENTS
SU1	Snow Removal	6	MO	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$3,750.00	$3,750.00	$22,500.00	0%	0%	$22,500	P Previous Work	Snow removal services required for 6 months per year. Based on costs provided by the contractor for the Gladstone IWTP.
												TOTAL UNIT COST:			$22,500		

	Representative Unit Quantity	Unit(s)	Total Cost	Unit Cost
COST WORKSHEET SUMMARY	1	LS	$22,500	$22,500

Notes:
HTRW productivity factor is from Exhibit B-3 or B-4 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000
The Cost Database Code is a reference code for linking with line item cost information with the cost source database and is not otherwise used within these cost worksheets.
The quantity bolded in the QTY column is the quantity selected as the representative unit quantity for this cost worksheet. If multiple quantities are bolded, the representative unit quantity is the sum of those quantities. When the LS unit is utilized, the default representative unit quantity is 1.

Source of Cost Data:
NA Not Applicable - costs are from previous work or vendor quote
For citation references, the following sources apply:
MII (MII Assemblies), GSA (www.gsa.gov), FLC (FLC Datacenter), A (Allowance), V (Vendor Quote), CW (Means CostWorks 2016), P (Previous Work), CB (MII English Cost Book), and FRTR (www.frtr.gov)

Abbreviations:

QTY	Quantity	DY	Days
EQUIP	Equipment	EA	Each
MATL	Material	HR	Hours
HPF	HTRW Productivity Factor	LS	Lump Sum
ADJ LABOR	Adjusted Labor for HFP	MO	Months
ADJ EQUIP	Adjusted Equipment for HFP	WK	Weeks
UNMOD UC	Unmodified Unit Cost	YR	Years
UNMOD LIC	Unmodified Line Item Cost		
UNBUR LIC	Unburdened Line Item Cost		
PC OH	Prime Contractor Overhead		
PC PF	Prime Contractor Profit		
BUR LIC	Burdened Line Item Cost		

Cost Adjustment Checklist:	**NOTES:**
FACTOR:	Field work will be in Level "D" PPE.
H&S Productivity (labor and equipment only)	MII assembly costs include HPF adjustments.
Escalation to Base Year	2016 cost sources are not escalated (EF=1.00). All other costs are escalated based on the USACE CWCCIS, EM 1110-2-1304, 31 Mar 2016
Area Cost Factor	An AF of 0.96 is used for Colorado, except that an AF of 1.00 (national unmodified average) is used for MII assembly costs and local vendor quotes.
Subcontractor Overhead and Profit	It is assumed that Subcontractor O&P is either included in the PC O&P or has been factored into vendor quotes or previous work.
Prime Contractor Overhead and Profit	It is assumed that home office OH is 8% and profit is 9% for the Prime Contractor. Professional labor overhead is 100%. Allowances and items with mandated costs such as per diem do not have overhead and profit applied.

TABLE CW1-2

Alternative RA1 **Cost Worksheet:** **CW1-2**
Capital Cost Sub-Element
Equalization Pond Cleaning

COST WORKSHEET

Site: Gladstone Interim Water Treatment Plant
Bonita Peak Mining District Superfund Site
Location: San Juan County, Colorado
Phase: Engineering Evaluation / Cost Analysis
Base Year: 2016

Prepared By: JN **Date:** 10/5/2016

Checked By: EB **Date:** 10/10/2016

Work Statement:
This sub-element involves cleaning of the equalization pond at the Gladstone IWTP. Assumes equalization pond cleaning with vac truck twice per year (once in the spring and once in the fall). Costs are based on previously incurred costs for the site.

Cost Analysis:
Cost for Equalization Pond Cleaning (Lump Sum)

COST DATABASE CODE	DESCRIPTION	QTY	UNIT(S)	HPF	LABOR	ADJ LABOR	EQUIP	ADJ EQUIP	MATL	OTHER	UNMOD UC	UNMOD LIC	PC OH	PC PF	BUR LIC	COST SOURCE CITATION	COMMENTS
SU2	Equalization Pond Cleaning	2	EA	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$20,000.00	$20,000.00	$40,000.00	0%	0%	$40,000	P Previous Work	Pond cleaning with vac truck. Occurs twice per year (once in the spring and once in the fall). Based on costs provided by the contractor for the Gladstone IWTP.
												TOTAL UNIT COST:			$40,000		

	Representative Unit Quantity	Unit(s)	Total Cost	Unit Cost
COST WORKSHEET SUMMARY	1	LS	$40,000	$40,000

Notes:
HTRW productivity factor is from Exhibit B-3 or B-4 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000
The Cost Database Code is a reference code for linking with line item cost information with the cost source database and is not otherwise used within these cost worksheets.
The quantity bolded in the QTY column is the quantity selected as the representative unit quantity for this cost worksheet. If multiple quantities are bolded, the representative unit quantity is the sum of those quantities. When the LS unit is utilized, the default representative unit quantity is 1.

Source of Cost Data:
NA Not Applicable - costs are from previous work or vendor quote
For citation references, the following sources apply:
MII (MII Assemblies), GSA (www.gsa.gov), FLC (FLC Datacenter), A (Allowance), V (Vendor Quote), CW (Means CostWorks 2016), P (Previous Work), CB (MII English Cost Book), and FRTR (www.frtr.gov)

Abbreviations:

QTY	Quantity	DY	Days
EQUIP	Equipment	EA	Each
MATL	Material	HR	Hours
HPF	HTRW Productivity Factor	LS	Lump Sum
ADJ LABOR	Adjusted Labor for HFP	MO	Months
ADJ EQUIP	Adjusted Equipment for HFP	WK	Weeks
UNMOD UC	Unmodified Unit Cost	YR	Years
UNMOD LIC	Unmodified Line Item Cost		
UNBUR LIC	Unburdened Line Item Cost		
PC OH	Prime Contractor Overhead		
PC PF	Prime Contractor Profit		
BUR LIC	Burdened Line Item Cost		

Cost Adjustment Checklist:	**NOTES:**
FACTOR:	Field work will be in Level "D" PPE.
H&S Productivity (labor and equipment only)	MII assembly costs include HPF adjustments.
Escalation to Base Year	2016 cost sources are not escalated (EF=1.00). All other costs are escalated based on the USACE CWCCIS, EM 1110-2-1304, 31 Mar 2016
Area Cost Factor	An AF of 0.96 is used for Colorado, except that an AF of 1.00 (national unmodified average) is used for MII assembly costs and local vendor quotes.
Subcontractor Overhead and Profit	It is assumed that Subcontractor O&P is either included in the PC O&P or has been factored into vendor quotes or previous work.
Prime Contractor Overhead and Profit	It is assumed that home office OH is 8% and profit is 9% for the Prime Contractor. Professional labor overhead is 100%. Allowances and items with mandated costs such as per diem do not have overhead and profit applied.

TABLE CW1-3

Alternative RA1 **Cost Worksheet:** **CW1-3**
Capital Cost Sub-Element
Sludge Removal and Liner Replacement

COST WORKSHEET

Site: Gladstone Interim Water Treatment Plant
Bonita Peak Mining District Superfund Site
Location: San Juan County, Colorado
Phase: Engineering Evaluation / Cost Analysis
Base Year: 2016

Prepared By: JN **Date:** 10/5/2016

Checked By: EB **Date:** 10/10/2016

Work Statement:
This sub-element involves sludge removal and liner replacement at the Gladstone IWTP. Assumes sludge removal and liner replacement twice per year (once in the spring and once in the fall). Costs are based on previously incurred costs for the site.

Cost Analysis:
Cost for Sludge Removal and Liner Replacement (Lump Sum)

COST DATABASE CODE	DESCRIPTION	QTY	UNIT(S)	HPF	LABOR	ADJ LABOR	EQUIP	ADJ EQUIP	MATL	OTHER	UNMOD UC	UNMOD LIC	PC OH	PC PF	BUR LIC	COST SOURCE CITATION	COMMENTS
SU3	Sludge Removal and Liner Replacement	2	EA	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$125,000.00	$125,000.00	$250,000.00	0%	0%	$250,000	P Previous Work	Occurs twice per year (once in the spring and once in the fall). Based on costs provided by the contractor for the Gladstone IWTP.
												TOTAL UNIT COST:			$250,000		

	Representative Unit Quantity	Unit(s)	Total Cost	Unit Cost
COST WORKSHEET SUMMARY	1	LS	$250,000	$250,000

Notes:
HTRW productivity factor is from Exhibit B-3 or B-4 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000
The Cost Database Code is a reference code for linking with line item cost information with the cost source database and is not otherwise used within these cost worksheets.
The quantity bolded in the QTY column is the quantity selected as the representative unit quantity for this cost worksheet. If multiple quantities are bolded, the representative unit quantity is the sum of those quantities. When the LS unit is utilized, the default representative unit quantity is 1.

Source of Cost Data:
NA Not Applicable - costs are from previous work or vendor quote
For citation references, the following sources apply:
MII (MII Assemblies), GSA (www.gsa.gov), FLC (FLC Datacenter), A (Allowance), V (Vendor Quote), CW (Means CostWorks 2016), P (Previous Work), CB (MII English Cost Book), and FRTR (www.frtr.gov)

Abbreviations:

QTY	Quantity	DY	Days
EQUIP	Equipment	EA	Each
MATL	Material	HR	Hours
HPF	HTRW Productivity Factor	LS	Lump Sum
ADJ LABOR	Adjusted Labor for HFP	MO	Months
ADJ EQUIP	Adjusted Equipment for HFP	WK	Weeks
UNMOD UC	Unmodified Unit Cost	YR	Years
UNMOD LIC	Unmodified Line Item Cost		
UNBUR LIC	Unburdened Line Item Cost		
PC OH	Prime Contractor Overhead		
PC PF	Prime Contractor Profit		
BUR LIC	Burdened Line Item Cost		

Cost Adjustment Checklist:

	NOTES:
FACTOR:	Field work will be in Level "D" PPE.
H&S Productivity (labor and equipment only)	MII assembly costs include HPF adjustments.
Escalation to Base Year	2016 cost sources are not escalated (EF=1.00). All other costs are escalated based on the USACE CWCCIS, EM 1110-2-1304, 31 Mar 2016
Area Cost Factor	An AF of 0.96 is used for Colorado, except that an AF of 1.00 (national unmodified average) is used for MII assembly costs and local vendor quotes.
Subcontractor Overhead and Profit	It is assumed that Subcontractor O&P is either included in the PC O&P or has been factored into vendor quotes or previous work.
Prime Contractor Overhead and Profit	It is assumed that home office OH is 8% and profit is 9% for the Prime Contractor. Professional labor overhead is 100%. Allowances and items with mandated costs such as per diem do not have overhead and profit applied.

TABLE CW1-4

Alternative RA1 **Cost Worksheet:** **CW1-4**
Capital Cost Sub-Element
Annual Operation of Interim Water Treatment Plant

COST WORKSHEET

Site: Gladstone Interim Water Treatment Plant
Bonita Peak Mining District Superfund Site
Location: San Juan County, Colorado
Phase: Engineering Evaluation / Cost Analysis
Base Year: 2016

Prepared By: JN **Date:** 10/5/2016

Checked By: EB **Date:** 10/10/2016

Work Statement:
This sub-element involves the operation of the Gladstone interim water treatment plant (IWTP). Operation costs include labor for operation of the plant, maintenance, and emptying of geo bags and are based on incurred costs for the site. Material costs include chemicals (lime and polymer) and geo bags. Additional costs include, but are not limited to, electricity, weekly status reports, and equipment maintenance. Based on prior experience at the site, it is assumed that there will be 4 weeks of high peak flow and 2 weeks of low peak flow which will result in higher weekly operation costs during those peak times.

Cost Analysis:
Cost for Operation of Interim Water Treatment Plant (Lump Sum)

COST DATABASE CODE	DESCRIPTION	QTY	UNIT(S)	HPF	LABOR	ADJ LABOR	EQUIP	ADJ EQUIP	MATL	OTHER	UNMOD UC	UNMOD LIC	PC OH	PC PF	BUR LIC	COST SOURCE CITATION	COMMENTS
SU4	Weekly Operation (Typical)	46	WK	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$16,000.00	$16,000.00	$736,000.00	0%	0%	$736,000	P Previous Work	Typical non-peak operation costs. Based on costs provided by the contractor for the Gladstone IWTP.
SU5	Weekly Operation (Peak - High)	4	WK	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$34,000.00	$34,000.00	$136,000.00	0%	0%	$136,000	P Previous Work	Cost during high peak metal loads. Assumes 4 weeks per year of high peak metal loads. Based on costs provided by the contractor for the Gladstone IWTP.
SU6	Weekly Operation (Peak - Moderate)	2	WK	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$26,000.00	$26,000.00	$52,000.00	0%	0%	$52,000	P Previous Work	Cost during low peak metal loads. Assumes 2 weeks per year of low peak metal loads. Based on costs provided by the contractor for the Gladstone IWTP.
												TOTAL UNIT COST:			$924,000		

	Representative Unit Quantity	Unit(s)	Total Cost	Unit Cost
COST WORKSHEET SUMMARY	1	YR	$924,000	$924,000

Notes:
HTRW productivity factor is from Exhibit B-3 or B-4 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000
The Cost Database Code is a reference code for linking with line item cost information with the cost source database and is not otherwise used within these cost worksheets.
The quantity bolded in the QTY column is the quantity selected as the representative unit quantity for this cost worksheet. If multiple quantities are bolded, the representative unit quantity is the sum of those quantities. When the LS unit is utilized, the default representative unit quantity is 1.

Source of Cost Data:
NA Not Applicable - costs are from previous work or vendor quote
For citation references, the following sources apply:
MII (MII Assemblies), GSA (www.gsa.gov), FLC (FLC Datacenter), A (Allowance), V (Vendor Quote), CW (Means CostWorks 2016), P (Previous Work), CB (MII English Cost Book), and FRTR (www.frtr.gov)

Abbreviations:

QTY	Quantity	DY	Days
EQUIP	Equipment	EA	Each
MATL	Material	HR	Hours
HPF	HTRW Productivity Factor	LS	Lump Sum
ADJ LABOR	Adjusted Labor for HFP	MO	Months
ADJ EQUIP	Adjusted Equipment for HFP	WK	Weeks
UNMOD UC	Unmodified Unit Cost	YR	Years
UNMOD LIC	Unmodified Line Item Cost		
UNBUR LIC	Unburdened Line Item Cost		
PC OH	Prime Contractor Overhead		
PC PF	Prime Contractor Profit		
BUR LIC	Burdened Line Item Cost		

Cost Adjustment Checklist:	**NOTES:**
FACTOR:	Field work will be in Level "D" PPE.
H&S Productivity (labor and equipment only)	MII assembly costs include HPF adjustments.
Escalation to Base Year	2016 cost sources are not escalated (EF=1.00). All other costs are escalated based on the USACE CWCCIS, EM 1110-2-1304, 31 Mar 2016
Area Cost Factor	An AF of 0.96 is used for Colorado, except that an AF of 1.00 (national unmodified average) is used for MII assembly costs and local vendor quotes.
Subcontractor Overhead and Profit	It is assumed that Subcontractor O&P is either included in the PC O&P or has been factored into vendor quotes or previous work.
Prime Contractor Overhead and Profit	It is assumed that home office OH is 8% and profit is 9% for the Prime Contractor. Professional labor overhead is 100%. Allowances and items with mandated costs such as per diem do not have overhead and profit applied.

TABLE CW1-5

Alternative RA1 **Cost Worksheet: CW1-5**
Capital Cost Sub-Element
Transport and Placement of Sludge at Interim Storage Location (Year 1)

COST WORKSHEET

Site: Gladstone Interim Water Treatment Plant
Bonita Peak Mining District Superfund Site
Location: San Juan County, Colorado
Phase: Engineering Evaluation / Cost Analysis
Base Year: 2016

Prepared By: JN **Date:** 10/5/2016

Checked By: EB **Date:** 10/10/2016

Work Statement:
This sub-element involves the transport and disosal of sludge that is currently stockpiled onsite and the sludge that will be generated during the year to an additional interim sludge management area. It assumes 6,000 cy of sludge is currently stockpiled and an additional 6,000 cy of sludge would be generated that year. It is assumed this sludge volume is hauled off to a location 12 miles away.

Cost Analysis:
Cost for Transport and Disposal of Sludge - Year 1 (Lump Sum)

COST DATABASE CODE	DESCRIPTION	QTY	UNIT(S)	HPF	LABOR	ADJ LABOR	EQUIP	ADJ EQUIP	MATL	OTHER	UNMOD UC	UNMOD LIC	PC OH	PC PF	BUR LIC	COST SOURCE CITATION	COMMENTS
AA6	Loading of Sludge	12,000	LCY	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.73	$0.73	$8,760.00	8%	9%	$10,312	MII MII Assemblies	
AA7	Transportation of Sludge	12,000	LCY	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$5.40	$5.40	$64,800.00	8%	9%	$76,283	MII MII Assemblies	Assumes 12 mile one-way haul distance
AA8	Material Spreading at Sludge Management Area	1,200	LCY	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1.46	$1.46	$1,752.00	8%	9%	$2,062	MII MII Assemblies	Assumes spreading for 10% of the volume
												TOTAL UNIT COST:			$88,657		

	Representative Unit Quantity	Unit(s)	Total Cost	Unit Cost
COST WORKSHEET SUMMARY	12,000	LCY	$88,657	$7

Notes:
HTRW productivity factor is from Exhibit B-3 or B-4 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000
The Cost Database Code is a reference code for linking with line item cost information with the cost source database and is not otherwise used within these cost worksheets.
The quantity bolded in the QTY column is the quantity selected as the representative unit quantity for this cost worksheet. If multiple quantities are bolded, the representative unit quantity is the sum of those quantities. When the LS unit is utilized, the default representative unit quantity is 1.

Source of Cost Data:
NA Not Applicable - costs are from previous work or vendor quote
For citation references, the following sources apply:
MII (MII Assemblies), GSA (www.gsa.gov), FLC (FLC Datacenter), A (Allowance), V (Vendor Quote), CW (Means CostWorks 2016), P (Previous Work), CB (MII English Cost Book), and FRTR (www.frtr.gov)

Abbreviations:

QTY	Quantity	DY	Days
EQUIP	Equipment	EA	Each
MATL	Material	HR	Hours
HPF	HTRW Productivity Factor	LS	Lump Sum
ADJ LABOR	Adjusted Labor for HFP	MO	Months
ADJ EQUIP	Adjusted Equipment for HFP	WK	Weeks
UNMOD UC	Unmodified Unit Cost	YR	Years
UNMOD LIC	Unmodified Line Item Cost		
UNBUR LIC	Unburdened Line Item Cost		
PC OH	Prime Contractor Overhead		
PC PF	Prime Contractor Profit		
BUR LIC	Burdened Line Item Cost		

Cost Adjustment Checklist:	**NOTES:**
FACTOR:	Field work will be in Level "D" PPE.
H&S Productivity (labor and equipment only)	MII assembly costs include HPF adjustments.
Escalation to Base Year	2016 cost sources are not escalated (EF=1.00). All other costs are escalated based on the USACE CWCCIS, EM 1110-2-1304, 31 Mar 2016
Area Cost Factor	An AF of 0.96 is used for Colorado, except that an AF of 1.00 (national unmodified average) is used for MII assembly costs and local vendor quotes.
Subcontractor Overhead and Profit	It is assumed that Subcontractor O&P is either included in the PC O&P or has been factored into vendor quotes or previous work.
Prime Contractor Overhead and Profit	It is assumed that home office OH is 8% and profit is 9% for the Prime Contractor. Professional labor overhead is 100%. Allowances and items with mandated costs such as per diem do not have overhead and profit applied.

TABLE CW1 6

Alternative RA1 **Cost Worksheet: CW1-6**
Capital Cost Sub-Element
Transport and Placement of Sludge at Interim Storage Location (Years 2-5)

COST WORKSHEET

Site: Gladstone Interim Water Treatment Plant
Bonita Peak Mining District Superfund Site
Location: San Juan County, Colorado
Phase: Engineering Evaluation / Cost Analysis
Base Year: 2016

Prepared By: JN **Date:** 10/5/2016

Checked By: EB **Date:** 10/10/2016

Work Statement:
This sub-element involves the transport of sludge generated during the year to an additional interim sludge management area. It assumes 6,000 cy of sludge would be generated each year. It is assumed this annual sludge volume is hauled off every year to a location 12 miles away.

Cost Analysis:
Cost for Transport and Disposal of Sludge - Years 2 through 5 (Lump Sum)

COST DATABASE CODE	DESCRIPTION	QTY	UNIT(S)	HPF	LABOR	ADJ LABOR	EQUIP	ADJ EQUIP	MATL	OTHER	UNMOD UC	UNMOD LIC	PC OH	PC PF	BUR LIC	COST SOURCE CITATION	COMMENTS
AA6	Loading of Sludge	6,000	LCY	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.73	$0.73	$4,380.00	8%	9%	$5,156	MII MII Assemblies	
AA7	Transportation of Sludge	6,000	LCY	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$5.40	$5.40	$32,400.00	8%	9%	$38,141	MII MII Assemblies	Assumes 12 mile one-way haul distance
AA8	Material Spreading at Sludge Management Area	600	LCY	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1.46	$1.46	$876.00	8%	9%	$1,031	MII MII Assemblies	Assumes spreading for 10% of the volume
												TOTAL UNIT COST:			$44,328		

	Representative Unit Quantity	Unit(s)	Total Cost	Unit Cost
COST WORKSHEET SUMMARY	6,000	LCY	$44,328	$7

Notes:
HTRW productivity factor is from Exhibit B-3 or B-4 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000
The Cost Database Code is a reference code for linking with line item cost information with the cost source database and is not otherwise used within these cost worksheets.
The quantity bolded in the QTY column is the quantity selected as the representative unit quantity for this cost worksheet. If multiple quantities are bolded, the representative unit quantity is the sum of those quantities. When the LS unit is utilized, the default representative unit quantity is 1.

Source of Cost Data:
NA Not Applicable - costs are from previous work or vendor quote
For citation references, the following sources apply:
MII (MII Assemblies), GSA (www.gsa.gov), FLC (FLC Datacenter), A (Allowance), V (Vendor Quote), CW (Means CostWorks 2016), P (Previous Work), CB (MII English Cost Book), and FRTR (www.frtr.gov)

Abbreviations:

QTY	Quantity	DY	Days
EQUIP	Equipment	EA	Each
MATL	Material	HR	Hours
HPF	HTRW Productivity Factor	LS	Lump Sum
ADJ LABOR	Adjusted Labor for HFP	MO	Months
ADJ EQUIP	Adjusted Equipment for HFP	WK	Weeks
UNMOD UC	Unmodified Unit Cost	YR	Years
UNMOD LIC	Unmodified Line Item Cost		
UNBUR LIC	Unburdened Line Item Cost		
PC OH	Prime Contractor Overhead		
PC PF	Prime Contractor Profit		
BUR LIC	Burdened Line Item Cost		

Cost Adjustment Checklist:	**NOTES:**
FACTOR:	Field work will be in Level "D" PPE.
H&S Productivity (labor and equipment only)	MII assembly costs include HPF adjustments.
Escalation to Base Year	2016 cost sources are not escalated (EF=1.00). All other costs are escalated based on the USACE CWCCIS, EM 1110-2-1304, 31 Mar 2016
Area Cost Factor	An AF of 0.96 is used for Colorado, except that an AF of 1.00 (national unmodified average) is used for MII assembly costs and local vendor quotes.
Subcontractor Overhead and Profit	It is assumed that Subcontractor O&P is either included in the PC O&P or has been factored into vendor quotes or previous work.
Prime Contractor Overhead and Profit	It is assumed that home office OH is 8% and profit is 9% for the Prime Contractor. Professional labor overhead is 100%. Allowances and items with mandated costs such as per diem do not have overhead and profit applied.

TABLE CW1-7

Alternative RA1 **Cost Worksheet:** **CW1-7**
Capital Cost Sub-Element
Interim Sludge Management Area Construction

COST WORKSHEET

Site: Gladstone Interim Water Treatment Plant
Bonita Peak Mining District Superfund Site
Location: San Juan County, Colorado
Phase: Engineering Evaluation / Cost Analysis
Base Year: 2016

Prepared By: JN **Date:** 10/31/2016

Checked By: EW **Date:** 11/1/2016

Work Statement:
This sub-element involves the construction of an interim sludge management area. It assumes construction of an interim sludge management area with capacity for storing approximately five years worth of sludge production from the Gladstone IWTP plus the sludge currently stockpiled at the Gladstone IWTP.

Cost Analysis:
Cost for Interim Sludge Management Area Construction (Lump Sum)

COST DATABASE CODE	DESCRIPTION	QTY	UNIT(S)	HPF	LABOR	ADJ LABOR	EQUIP	ADJ EQUIP	MATL	OTHER	UNMOD UC	UNMOD LIC	PC OH	PC PF	BUR LIC	COST SOURCE CITATION	COMMENTS
AA9	Clearing and Grubbing	4.8	ACR	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$2,323.27	$2,323.27	$11,151.70	8%	9%	$13,128	MII MII Assemblies	
AA10	Excavation	36,000	BCY	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.98	$0.98	$35,280.00	8%	9%	$41,532	MII MII Assemblies	
AA11	Grading	23,400	LCY	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$1.85	$1.85	$43,290.00	8%	9%	$50,961	MII MII Assemblies	
AA12	Compaction	7,800	ECY	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.52	$0.52	$4,056.00	8%	9%	$4,775	MII MII Assemblies	
AA13	Geomembrane Liner Installation	231,600	SF	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.14	$0.14	$32,424.00	8%	9%	$38,170	MII MII Assemblies	
MA2	Geomembrane Liner	231,600	SF	1.00	$0.00	$0.00	$0.00	$0.00	$0.30	$0.00	$0.30	$69,480.00	0%	0%	$69,480	V Vendor Quote	Source: GSE, 2016
												TOTAL UNIT COST:			$218,046		

	Representative Unit Quantity	Unit(s)	Total Cost	Unit Cost
COST WORKSHEET SUMMARY	1	LS	$218,046	$218,046

Notes:
HTRW productivity factor is from Exhibit B-3 or B-4 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000
The Cost Database Code is a reference code for linking with line item cost information with the cost source database and is not otherwise used within these cost worksheets.
The quantity bolded in the QTY column is the quantity selected as the representative unit quantity for this cost worksheet. If multiple quantities are bolded, the representative unit quantity is the sum of those quantities. When the LS unit is utilized, the default representative unit quantity is 1.

Source of Cost Data:
NA Not Applicable - costs are from previous work or vendor quote
For citation references, the following sources apply:
MII (MII Assemblies), GSA (www.gsa.gov), FLC (FLC Datacenter), A (Allowance), V (Vendor Quote), CW (Means CostWorks 2016), P (Previous Work), CB (MII English Cost Book), and FRTR (www.frtr.gov)

Abbreviations:

QTY	Quantity	DY	Days
EQUIP	Equipment	EA	Each
MATL	Material	HR	Hours
HPF	HTRW Productivity Factor	LS	Lump Sum
ADJ LABOR	Adjusted Labor for HFP	MO	Months
ADJ EQUIP	Adjusted Equipment for HFP	WK	Weeks
UNMOD UC	Unmodified Unit Cost	YR	Years
UNMOD LIC	Unmodified Line Item Cost		
UNBUR LIC	Unburdened Line Item Cost		
PC OH	Prime Contractor Overhead		
PC PF	Prime Contractor Profit		
BUR LIC	Burdened Line Item Cost		

Cost Adjustment Checklist:

	NOTES:
FACTOR:	Field work will be in Level "D" PPE.
H&S Productivity (labor and equipment only)	MII assembly costs include HPF adjustments.
Escalation to Base Year	2016 cost sources are not escalated (EF=1.00). All other costs are escalated based on the USACE CWCCIS, EM 1110-2-1304, 31 Mar 2016
Area Cost Factor	An AF of 0.96 is used for Colorado, except that an AF of 1.00 (national unmodified average) is used for MII assembly costs and local vendor quotes.
Subcontractor Overhead and Profit	It is assumed that Subcontractor O&P is either included in the PC O&P or has been factored into vendor quotes or previous work.
Prime Contractor Overhead and Profit	It is assumed that home office OH is 8% and profit is 9% for the Prime Contractor. Professional labor overhead is 100%. Allowances and items with mandated costs such as per diem do not have overhead and profit applied.

Cost Worksheets

Alternative RA2

TABLE CW2-1

Alternative RA2 **Cost Worksheet: CW2-1**
Capital Cost Sub-Element
Shutdown and Mothballing of Gladstone Interim Water Treatment Plant

COST WORKSHEET

Site: Gladstone Interim Water Treatment Plant
Location: San Juan County, Colorado
Phase: Engineering Evaluation / Cost Analysis
Base Year: 2016

Prepared By: JN **Date:** 10/5/2016
Checked By: EB **Date:** 10/10/2016

Work Statement:
This sub-element involves the shutdown and mothballing of the Gladstone interim water treatment plant (IWTP).

Cost Analysis:
Cost for Shutdown and Mothballing of the Gladstone Interim Water Treatment Plant (Lump Sum)

COST DATABASE CODE	DESCRIPTION	QTY	UNIT(S)	HPF	LABOR	ADJ LABOR	EQUIP	ADJ EQUIP	MATL	OTHER	UNMOD UC	UNMOD LIC	PC OH	PC PF	BUR LIC	COST SOURCE CITATION	COMMENTS
AA1	Shutdown and Mothballing Crew	4	WK	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$4,853.14	$4,853.14	$19,412.56	8%	9%	$22,852	MII MII Assemblies	
MA1	Shutdown and Mothballing Allowance	1	LS	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$15,000.00	$15,000.00	$15,000.00	0%	0%	$15,000	A Allowance	Per Estimator
												TOTAL UNIT COST:			$37,852		

	Representative Unit Quantity	Unit(s)	Total Cost	Unit Cost
COST WORKSHEET SUMMARY	1	LS	$37,852	$37,852

Notes:
HTRW productivity factor is from Exhibit B-3 or B-4 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000
The Cost Database Code is a reference code for linking with line item cost information with the cost source database and is not otherwise used within these cost worksheets.
The quantity bolded in the QTY column is the quantity selected as the representative unit quantity for this cost worksheet. If multiple quantities are bolded, the representative unit quantity is the sum of those quantities. When the LS unit is utilized, the default representative unit quantity is 1.

Source of Cost Data:
NA Not Applicable - costs are from previous work or vendor quote
For citation references, the following sources apply:
MII (MII Assemblies), GSA (www.gsa.gov), FLC (FLC Datacenter), A (Allowance), V (Vendor Quote), CW (Means CostWorks 2016), P (Previous Work), CB (MII English Cost Book), and FRTR (www.frtr.gov)

Abbreviations:

QTY	Quantity	DY	Days
EQUIP	Equipment	EA	Each
MATL	Material	HR	Hours
HPF	HTRW Productivity Factor	LS	Lump Sum
ADJ LABOR	Adjusted Labor for HFP	MO	Months
ADJ EQUIP	Adjusted Equipment for HFP	WK	Weeks
UNMOD UC	Unmodified Unit Cost	YR	Years
UNMOD LIC	Unmodified Line Item Cost		
UNBUR LIC	Unburdened Line Item Cost		
PC OH	Prime Contractor Overhead		
PC PF	Prime Contractor Profit		
BUR LIC	Burdened Line Item Cost		

Cost Adjustment Checklist:	**NOTES:**
FACTOR:	Field work will be in Level "D" PPE.
H&S Productivity (labor and equipment only)	MII assembly costs include HPF adjustments.
Escalation to Base Year	2016 cost sources are not escalated (EF=1.00). All other costs are escalated based on the USACE CWCCIS, EM 1110-2-1304, 31 Mar 2016
Area Cost Factor	An AF of 0.96 is used for Colorado, except that an AF of 1.00 (national unmodified average) is used for MII assembly costs and local vendor quotes.
Subcontractor Overhead and Profit	It is assumed that Subcontractor O&P is either included in the PC O&P or has been factored into vendor quotes or previous work.
Prime Contractor Overhead and Profit	It is assumed that home office OH is 8% and profit is 9% for the Prime Contractor. Professional labor overhead is 100%. Allowances and items with mandated costs such as per diem do not have overhead and profit applied.

TABLE CW2-2

Alternative RA2 **Cost Worksheet:** **CW2-2**
Capital Cost Sub-Element
Demobilization of Lime Storage Silo

COST WORKSHEET

Site: Gladstone Interim Water Treatment Plant
Location: San Juan County, Colorado
Phase: Engineering Evaluation / Cost Analysis
Base Year: 2016

Prepared By: JN **Date:** 10/5/2016
Checked By: EB **Date:** 10/10/2016

Work Statement:
This sub-element involves the demobilization of the lime storage silo. It assumes that following shutdown of the Gladstone IWTP, the storage silo currently used for lime storage will be demobilized off-site.

Cost Analysis:
Cost for Demobilization of Lime Storage Silo (Lump Sum)

COST DATABASE CODE	DESCRIPTION	QTY	UNIT(S)	HPF	LABOR	ADJ LABOR	EQUIP	ADJ EQUIP	MATL	OTHER	UNMOD UC	UNMOD LIC	PC OH	PC PF	BUR LIC	COST SOURCE CITATION	COMMENTS
AA2	Mobilization/Demobilization of Crane	1	LS	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$535.24	$535.24	$535.24	8%	9%	$630	MII MII Assemblies	
AA3	Loading of Storage Silo	1	LS	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$403.87	$403.87	$403.87	8%	9%	$475	MII MII Assemblies	
AA4	Demobilization of Storage Silo	1	LS	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$603.52	$603.52	$603.52	8%	9%	$710	MII MII Assemblies	
												TOTAL UNIT COST:			$1,815		

	Representative Unit Quantity	Unit(s)	Total Cost	Unit Cost
COST WORKSHEET SUMMARY	1	LS	$1,815	$1,815

Notes:
HTRW productivity factor is from Exhibit B-3 or B-4 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000
The Cost Database Code is a reference code for linking with line item cost information with the cost source database and is not otherwise used within these cost worksheets.
The quantity bolded in the QTY column is the quantity selected as the representative unit quantity for this cost worksheet. If multiple quantities are bolded, the representative unit quantity is the sum of those quantities. When the LS unit is utilized, the default representative unit quantity is 1.

Source of Cost Data:
NA Not Applicable - costs are from previous work or vendor quote
For citation references, the following sources apply:
MII (MII Assemblies), GSA (www.gsa.gov), FLC (FLC Datacenter), A (Allowance), V (Vendor Quote), CW (Means CostWorks 2016), P (Previous Work), CB (MII English Cost Book), and FRTR (www.frtr.gov)

Abbreviations:

QTY	Quantity	DY	Days
EQUIP	Equipment	EA	Each
MATL	Material	HR	Hours
HPF	HTRW Productivity Factor	LS	Lump Sum
ADJ LABOR	Adjusted Labor for HFP	MO	Months
ADJ EQUIP	Adjusted Equipment for HFP	WK	Weeks
UNMOD UC	Unmodified Unit Cost	YR	Years
UNMOD LIC	Unmodified Line Item Cost		
UNBUR LIC	Unburdened Line Item Cost		
PC OH	Prime Contractor Overhead		
PC PF	Prime Contractor Profit		
BUR LIC	Burdened Line Item Cost		

Cost Adjustment Checklist:

	NOTES:
FACTOR:	Field work will be in Level "D" PPE.
H&S Productivity (labor and equipment only)	MII assembly costs include HPF adjustments.
Escalation to Base Year	2016 cost sources are not escalated (EF=1.00). All other costs are escalated based on the USACE CWCCIS, EM 1110-2-1304, 31 Mar 2016
Area Cost Factor	An AF of 0.96 is used for Colorado, except that an AF of 1.00 (national unmodified average) is used for MII assembly costs and local vendor quotes.
Subcontractor Overhead and Profit	It is assumed that Subcontractor O&P is either included in the PC O&P or has been factored into vendor quotes or previous work.
Prime Contractor Overhead and Profit	It is assumed that home office OH is 8% and profit is 9% for the Prime Contractor. Professional labor overhead is 100%. Allowances and items with mandated costs such as per diem do not have overhead and profit applied.

TABLE CW2-3

Alternative RA2 **Cost Worksheet:** **CW2-3**
Capital Cost Sub-Element
Inspection of Diversion Features

COST WORKSHEET

Site: Gladstone Interim Water Treatment Plant
Location: San Juan County, Colorado
Phase: Engineering Evaluation / Cost Analysis
Base Year: 2016

Prepared By: JN **Date:** 10/5/2016
Checked By: EB **Date:** 10/10/2016

Work Statement:
This sub-element involves quarterly inspection of diversion features to ensure they are not clogging and are continuing to function properly. It is assumed that quarterly events would include inspections of the piping or channels used to divert the Gold King adit discharge around the mine dump and to North Fork of Cement Creek. It assumes 1 day (8 hours) of inspection per quarterly inspection event.

Cost Analysis:
Cost for Inspection of Diversion Features (Lump Sum)

COST DATABASE CODE	DESCRIPTION	QTY	UNIT(S)	HPF	LABOR	ADJ LABOR	EQUIP	ADJ EQUIP	MATL	OTHER	UNMOD UC	UNMOD LIC	PC OH	PC PF	BUR LIC	COST SOURCE CITATION	COMMENTS
L1	Environmental Engineer	32	HR	1.00	$41.78	$41.78	$0.00	$0.00	$0.00	$0.00	$41.78	$1,336.96	100%	9%	$2,915	FLC FLC Datacenter	Assumes 8 hours per quarterly inspection.
L2	Field Engineer	32	HR	1.00	$22.73	$22.73	$0.00	$0.00	$0.00	$0.00	$22.73	$727.36	100%	9%	$1,586	FLC FLC Datacenter	Assumes 8 hours per quarterly inspection.
AA5	Pickup Truck	4	DY	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$97.42	$97.42	$389.68	8%	9%	$459	MII MII Assemblies	Assumes 1 day per quarterly inspection.
												TOTAL UNIT COST:			$4,960		

	Representative Unit Quantity	Unit(s)	Total Cost	Unit Cost
COST WORKSHEET SUMMARY	1	LS	$4,960	$4,960

Notes:
HTRW productivity factor is from Exhibit B-3 or B-4 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000
The Cost Database Code is a reference code for linking with line item cost information with the cost source database and is not otherwise used within these cost worksheets.
The quantity bolded in the QTY column is the quantity selected as the representative unit quantity for this cost worksheet. If multiple quantities are bolded, the representative unit quantity is the sum of those quantities. When the LS unit is utilized, the default representative unit quantity is 1.

Source of Cost Data:
NA Not Applicable - costs are from previous work or vendor quote
For citation references, the following sources apply:
MII (MII Assemblies), GSA (www.gsa.gov), FLC (FLC Datacenter), A (Allowance), V (Vendor Quote), CW (Means CostWorks 2016), P (Previous Work), CB (MII English Cost Book), and FRTR (www.frtr.gov)

Abbreviations:

QTY	Quantity	DY	Days
EQUIP	Equipment	EA	Each
MATL	Material	HR	Hours
HPF	HTRW Productivity Factor	LS	Lump Sum
ADJ LABOR	Adjusted Labor for HFP	MO	Months
ADJ EQUIP	Adjusted Equipment for HFP	WK	Weeks
UNMOD UC	Unmodified Unit Cost	YR	Years
UNMOD LIC	Unmodified Line Item Cost		
UNBUR LIC	Unburdened Line Item Cost		
PC OH	Prime Contractor Overhead		
PC PF	Prime Contractor Profit		
BUR LIC	Burdened Line Item Cost		

Cost Adjustment Checklist:	**NOTES:**
FACTOR:	Field work will be in Level "D" PPE.
H&S Productivity (labor and equipment only)	MII assembly costs include HPF adjustments.
Escalation to Base Year	2016 cost sources are not escalated (EF=1.00). All other costs are escalated based on the USACE CWCCIS, EM 1110-2-1304, 31 Mar 2016
Area Cost Factor	An AF of 0.96 is used for Colorado, except that an AF of 1.00 (national unmodified average) is used for MII assembly costs and local vendor quotes.
Subcontractor Overhead and Profit	It is assumed that Subcontractor O&P is either included in the PC O&P or has been factored into vendor quotes or previous work.
Prime Contractor Overhead and Profit	It is assumed that home office OH is 8% and profit is 9% for the Prime Contractor. Professional labor overhead is 100%. Allowances and items with mandated costs such as per diem do not have overhead and profit applied.

TABLE CW2-4

Alternative RA2
Capital Cost Sub-Element
Equalization Pond Cleaning

Cost Worksheet: **CW2-4**

COST WORKSHEET

Site: Gladstone Interim Water Treatment Plant
Location: San Juan County, Colorado
Phase: Engineering Evaluation / Cost Analysis
Base Year: 2016

Prepared By: JN **Date:** 10/31/2016
Checked By: EW **Date:** 11/1/2016

Work Statement:
This sub-element involves cleaning of the equalization pond at the interim water treatment plant. Assumes equalization pond cleaning with vac truck following suspension of water treatment activities. Costs are based on previously incurred costs for the site.

Cost Analysis:
Cost for Equalization Pond Cleaning (Lump Sum)

COST DATABASE CODE	DESCRIPTION	QTY	UNIT(S)	HPF	LABOR	ADJ LABOR	EQUIP	ADJ EQUIP	MATL	OTHER	UNMOD UC	UNMOD LIC	PC OH	PC PF	BUR LIC	COST SOURCE CITATION	COMMENTS
SU2	Equalization Pond Cleaning	1	EA	1.00	$0.00	$0.00	$0.00	$0.00	$0.00	$20,000.00	$20,000.00	$20,000.00	0%	0%	$20,000	P Previous Work	Pond cleaning with vac truck. Based on costs provided by the contractor for the Gladstone IWTP.
												TOTAL UNIT COST:			$20,000		

	Representative Unit Quantity	Unit(s)	Total Cost	Unit Cost
COST WORKSHEET SUMMARY	1	LS	$20,000	$20,000

Notes:
HTRW productivity factor is from Exhibit B-3 or B-4 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000
The Cost Database Code is a reference code for linking with line item cost information with the cost source database and is not otherwise used within these cost worksheets.
The quantity bolded in the QTY column is the quantity selected as the representative unit quantity for this cost worksheet. If multiple quantities are bolded, the representative unit quantity is the sum of those quantities. When the LS unit is utilized, the default representative unit quantity is 1.

Source of Cost Data:
NA Not Applicable - costs are from previous work or vendor quote
For citation references, the following sources apply:
MII (MII Assemblies), GSA (www.gsa.gov), FLC (FLC Datacenter), A (Allowance), V (Vendor Quote), CW (Means CostWorks 2016), P (Previous Work), CB (MII English Cost Book), and FRTR (www.frtr.gov)

Abbreviations:

QTY	Quantity	DY	Days
EQUIP	Equipment	EA	Each
MATL	Material	HR	Hours
HPF	HTRW Productivity Factor	LS	Lump Sum
ADJ LABOR	Adjusted Labor for HFP	MO	Months
ADJ EQUIP	Adjusted Equipment for HFP	WK	Weeks
UNMOD UC	Unmodified Unit Cost	YR	Years
UNMOD LIC	Unmodified Line Item Cost		
UNBUR LIC	Unburdened Line Item Cost		
PC OH	Prime Contractor Overhead		
PC PF	Prime Contractor Profit		
BUR LIC	Burdened Line Item Cost		

Cost Adjustment Checklist:	**NOTES:**
FACTOR:	Field work will be in Level "D" PPE.
H&S Productivity (labor and equipment only)	MII assembly costs include HPF adjustments.
Escalation to Base Year	2016 cost sources are not escalated (EF=1.00). All other costs are escalated based on the USACE CWCCIS, EM 1110-2-1304, 31 Mar 2016
Area Cost Factor	An AF of 0.96 is used for Colorado, except that an AF of 1.00 (national unmodified average) is used for MII assembly costs and local vendor quotes.
Subcontractor Overhead and Profit	It is assumed that Subcontractor O&P is either included in the PC O&P or has been factored into vendor quotes or previous work.
Prime Contractor Overhead and Profit	It is assumed that home office OH is 8% and profit is 9% for the Prime Contractor. Professional labor overhead is 100%. Allowances and items with mandated costs such as per diem do not have overhead and profit applied.

Cost Estimate Backup

TABLE PV-ADRFT

PRESENT VALUE ANALYSIS

Annual Discount Rate Factors Table

Site: Gladstone Interim Water Treatment Plant
Bonita Peak Mining District Superfund Site
Location: San Juan County, Colorado
Phase: Engineering Evaluation / Cost Analysis
Base Year: 2016

Discount Rate (Percent): 7.0

Year	Discount Factor[1,2]	Year	Discount Factor[1,2]
0	1.0000	26	0.1722
1	0.9346	27	0.1609
2	0.8734	28	0.1504
3	0.8163	29	0.1406
4	0.7629	30	0.1314
5	0.7130	31	0.1228
6	0.6663	32	0.1147
7	0.6227	33	0.1072
8	0.5820	34	0.1002
9	0.5439	35	0.0937
10	0.5083		
11	0.4751		
12	0.4440		
13	0.4150		
14	0.3878		
15	0.3624		
16	0.3387		
17	0.3166		
18	0.2959		
19	0.2765		
20	0.2584		
21	0.2415		
22	0.2257		
23	0.2109		
24	0.1971		
25	0.1842		

Notes:

[1] Annual discount factors were calculated using the formulas and guidance presented in Section 4.0 of "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000.

[2] The real discount rate of 7.0% was obtained from "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 2000, Page 4-5.

COST INDICES FOR ESCALATION

Base Year for Work: **2016**

Year	Cost Index[1]
2000	497.07
2001	503.52
2002	517.46
2003	529.95
2004	571.29
2005	608.36
2006	641.91
2007	673.52
2008	716.54
2009	703.00
2010	724.17
2011	756.48
2012	773.75
2013	787.64
2014	804.05
2015	804.97
2016	805.59
2017	819.66
2018	834.42
2019	851.11
2020	868.13
2021	885.49
2022	903.20
2023	921.27
2024	939.69
2025	958.48

1 Yearly composite cost index (weighted average) from the U.S. Army Corps of Engineers Civil Works Construction Cost Index System (CWCCIS), EM 1110-2-1304, 31 March 2000. Revised as of 31 March 2016.

FLC Data Center

Base Year: **2016**

COST CODES FOR LABOR AND UNIT COSTS

Cost Code	Description	Units	Unit Labor Cost	Unit Equipment Cost	Unit Material Cost	Unit Other Cost	Year of Cost Source	Escalation Factor	Area Factor	Adjusted Labor Cost	Adjusted Equipment Cost	Adjusted Material Cost	Adjusted Other Cost	PC OH	PC PF	Cost Source		Comments
																Source	Source ID	
L1	Environmental Engineer	HR	$41.78	$0.00	$0.00	$0.00	2016	1	1	$41.78	$0.00	$0.00	$0.00	100%	9%	FLC	FLC Datacenter	
L2	Field Engineer	HR	$22.73	$0.00	$0.00	$0.00	2016	1	1	$22.73	$0.00	$0.00	$0.00	100%	9%	FLC	FLC Datacenter	

Base Year: 2016

COST CODES FOR MATERIAL AND UNIT COSTS

Cost Code	Description	Units	Unit Labor Cost	Unit Equipment Cost	Unit Material Cost	Unit Other Cost	Year of Cost Source	Escalation Factor	Area Factor	Adjusted Labor Cost	Adjusted Equipment Cost	Adjusted Material Cost	Adjusted Other Cost	PC OH	PC PF	Cost Source		Comments
																Source	Source ID	
MA1	Shutdown and Mothballing Allowance	LS	$0.00	$0.00	$0.00	$15,000.00	2016	1	1	$0.00	$0.00	$0.00	$15,000.00	0%	0%	A	Allowance	Per Estimator
MA2	Geomembrane Liner	SF	$0.00	$0.00	$0.30	$0.00	2016	1	1	$0.00	$0.00	$0.30	$0.00	0%	0%	V	Vendor Quote	Source: GSE, 2016

Base Year: 2016

COST CODES FOR SUBCONTRACTORS AND UNIT COSTS

Cost Code	Work or Material Description	escription for Cost Workshee	Units	Unit Cost	Year of Cost Source	Escalation Factor	Area Factor	Adjusted Unit Cost	PC OH	PC PF	Cost Source		Comments
											Source	Source ID	
SU1	Snow Removal	Snow Removal	MO	$3,750.00	2016	1.00	1	$3,750.00	0%	0%	P	Previous Work	Snow removal services required for 6 months per year. Based on costs provided by the contractor for the Gladstone IWTP.
SU2	Pond Cleaning	Pond Cleaning	EA	$20,000.00	2016	1.00	1	$20,000.00	0%	0%	P	Previous Work	Pond cleaning with vac truck. Occurs twice per year (once in the spring and once in the fall). Based on costs provided by the contractor for the Gladstone IWTP.
SU3	Sludge Removal and Liner Replacement	Sludge Removal and Liner Replacement	EA	$125,000.00	2016	1.00	1	$125,000.00	0%	0%	P	Previous Work	Occurs twice per year (once in the spring and once in the fall). Based on costs provided by the contractor for the Gladstone IWTP.
SU4	Weekly Operation (Typical)	Weekly Operation (Typical)	WK	$16,000.00	2016	1.00	1	$16,000.00	0%	0%	P	Previous Work	Typical non-peak operation costs. Based on costs provided by the contractor for the Gladstone IWTP.
SU5	Weekly Operation (Peak - High)	Weekly Operation (Peak - High)	WK	$34,000.00	2016	1.00	1	$34,000.00	0%	0%	P	Previous Work	Cost during high peak metal loads. Assumes 4 weeks per year of high peak metal loads. Based on costs provided by the contractor for the Gladstone IWTP.
SU6	Weekly Operation (Peak - Low)	Weekly Operation (Peak - Moderate)	WK	$26,000.00	2016	1.00	1	$26,000.00	0%	0%	P	Previous Work	Cost during low peak metal loads. Assumes 2 weeks per year of low peak metal loads. Based on costs provided by the contractor for the Gladstone IWTP.

Base Year: **2016**

COST CODES FOR MII ASSEMBLIES AND UNIT COSTS

Cost Code	Work or Material Description	Description for Cost Worksheets	Units	MII Unit Cost	Year of Cost Source	Escalation Factor	Area Factor	Adjusted MII Unit Cost	PC OH	PC PF	Cost Source		Comments
											Source	Source ID	
AA1	Shutdown and Mothballing Crew	Shutdown and Mothballing Crew	WK	$4,853.14	2016	1.00	1	$4,853.14	8%	9%	MII	MII Assemblies	
AA2	Mobilization/Demobilization of Crane	Mobilization/Demobilization of Crane	LS	$535.24	2016	1.00	1	$535.24	8%	9%	MII	MII Assemblies	
AA3	Loading of Storage Silo	Loading of Storage Silo	LS	$403.87	2016	1.00	1	$403.87	8%	9%	MII	MII Assemblies	
AA4	Demobilization of Storage Silo	Demobilization of Storage Silo	LS	$603.52	2016	1.00	1	$603.52	8%	9%	MII	MII Assemblies	
AA5	Pickup Truck	Pickup Truck	DY	$97.42	2016	1.00	1	$97.42	8%	9%	MII	MII Assemblies	
AA6	Loading of Sludge	Loading of Sludge	LCY	$0.73	2016	1.00	1	$0.73	8%	9%	MII	MII Assemblies	
AA7	Transporation of Sludge	Transportation of Sludge	LCY	$5.40	2016	1.00	1	$5.40	8%	9%	MII	MII Assemblies	Assumes 12 mile one-way haul distance
AA8	Material Spreading at Sludge Management Area	Material Spreading at Sludge Management Area	LCY	$1.46	2016	1.00	1	$1.46	8%	9%	MII	MII Assemblies	
AA9	Clearing and Grubbing	Clearing and Grubbing	ACR	$2,323.27	2016	1.00	1	$2,323.27	8%	9%	MII	MII Assemblies	
AA10	Excavation	Excavation	BCY	$0.98	2016	1.00	1	$0.98	8%	9%	MII	MII Assemblies	
AA11	Grading	Grading	LCY	$1.85	2016	1.00	1	$1.85	8%	9%	MII	MII Assemblies	
AA12	Compaction	Compaction	ECY	$0.52	2016	1.00	1	$0.52	8%	9%	MII	MII Assemblies	
AA13	Geomembrane Liner Installation	Geomembrane Liner Installation	SF	$0.14	2016	1.00	1	$0.14	8%	9%	MII	MII Assemblies	

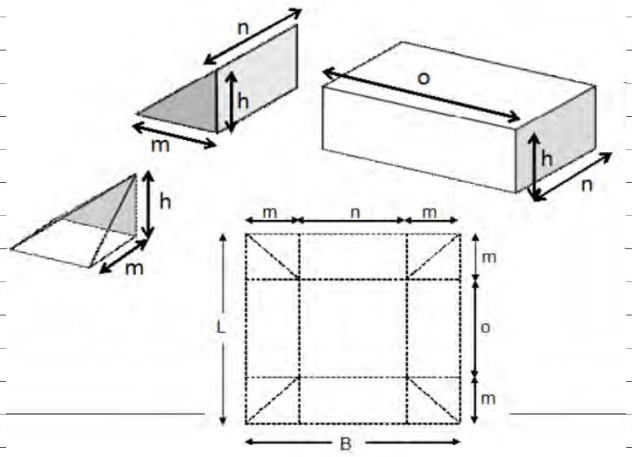
Calculations

PROJECT:	Gladstone Interim Water Treatment Plant	COMPUTED BY :	JN	CHECKED BY:	EW
JOB NO.:	213478.6460.DK2.004.EECAZ	DATE :	10/31/2016	DATE CHECKED:	11/1/2016
CLIENT:	EPA Region 8			WRKSHT NO.:	Sludge Area Calcs

Description: Calculations and assumptions for the development of quantities for the contruction of an interim sludge management area for Alternative RA1

Interim Sludge Management Area Construction (Alternative RA1)

Estimated Annual Sludge Production, CY:	6,000	*Based on previous experience*
Estimated Sludge Currently Stockpiled at Gladstone IWTP, CY:	6,000	*Estimated 1 years worth of sludge currently stockpiled*
Length after Initiation of NTCRA, YR:	5	*Based on assumptions in the EE/CA report*
Sludge Generated after Initiation of NTCRA, CY:	30,000	
Assumed Capacity for Interim Sludge Management Area, CY:	36,000	*Assumes volume currently stockpiled plus 5 additional years of sludge generation*



Vertical Slope:	1	*Assumed*
Horizontal Slope:	3	*Assumed*
Repository Slope:	0.333	
Proposed Storage Cell Capacity, CY:	36,000	*Calculated above*
Proposed Storage Cell Capacity, CF:	972,000	
Base_L, FT:	600	*Assumed*
Storage Cell Height, FT:	5	*Assumed*

Storage Cell Equations

$$Proposed\ Cell\ Capacity = \frac{1}{3} * Repository\ Height * (2 * Base_m)^2 + 2 * \left(\frac{1}{2} * Repository\ Height * Base\_m * Base\_o\right) + 2 * \left(\frac{1}{2} * Repository\ Height * Base\_m * Base\_n\right) + Base\_o * Base\_n * Repository\ Height$$

$$Surface\ Area\ of\ Cell\ = 2 * \left(\sqrt{Base_m{}^2 + Repository\ Height^2} * Base_o\right) + 2 * \left(\sqrt{Base\_m^2 + Repository\ Height^2} * Base\_n\right) + Base\_o * Base\_n$$

PROJECT:	Gladstone Interim Water Treatment Plant	COMPUTED BY :	JN	CHECKED BY:	EW
JOB NO.:	213478.6460.DK2.004.EECAZ	DATE :	10/31/2016	DATE CHECKED:	11/1/2016
CLIENT:	EPA Region 8			WRKSHT NO.:	Sludge Area Calcs

Description: Calculations and assumptions for the development of quantities for the contruction of an interim sludge management area for Alternative RA1

Calculated Storage Cell Dimensions and Surface Area		
Base_m, FT:	15	
Base_o, FT:	570	
Base_n, FT:	320	
Base_B, FT:	350	
Storage Cell Area Footprint, AC:	4.8	
Storage Cell Liner Surface Area, AC:	4.8	
Storage Cell Liner Surface Area, SF:	210,540	
Storage Cell Liner Surface Area, SY:	23,393	
Site Preparation		
Clearing and Grubbing, AC:	**4.8**	
Excavation, BCY:	**36,000**	*Assumes full sludge cell will be below ground surface*
Grading, SY:	**23,400**	*Rounded up to nearest tens*
Compaction, ECY:	**7,800**	*Assumes 12" surface layer will require compaction following grading. Rounded up to nearest tens*
Install Geomembrane Liner		
Approximate Surface Area of Storage Cell Liner, SF:	210,540	
Assumed Overlap, %:	*10%*	
Install Geomembrane Liner, SF:	**231,600**	*Rounded up to nearest hundreds*

PROJECT:	Gladstone Interim Water Treatment Plant	COMPUTED BY :	EW	CHECKED BY:	JN
JOB NO.:	213478.6460.DK2.004.EECAZ	DATE :	10/28/2016	DATE CHECKED:	10/31/2016
CLIENT:	EPA Region 8			WRKSHT NO.:	PD-01A

Description: Determine the productivity of hauling sludge to interim storage area.

Productivity Determinations - Hauling Sludge to Interim Storage Area

	Dump Truck	
Type of Truck (Make and Model):	---	
Truck Capacity, LCY:	20	*MII Equipment Library*
Assumptions		
Truck Capacity Factor, %:	90%	
Work Efficiency, %:	80%	
Hours per Shift, HR:	7	
Distance for Haul, MI:	12	
Average Speed, MPH:	20	
Unloaded Haul Time, MIN:	36	
Loaded Haul Time (20% additional time), MIN:	43	
Hauling Productivity Determination		
Truck Capacity, LCY:	20	
Truck Capacity Factor, %	90%	
Payload Capacity, LCY:	18	
Work Efficiency, %:	80%	
Adjusted Loading Productivity, LCY/HR:	147.3	*See PD-02A*
Load Time per Truck, MIN:	7.3	
Dump and Maneuver Time, MIN:	5.0	
On Road Haul Time, MIN:	43	
On Road Return Time, MIN:	36	
Cycle Time per Truck, MIN/Cycle:	91.5	
Cycle Time per Truck, HR/Cycle:	1.53	
Ideal Cycles Per Day, Cycle/Truck/DY:	5	
Ideal Productivity per Truck, LCY/HR:	12.9	
Adjusted Productivity per Truck, LCY/HR:	**10.3**	
Number of Haul Trucks Anticipated:	1	
Total Hauling Productivity, CY/HR:	**10.3**	

PROJECT:	Gladstone Interim Water Treatment Plant	COMPUTED BY :	EW	CHECKED BY:	JN
JOB NO.:	213478.6460.DK2.004.EECAZ	DATE :	10/28/2016	DATE CHECKED:	10/31/2016
CLIENT:	EPA Region 8			WRKSHT NO.:	PD-01B

Description: General assumptions for loader productivity of sludge.

Productivity Determinations - Loader - Sludge

Wheel Loader

Type of loader (make and model): **CAT - 930 Series**

Assumptions

Assumed Bucket Capacity, CY:	3	
Hours per Shift, HR:	8	
Work Efficiency, %:	50%	
Operator Ability Correction Factor:	0.9	

Loader Productivity Determination

Bucket Size, CY:	3	
	Moist Loam	
Bucket Fill Factor, %:	100%	*(Ref: CAT Performance Handbook-40, Pages 12-107 to -108)*
Bucket Payload, CY:	3	
Work Efficiency, %:	50%	*Assumed*
Operator Ability Correction Factor:	0.9	*Assumed*
Total Cycle Time, MIN/cycle:	0.55	*(Ref: CAT Performance Handbook-40, Page 12-107)*
Ideal Loader Productivity, LCY/HR:	327.3	
Adjusted Loader Productivity, LCY/HR:	147.3	
Total Loader Productivity, LCY/HR:	**147.3**	

MII Assemblies Cost Backup

Gladstone Interim Water Treatment Plant
Bonita Peak Mining District Superfund Site
Engineering Evaluation/Cost Analysis
San Juan County, Colorado
November 2016

Estimated by	CDM Federal Programs Corporation
Designed by	CDM Federal Programs Corporation
Prepared by	Justin Nielsen
Preparation Date	11/1/2016
Effective Date of Pricing	11/1/2016
Estimated Construction Time	365 Days

Table of Contents

Description	CrewHours	MemberType	MemberRate	ManHours	LaborCost	EQHours	EQCost	CrewCost
Crews (Bare Costs), Report								
Shutdown and Mothballing of Treatment System								
USR A4 Shutdown and Mothballing Crew	**40.00**			**180.00**	**3,507.40**	**100.00**	**1,345.74**	**4,853.14**
MIL B-EQOPRLT Equip. Operators, Light		Journeyman	19.45	0.50	9.73			
MIL B-SKILLWKR Skilled Workers		Journeyman	19.49	4.00	77.96			
GEN F10Z3000 FORK LIFT, ROUGH TERRAIN, 4,000 LB (1,814 KG), 14.0' (4.3 M) HIGH, TELESCOPING MAST		EP / Average	18.58			0.50	9.29	
EP T50XX012 TRUCK, HIGHWAY, CREW, 1 TON PICKUP, 4X4		EP / Average	12.18			2.00	24.36	
Demobilization of Rental Storage Silo								
USR A7 Mobilization/Demobilization of Crane				**5.00**	**102.95**	**15.00**	**432.29**	**535.24**
MIL B-TRKDVRHV Truck Drivers, Heavy		Journeyman	20.59	5.00	102.95			
EP C75BD010 CRANES, HYDRAULIC, SELF-PROPELLED, YARD, 18.0 TON, 50' BOOM, 4X4		EP / Average	31.61			5.00	158.04	
MAP T45XX019 TRUCK TRAILER, LOWBOY, 75 TON, 3 AXLE (ADD TOWING TRUCK)		EP / Average	11.79			5.00	58.93	
MAP T50XX031 TRUCK, HIGHWAY, 75,000 LBS GVW, 3 AXLE, 6X4 (CHASSIS ONLY-ADD OPTIONS)		EP / Average	43.06			5.00	215.32	
USR A8 Loading of Storage Silo				**16.00**	**277.44**	**4.00**	**126.43**	**403.87**
MIL B-LABORER Laborers, (Semi-Skilled)		Journeyman	14.91	12.00	178.92			
MIL B-EQOPRCRN Equip. Operators, Heavy		Journeyman	24.63	4.00	98.52			
EP C75BD010 CRANES, HYDRAULIC, SELF-PROPELLED, YARD, 18.0 TON, 50' BOOM, 4X4		EP / Average	31.61			4.00	126.43	
USR A9 Demobilization of Storage Silo				**8.00**	**164.72**	**16.00**	**438.80**	**603.52**
MIL B-TRKDVRHV Truck Drivers, Heavy		Journeyman	20.59	8.00	164.72			
MAP T45XX019 TRUCK TRAILER, LOWBOY, 75 TON, 3 AXLE (ADD TOWING TRUCK)		EP / Average	11.79			8.00	94.29	
MAP T50XX031 TRUCK, HIGHWAY, 75,000 LBS GVW, 3 AXLE, 6X4 (CHASSIS ONLY-ADD OPTIONS)		EP / Average	43.06			8.00	344.51	
Inspections of Diversion Features								
USR A8 Pickup Truck	**8.00**			**0.00**	**0.00**	**8.00**	**97.42**	**97.42**
EP T50XX012 TRUCK, HIGHWAY, CREW, 1 TON PICKUP, 4X4		EP / Average	12.18			1.00	12.18	
Transportation of Sludge								
USR EW-HAUL-01 Hauling				**0.10**	**2.00**	**0.19**	**3.40**	**5.40**
MIL B-TRKDVRHV Truck Drivers, Heavy		Journeyman	20.59	1.00	20.59			
GEN T40Z6860 TRUCK OPTION, DUMP BODY, REAR, 16-23.5 CY (12.2-18 M3) (ADD 45,000 LB (20,412 KG) GVW TRUCK)		EP / Average	3.67			1.00	3.67	
GEN T50Z7580 TRUCK, HIGHWAY, 45,000 LB (20,412 KG) GVW, 6X4, 3 AXLE (ADD ACCESSORIES)		EP / Average	31.34			1.00	31.34	
USR EW-MATLHNDL-001 Material Loading				**0.01**	**0.24**	**0.01**	**0.49**	**0.73**

Labor ID: GK_2016 EQ ID: EP14R05 Currency in US dollars TRACES MII Version 4.3

Description	CrewHours	MemberType	MemberRate	ManHours	LaborCost	EQHours	EQCost	CrewCost
MIL B-EQOPRCRN Equip. Operators, Heavy		Journeyman	24.63	1.00	24.63			
MIL B-SKILLWKR Skilled Workers		Foreman	20.49	0.50	10.25			
MAP L40CS010 LOADER, FRONT END, WHEEL, 3.0 CY BUCKET, ARTICULATED, 4X4		EP / Severe	67.56			1.00	67.56	
MAP L40CS010 LOADER, FRONT END, WHEEL, 3.0 CY BUCKET, ARTICULATED, 4X4		EP / Standby	9.46			0.50	4.73	
USR EW-MATLHNDL-002 Material Spreading				**0.02**	**0.47**	**0.02**	**0.98**	**1.46**
MIL B-EQOPRCRN Equip. Operators, Heavy		Journeyman	24.63	1.00	24.63			
MIL B-SKILLWKR Skilled Workers		Foreman	20.49	0.50	10.25			
MAP L40CS010 LOADER, FRONT END, WHEEL, 3.0 CY BUCKET, ARTICULATED, 4X4		EP / Severe	67.56			1.00	67.56	
MAP L40CS010 LOADER, FRONT END, WHEEL, 3.0 CY BUCKET, ARTICULATED, 4X4		EP / Standby	9.46			0.50	4.73	
Interim Sludge Management Area Construction								
USR EW-COM-001 Compaction				**0.01**	**0.22**	**0.01**	**0.29**	**0.52**
MIL B-SKILLWKR Skilled Workers		Foreman	20.49	1.00	20.49			
MIL B-EQOPRMED Equip. Operators, Medium		Journeyman	19.51	1.00	19.51			
EP R50BO013 ROLLER, VIBRATORY, SELF-PROPELLED, SINGLE DRUM, PAD FOOT, 14.1 TON, 83.9" WIDE, 3X2, SOIL COMPACTOR		EP / Average	52.34			1.00	52.34	
USR EW-EXC-001 Excavation				**0.02**	**0.34**	**0.01**	**0.64**	**0.98**
MIL B-EQOPRCRN Equip. Operators, Heavy		Journeyman	24.63	1.00	24.63			
MIL B-SKILLWKR Skilled Workers		Foreman	20.49	0.50	10.25			
MIL B-LABORER Laborers, (Semi-Skilled)		Journeyman	14.91	1.00	14.91			
GEN H25Z3205 HYDRAULIC EXCAVATOR, CRAWLER, 110,000 LB (49,895 KG), 3.00 CY (2.3 M3) BUCKET, 27.5' (8.4 M) MAX DIGGING DEPTH		EP / Severe	95.56			1.00	95.56	
USR EW-GEO-INS-001 Geomembrane Liner Installation				**0.01**	**0.11**	**0.00**	**0.04**	**0.14**
MIL B-LABORER Laborers, (Semi-Skilled)		Journeyman	14.91	4.00	59.64			
MIL B-SKILLWKR Skilled Workers		Foreman	20.49	1.00	20.49			
MAP L40ME012 LOADER, FRONT END, WHEEL, SKID-STEER, 14.3 CF, 60" BUCKET		EP / Average	10.03			1.00	10.03	
MAP T45XX025 TRUCK TRAILER, FLATBED, 25 TON, 2 AXLE (ADD TOWING TRUCK)		EP / Average	5.78			1.00	5.78	
EP T50XX006 TRUCK, HIGHWAY, CONVENTIONAL, 1 TON PICKUP, 4X4		EP / Average	11.64			1.00	11.64	
USR EW-GRAD-001 Grading				**0.03**	**0.49**	**0.01**	**1.35**	**1.85**
MIL B-LABORER Laborers, (Semi-Skilled)		Journeyman	14.91	1.00	14.91			
MIL B-EQOPRCRN Equip. Operators, Heavy		Journeyman	24.63	1.00	24.63			
GEN T15Z6520 TRACTOR, CRAWLER (DOZER), 181-250 HP (135-186 KW), POWERSHIFT, LGP, W/UNIVERSAL BLADE		EP / Severe	108.34			1.00	108.34	

Labor ID: GK_2016 EQ ID: EP14R05 Currency in US dollars TRACES MII Version 4.3

Description	CrewHours	MemberType	MemberRate	ManHours	LaborCost	EQHours	EQCost	CrewCost
USR SW-GRUB-001 Clearing and Grubbing				**30.00**	**558.94**	**20.00**	**1,764.33**	**2,323.27**
MIL B-SKILLWKR Skilled Workers		Foreman	20.49	0.50	10.25			
MIL B-TRKDVRHV Truck Drivers, Heavy		Journeyman	20.59	1.00	20.59			
MIL B-LABORER Laborers, (Semi-Skilled)		Journeyman	14.91	4.00	59.64			
MIL B-EQOPRCRN Equip. Operators, Heavy		Journeyman	24.63	2.00	49.26			
GEN B20Z1000 BRUSH CHIPPER, 22" (559 MM) DIA LOG DISC TYPE CUTTER, TRAILER MOUNTED		EP / Average	188.67			1.00	188.67	
GEN C05Z1210 CHAINSAW, 24" - 42" (610-1,067 MM) BAR		EP / Average	2.56			2.00	5.13	
EP T55VO004 TRUCK, OFF-HIGHWAY, ARTICULATED FRAME, 19-25 CY, 35 TON, 6X6, REAR DUMP		EP / Severe	166.28			1.00	166.28	
GEN H25Z3190 HYDRAULIC EXCAVATOR, CRAWLER, 70,000 LB (31,751 KG), 2.00 CY (1.5 M3) BUCKET, 21.6' (6.6 M) MAX DIGGING DEPTH		EP / Severe	81.01			1.00	81.01	

Labor ID: GK_2016 EQ ID: EP14R05 Currency in US dollars TRACES MII Version 4.3