Montana Environmental Trust Group

Public Review Draft

Former ASARCO East Helena Facility Corrective Measures Study Report



March 2018

Prepared for

Montana Environmental Trust Group, LLC
Trustee of the Montana Environmental Custodial Trust

ch2m

Questions or comments regarding the
Custodial Trust and its activities at the former
ASARCO East Helena Facility can be directed to:

Cynthia Brooks
President
Greenfield Environmental Trust Group, Inc
Montana Environmental Trust Group, LLC, Trustee
of the Montana Environmental Custodial Trust
44 Shattuck Road
Watertown, MA 02472
e-mail: cb@g-etg.com

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Acronyms and Abbreviations

µg/dL	microgram(s) per deciliter
ACM	asbestos-containing material
ALM	Adult Lead Model
ANPR	Advanced Notice of Proposed Rule-Making
AOC	Area of Contamination
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BTAG	Biological Technical Assistance Group
BTV	Background Threshold Value
CAMP	Corrective Action Monitoring Plan
CAMU	Corrective Action Management Unit
CC/RA	*Current Conditions/Release Assessment, East Helena Facility*
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMI	Corrective Measures Implementation
CMS	Corrective Measures Study
CMS Report	*Former ASARCO East Helena Facility Corrective Measures Study Report*
COC	constituent of concern
COEH	City of East Helena
COPC	constituent of potential concern
CSM	conceptual site model
Custodial Trust	Montana Environmental Custodial Trust
DEQ-7	Circular MDEQ-7 (from Montana Department of Environmental Quality)
DNRC	Montana Department of Natural Resources and Conservation
EC	engineering control
EPC	Exposure Point Concentration
ET	evapotranspiration
EVCGWA	East Valley Controlled Groundwater Area
H:V	horizontal to vertical (slope)
HDS	high-density sludge
HQ	hazard quotient
IC	institutional control
IM	interim measure
ISM	incremental sampling methodology

ITRC	Interstate Technology and Regulatory Council
LOEC	lowest observed effect concentration
MCL	maximum contaminant level
MCS	media cleanup standard
MDEQ	Montana Department of Environmental Quality
mg/kg	milligram(s) per kilogram
mg/L	milligram(s) per liter
MVS	Mining Visualization System
NOAEL	no observed adverse effect level
NPW	net present worth
OU	Operable Unit
OU-2	Operable Unit 2
PPE	personal protective equipment
PPC	Prickly Pear Creek
PRB	permeable/passive reactive barrier
RAO	remedial action objective
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation and Feasibility Study
RFI	RCRA Facility Investigation
RME	Reasonable Maximum Exposure
ROD	Record of Decision
RSL	regional screening level
SAI	source area investigation
SPHC	South Plant Hydraulic Control
SSL	soil screening level
TPA	Tito Park Area
TRV	Toxicity Reference Value
UCL	Upper Confidence Limit
U.S.	United States
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
UTL	Upper Tolerance Limit
WSA	West Selenium [Source] Area
yd^3	cubic yard(s)

SECTION 1

Introduction

The former ASARCO East Helena site (Facility) in East Helena, Montana, has been the focus of environmental investigation, demolition, and remediation since closure of operations in 2001. The Montana Environmental Trust Group, LLC, Trustee of the Montana Environmental Custodial Trust (Custodial Trust), submits this *Former ASARCO East Helena Facility Corrective Measures Study Report* (CMS Report) to the U.S. Environmental Protection Agency (USEPA) to address Paragraph 39 of the First Modification to the 1998 Resource Conservation and Recovery Act (RCRA) Consent Decree (First Modification) (Dreher et al., 2012) for the Facility, which states, "*…the primary purpose of a CMS is to investigate and evaluate potential alternative remedies to protect human health and the environment from the release or potential release of hazardous waste or hazardous constituents from the Facility and to restore contaminated media to standards acceptable to EPA.*" Accordingly, the primary purpose of this CMS Report is to describe the process by which remedial action alternatives were developed and evaluated in order to identify a recommended alternative for addressing soil, groundwater, surface water, and sediment contaminated by the Facility.

This CMS Report meets applicable regulatory requirements and is consistent with USEPA guidance, including the *RCRA Corrective Action Plan* (USEPA, 1994), *Advanced Notice of Proposed Rulemaking: Corrective Action for Solid Waste Management Units at Hazardous Waste Management Facilities* (ANPR) (USEPA, 1996), *RCRA Cleanup Reform*s (USEPA, 2013), *Expectations for Final Remedies at RCRA Corrective Action Facilities*, *Fact Sheet #2* (USEPA, 2000), and *Handbook of Groundwater Protection and Cleanup Policies for RCRA Corrective Action* (USEPA, 2004a).

1.1 Regulatory Background

The Custodial Trust has developed this CMS Report under the oversight of USEPA, as Lead Agency for the Facility and in consultation with the other Beneficiaries of the Custodial Trust (defined hereafter). The operations and activities of the Custodial Trust are governed by the Consent Decree and Settlement Agreement Regarding the Montana Sites, which became effective on December 9, 2009 (Settlement Agreement). Pursuant to the Settlement Agreement, the purpose of the Custodial Trust is "…*to own the Montana Designated Properties, carry out administrative and property management functions…manage and/or fund implementation of future Environmental Actions approved by the Lead Agency…and ultimately to sell, transfer, facilitate reuse of, or otherwise dispose or provide for the long-term stewardship of all or part of the Montana Designated Properties*…." (See Section 5.a of the Settlement Agreement.)

As noted above, USEPA is the Lead Agency for the Facility. The Beneficiaries of the Custodial Trust are the U.S. and the State of Montana. The U.S. is represented by USEPA, the U.S. Department of Justice, and the U.S. Fish and Wildlife Service (USFWS). The State of Montana is represented by the Montana Department of Environmental Quality (MDEQ) and the Montana Department of Justice. Additionally, Custodial Trust activities related to real property that are not environmental actions, including East Helena property leasing, conveyance, sale, or other land disposition, must be jointly approved by USEPA and the State. The Custodial Trust must fulfill its responsibilities under the Settlement Agreement consistent with its legal and fiduciary obligations to the Beneficiaries of the Custodial Trust.

1.2 Definitions

This section provides definitions for the key terms used throughout this CMS Report. Terms defined specifically within the First Modification are repeated herein for the convenience of the reader, and other common terms are defined for clarity.

Two terms have been developed to reflect distinctions made in Paragraph 38 of the First Modification and associated errata page with respect to CMS requirements. Paragraph 37 of the First Modification requires that all ASARCO Properties, including areas to which hazardous waste or hazardous constituents have, or may reasonably be expected to migrate beyond the ASARCO Properties, and groundwater, be addressed in the CMS. The former ASARCO Properties total 21 parcels, including the Facility and adjacent and nearby parcels, which are identified on Exhibit 3 of the First Modification. However, unique requirements with respect to the CMS are prescribed to different parcels in Paragraph 38, which states: "*Unless significant new information is found, which was not previously considered by USEPA in the development of the final agency decisions set forth in the OU2 ROD, the final corrective measures for the parcels of real property transferred by ASARCO to the Custodial Trust shall be the measures set forth in the OU2 ROD, and each CMS task described below shall fully take into account the application of the OU2 ROD remedies to these specific properties, except that final agency decisions on remedies for those properties designated on Exhibit 3 by the numbers 10, 11, 12, 15, 16, 17, 18, 19, 23, and the portions of 2 near Prickly Pear Creek shall be made by USEPA after completion of the investigations and studies set forth in this Decree.*"

Therefore, for purposes of this CMS, the former ASARCO Properties are organized into two groups, defined as follows to be consistent with Paragraph 38:

- CMS Parcels—Parcels 10, 11, 12, 15, 16, 17, 18, 19, 23, the portion of Parcel 8 located west of State Highway 518 (8W), and portions of Parcel 2 near Prickly Pear Creek (PPC; Parcel 2a), which are the parcels addressed in this CMS Report.
- Undeveloped Lands—The remaining properties, referred to as Undeveloped Lands, are Parcels 2, 3, 4, 6, 7, 9, 13, 14, the portion of Parcel 8 located east of State Highway 518 (8E), Parcel 21, and Parcel 22. This CMS Report presents information to document that "no significant new information" has been found and therefore, the *U.S. East Helena Superfund Site, Operable Unit No. 2, Residential Soils and Undeveloped Lands, Final Record of Decision* (OU-2 ROD) (USEPA, 2009) final corrective measures are still appropriate. According to the OU-2 ROD, these parcels will be evaluated whenever a change in land use is proposed and, if necessary, cleaned up to appropriate levels for the proposed use.

The CMS Parcels and the Undeveloped Lands are shown on **Figure 1-1**. Areas where "hazardous waste or hazardous constituents" have been found to have migrated beyond the ASARCO Properties are also shown on **Figure 1-1**.

Key terminology for this site, RCRA, and the CMS is defined as follows:

- **CMS Parcels** are those parcels enumerated in Paragraph 38 of the First Modification to be evaluated for the nature and extent of constituents of potential concern (COPCs), current conditions, and risk conditions sufficient to support a CMS evaluation.
- **Corrective measures** are those measures or actions appropriate to remediate, control, prevent, or mitigate the release, potential release, or movement of hazardous waste or hazardous constituents into the environment or within or from one media to another.
- **Corrective Measures Study** (CMS) is defined in the First Modification as "… *the investigation and evaluation of potential alternative remedies to protect human health and/or the environment from the release or potential release of hazardous waste or hazardous constituents, into the environment from and/or at the ASARCO Properties*..."
- **Custodial Trust** refers to the Montana Environmental Custodial Trust, a trust established to settle certain liabilities of debtors pursuant to the Owned Properties Consent Decree under the Reorganization Cases. The U.S. and the State of Montana are the Custodial Trust's sole beneficiaries.

- **Engineering controls** (ECs) as defined by USEPA consist of engineering measures designed to minimize the potential for human exposure to contamination by either limiting direct contact with contaminated areas, reducing contamination levels, or controlling migration of contaminants through environmental media. Some examples of ECs are capping, containment, slurry walls, and extraction wells.
- **Facility**, also referred to as the former Smelter site, is located on Parcels 16 and 19 and consists of the former operating Smelter.
- **First Modification** was filed on January 17, 2012, as Civil Action No. CV 98-3-H-CCL to modify the 1998 RCRA Consent Decree (Dreher et al., 2012) defining the responsibilities and requirements of the Custodial Trust to address contamination at the Facility for the benefit of the U.S. and State of Montana.
- **Institutional controls** (ICs) are defined by USEPA as nonengineered instruments, such as administrative and legal controls, that help to minimize the potential for exposure to contamination and protect the integrity of a response action. ICs typically are designed to work by limiting land or resource use or by providing information that helps modify or guide human behavior at a site.
- **Operable Unit 2** (OU-2) consists of nonsmelter property surface soil in residential areas, irrigation ditches, rural developments, and surrounding Undeveloped Lands.
- **OU-2 ROD** refers to the Record of Decision for East Helena Superfund Site, Operable Unit 2, Residential Soils and Undeveloped Lands, dated September 24, 2009.
- **Remedial action objectives** (RAOs) for remedy selection are media- or unit-specific goals that a cleanup alternative must achieve to protect human health and the environment. RAOs specify: (1) the contaminant(s) and media of concern, (2) the exposure route(s) and receptor(s) and (3) the remediation goal(s) for each exposure route.
- **Undeveloped Lands** comprise the parcels owned by the Custodial Trust that are not enumerated in Paragraph 38 of the First Modification but identified in Exhibit 3 of the First Modification. Existing conditions at these parcels were evaluated as part of the CMS to assess whether the corrective measures set forth in the OU-2 ROD are still appropriate.

This CMS Report references a number of process areas and buildings within the Facility, and **Figure 1-2** shows their current or former locations.

1.3 Report Organization

The CMS Report is organized as follows:

- **Section 1: Introduction**.
- **Section 2: Corrective Measures Study Goals, Objectives, and Scope** outlines the goals of the CMS as presented in the *Former ASARCO East Helena Facility Corrective Measures Study Work Plan* (CMS Work Plan) (CH2M HILL, 2015a) approved by USEPA on October 22, 2015, establishes the RAOs, and describes the CMS scope, geographic boundaries, current and reasonably anticipated land and groundwater use, and decision criteria in the form of media cleanup standards (MCSs) that will be used to evaluate potential remedial alternatives.
- **Section 3: Current Conceptual Site Model** describes the evolution of the current conceptual site model (CSM) and presents a summary of key background information, including former Smelter site operations and history, RCRA Facility investigation results, and interim measures (IMs) conducted by the Custodial Trust, pursuant to Section 12 of the First Modification.

- **Section 4: Risk Assessment** summarizes the final assessment for human health and ecological risks, and the parcels with identified risks and conditions, in accordance with Section VI of the First Modification.
- **Section 5: Selection and Evaluation of Corrective Measures Alternatives** provides an overview of the corrective measures alternative evaluation process, describes the initial source area removal evaluations conducted with mass distribution modeling, summarizes the groundwater contaminant fate and transport modeling, presents a comparative analysis of the alternatives against the threshold and balancing criteria, and outlines remedy alternative evaluation recommendations.
- **Section 6: Proposed Final Corrective Measures** describes the proposed final corrective measures for properties formerly owned by ASARCO and any other properties where hazardous waste or hazardous constituents from the Facility have migrated, and summarizes how each proposed remedy element meets the three remedy performance standards (i.e., threshold criteria) established by USEPA under RCRA— protection of human health and the environment, source control, and media cleanup objective.
- **Section 7: Public Involvement Plan** summarizes the community outreach efforts conducted by the Custodial Trust, provides contact information for the Custodial Trust and USEPA representatives, and presents future activities planned by the Custodial Trust.
- **Section 8: References** provides a list of the documents cited in this CMS Report. As a streamlining measure, the report notes key points from existing documents and refers the reader to the appropriate source document for details, rather than repeating large blocks of text.
- **Appendixes A through G** contain supporting documentation cited in the CMS Report text.

This CMS Report incorporates by reference in text, or directly in appendixes, the historical investigations and documents summarized in **Table 1-1** (*Summary of Supporting Investigations and Reports*).

SECTION 2

Corrective Measures Study Goals, Objectives, and Scope

This section outlines the goals of the CMS; establishes the RAOs; and describes the CMS scope, including geographic boundaries, current and reasonably anticipated land and groundwater use, and the decision criteria in the form of MCSs that will be used to evaluate potential remedial alternatives.

2.1 CMS Goals

The goals of a CMS are to identify, evaluate, and propose appropriate remedial actions that will protect human health and the environment. For this project, the primary CMS goals are as follows:

- Meet requirements of the First Modification and other applicable regulatory and USEPA guidance.
- Evaluate each proposed action, or combination of actions, following the factors set forth in the 1996 ANPR.
- Analyze potential actions with consideration of known risks to actual or potential receptors.
- Recommend potential actions that will create the greatest net environmental benefit and are compatible with expected future use, considering finite Custodial Trust funds.

2.2 CMS Remedial Action Objectives

Site-specific RAOs were identified in the USEPA-approved CMS Work Plan (CH2M HILL, 2015a) to provide criteria that were used for remedy evaluation and selection. The RAOs are as follows:

- Minimize long-term stewardship.
- Eliminate the need to manage and treat stormwater.
- Maximize use of sustainable remediation approaches.
- Develop and evaluate alternatives that allow continued asset recovery from slag pile.
- Develop alternatives that are consistent with the Custodial Trust's purpose to manage or fund implementation of environmental actions, and, ultimately, to sell, transfer, facilitate the reuse of, or otherwise dispose of or provide for the long-term stewardship of the properties.

RAO threshold and balancing criteria are discussed below.

2.2.1 Threshold Remedy Performance Criteria

The performance standards for site remedies are based on the three threshold criteria established by USEPA under RCRA; protection of human health and the environment, source control, and media cleanup objectives. All alternatives must achieve these criteria to be considered for further evaluation, and are then further evaluated using USEPA-established balancing criteria and site-specific remedial action objectives (RAOs).

The threshold criteria were defined in the USEPA-approved CMS Work Plan (CH2M HILL, 2015a) to include factors specific to the East Helena Facility and CMS Parcels as follows:

1. Protection of human health and the environment

a. Human and ecological receptors—No direct contact (dermal, inhalation, or ingestion) with environmental media having concentrations of constituents of concern (COCs) exceeding relevant risk-based standards (see description of MCSs under number 3 below).

b. Protection of the environment will appropriately consider the surrounding ecological setting.

c. Surface water—Prevent groundwater from discharging to surface water at concentrations that would cause the surface water to exceed Montana State Surface Water Standards and/or at concentrations that would degrade surface water quality beyond existing upstream water quality.

2. Source Control

   a. Soil

      i. Prevent migration of contaminated surface soil via wind-blown deposition or surface water runoff.

      ii. Reduce—to the extent practicable—the potential for groundwater to contact soil with COPC concentrations exceeding relevant groundwater protection standards through the following activities

         1) Reducing and/or eliminating to the extent practicable infiltration of stormwater through areas of contaminated soil and sediment to groundwater

         2) Reducing to the extent practicable the amount of contaminated soil in contact with groundwater

         3) Reducing to the extent practicable COC concentrations or mass through source removal where such removal will yield immediate reductions in contaminant loading to groundwater

   b. Slag

      i. Reduce—to the extent practicable— the potential for unfumed slag to leach COCs to groundwater.

         1) Reducing infiltration of stormwater
         2) Removal and recovery of recyclable slag

3. Media Cleanup Standards

   a. Soil

      i. Surface (0 to 2 feet below ground surface [bgs])

         1) Soil cleanup levels based on protection of human health and the environment for current and/or future new land uses (as shown on **Figure 2-1**). Note that if numeric standards cannot be achieved, ECs, ICs, or both will be implemented to interrupt pathways for exposure and to maintain protective conditions.

      ii. At depth (greater than [>] 2 feet bgs)

         1) Numeric standards based on protection of groundwater (as shown in **Table 2-1**), established regional background levels, <u>or</u>

         2) Non-numeric/concentration objective(s) based on impracticability associated with addressing large source mass (i.e., reduce toxicity, mobility, or ability of groundwater to come into contact with, leachable contaminant mass).

   b. Groundwater

i. Return usable groundwater to maximum beneficial uses wherever practicable, within a time that is reasonable considering all property-specific conditions.

ii. Reduce COC concentrations in groundwater within the Facility such that the Montana Numeric Water Quality Standards (as defined in MDEQ's Circular MDEQ-7, and hereafter referred to as DEQ-7; MDEQ, 2012) are met at the points of compliance established by USEPA. The point of compliance is the downgradient boundaries of Parcels 15 and 16 (the former Smelter site), as shown on Figure 1-1.

iii. Reduce COC loading to groundwater from Facility-related sources so that DEQ-7 groundwater standards may be attained downgradient of the site, to the extent practicable, within a reasonable time.

iv. During the timeframe when attainment of the DEQ-7 standards has not been achieved, minimize further migration of the plumes, prevent exposure to the contaminated groundwater, and evaluate further risk reduction approaches. To the extent practicable, control or eliminate other surface water and subsurface sources of contamination to groundwater within control of the Custodial Trust.

c. Surface Water—Meet DEQ-7 standards in surface water bodies that may be impacted by the Facility, while acknowledging the presence of upstream contaminant sources.

d. Sediment—USEPA Region III's Biological Technical Assistance Group (BTAG) has developed values to be used for the evaluation of sampling data at Superfund sites. Referred to as the Region III BTAG Screening Benchmarks, they represent an appropriate set of screening criteria to evaluate ecological risk in freshwater sediment for the CMS Parcels. The MCSs for sediment will be derived at a later date if determined to be necessary. (https://www.epa.gov/risk/freshwater-sediment-screening-benchmarks).

2.2.2 Balancing Criteria

In addition to the threshold criteria noted above, the following balancing criteria are considered in the CMS evaluations:

- Available funds in the East Helena Cleanup Account
- USEPA's "balancing criteria"
  - Long-term effectiveness
  - Reduction of toxicity, mobility, or volume of wastes
  - Short-term effectiveness
  - Implementability
  - Cost-to-benefit provided by all potential remedial actions
  - Community acceptance
- Other RCRA requirements (e.g., closure requirements, land disposal restrictions), and other legal requirements

2.3 CMS Scope

This section describes the geographic boundaries of the CMS, current and reasonably anticipated land and groundwater use, and the decision criteria in the form of MCSs that will be used to evaluate potential remedial alternatives.

2.3.1 Geographic Boundaries of CMS

The geographic boundaries of the CMS are shown on **Figure 1-1** as follows:

- As previously noted, Paragraph 37 of the First Modification requires CMS evaluations to address all former ASARCO Properties conveyed to the Custodial Trust as well as areas beyond the Custodial Trust's property boundaries where hazardous waste or constituents have "…or may reasonably be expected to have…" migrated from the Facility.
- Paragraph 38 of the First Modification specifies the Custodial Trust-owned parcels that must be addressed by the CMS as the Facility and CMS Parcels as defined in Section 1.2.
- For the Undeveloped Lands, former ASARCO Properties not enumerated in paragraph 38, consisting of Lamping Field, Dartman Parcel, and the East Fields, the record states that, "Unless significant new information is found, which was not previously considered by USEPA…the final corrective measures for the parcels of real property transferred…shall be the measures set forth in the OU-2 ROD (USEPA, 2009)… ." As no new information has been identified to impact this decision and a final corrective measure has been defined and approved by USEPA, no further corrective measures evaluations were conducted for these parcels.
- Non-Custodial Trust properties where hazardous waste or constituents have, or could reasonably be considered to have migrated with the exception of surface soil impacts which are being addressed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) per the OU-2 ROD. These have been identified as areas where contaminants have migrated in groundwater as shown on **Figure 1-1**. This area includes downstream reaches of PPC potentially contaminated by the Facility.

2.3.2 Current and Reasonably Anticipated Land and Groundwater Use

For the purposes of the CMS, current land and groundwater uses will be the assumed "reasonably anticipated future use" of the former ASARCO Properties. Reasonably anticipated land uses are shown on **Figure 2-1**. The Custodial Trust has investigated potential future use of these properties, taking into consideration market conditions, community goals and objectives, and other stakeholder interests. As a result of the investigations and in cooperation with the City of East Helena (COEH), the Custodial Trust and the City Zoning Commission adopted the proposed land uses for the Custodial Trust Parcels as shown on **Figure 2-1**. Current uses of Custodial Trust land, such as agricultural, are legal, nonconforming uses until a property changes hands.

Additional ordinances and ICs that impact land use include a Soil Ordinance adopted by Lewis and Clark County in June 2013 to control soil displacement and disposal activities. Future property owners and operators will have the option to conduct additional investigations and cleanup if necessary to achieve site conditions that would meet the surface soil cleanup standard associated with the newly intended use.

For groundwater, the highest potential future use at and downgradient of the Facility is as a drinking water source. However, existing ICs currently restrict groundwater use within the COEH and within the recently designated East Valley Controlled Groundwater Area (EVCGWA) until cleanup standards are met. The COEH municipal ordinance (Title 8, Chapter 3, Section 8.3.7) prohibits the installation of new private water wells within the City limits where municipal water system service is available. The EVCGWA was adopted by the Montana Department of Natural Resources and Conservation (DNRC) on February 6, 2016, to restrict new withdrawals until groundwater cleanup standards are attained.

2.3.3 Media Cleanup Standards

As a portion of the RAO for protection of human health and the environment, the RAO specifies the COC, exposure route, receptor, and acceptable COC level for each exposure route. **Table 2-1** summarizes the proposed numeric MCSs for the Facility. The table identifies by media, the COC, land use, proposed cleanup standard, the basis for the standard, and examples of how each standard would be applied. Key considerations in the identification of numeric standards are summarized as follows:

- Current, risk-based criteria established by USEPA and the State of Montana will be applied for groundwater and surface water (i.e., Montana's DEQ-7 standards, USEPA maximum contaminant levels [MCLs]).
- The *Supplemental Ecological Risk Assessment for the East Helena Smelter Site* (USEPA, 2005a; Hooper et al., 2002) stated that a soil lead level exceeding 650 milligrams per kilogram (mg/kg) may adversely impact passerine insectivores. Based on the Custodial Trust's discussions to date with USFWS, the Baseline Ecological Risk Assessment (BERA; Gradient, 2011) conducted by the Custodial Trust, as well as ecological risk evaluations from other smelter sites in Montana (e.g., Anaconda Smelter Superfund Site, Anaconda, Montana) (USEPA, 2015), lead is proposed as the primary indicator parameter for surface soil and a soil lead level of 650 mg/kg is proposed as the MCS considered protective of ecological receptors.
- For the purpose of establishing risk-based MCSs for surface soil, protective of human receptors for present and likely future use:
  - Lead and arsenic are considered the primary indicator parameters for soil. Existing data and CSMs have shown inorganic contaminants from the Facility to be co-located with these COCs, such that remedial actions taken to address these COCs can be reasonably expected to address all other site-related COPCs.
  - The regional screening levels (RSLs) for lead and arsenic levels in soil shown in **Table 2-1** are concentration levels currently being applied as MCSs at mining and smelter sites in Montana, and across the country. The Custodial Trust believes that an MCS of 400 mg/kg for lead in surface soil reflects current risk-based practices and is also consistent with the intended outcome of the OU-2 ROD, which states that the two-part residential cleanup action level for lead of 1,000 and 500 mg/kg "… *is expected to achieve a community-wide post-cleanup average lead concentration that is substantially less than 500*…" Community-wide averages include areas that have been remediated under the two-part cleanup action level, as well as areas that did not qualify for cleanup. The combined average soil lead concentrations are anticipated to be significantly less than the 500 mg/kg MCS.
- USEPA's Soil Screening Levels (SSLs) are proposed as the MCSs for COCs in subsurface soil to represent soil concentrations considered to be protective of groundwater. However, arsenic is naturally occurring at concentrations which exceed risk-based screening levels (both Preliminary Remediation Goals and the MCL-based SSL of 0.29 mg/kg [USEPA, 2015]). As noted in MDEQ's document *Project Report Background Concentrations of Inorganic Constituents in Montana Surface Soils* (MDEQ, 2013), the mean soil concentration is 22.5 mg/kg and the report text cites a generic action level of 40 mg/kg for residential surface soil from previous studies. The basis for the 40-mg/kg concentration is presented in the document titled *Montana Department of Environmental Quality Remediation Division Action Level for Arsenic in Surface Soil* (April 2005), which states in Section 2.0, Data Summary and Action Level Calculation, "….*DEQ determined that the 95% [Upper Confidence Level] UCL of 40 mg/kg represents an appropriate generic action level for arsenic because* ***it represents native soil concentrations that can reasonably be expected at most facilities***…" (emphasis added). Therefore, because a site-specific background level for arsenic has not been determined, the 22.5 mg/kg value is used as the background level for arsenic, and 40 mg/kg is used as a generic action level for initial evaluations.

Current Conceptual Site Model

A conceptual site model (CSM) communicates information on site conditions, and is one of the tools used to identify and evaluate the need for and scope of corrective measures. A CSM evolves over time, integrating new information about site operations and waste management practices, the physical setting, and the nature and extent of contamination in environmental media as data are developed. The CSM for the East Helena Facility and CMS Parcels incorporates information from the environmental investigations and associated documents completed to date (**Table 1-1**), ASARCO's operations and remedial actions between 1888 and 2001, and the Custodial Trust's environmental actions from 2009 through 2016.

This section describes the evolution of the current CSM and presents a summary of key background information, including the following:

- ASARCO's site operations and history
- RCRA Facility investigations performed by the Custodial Trust:
  - *Phase II RCRA Facility Investigation—East Helena Facility* (Phase II RFI; GSI Water Solutions, Inc., 2014) and the resulting 2011 CSM, which was used in the development of the CMS Work Plan (CH2M HILL, 2015a).
  - Supplemental soil sampling performed in 2015-2016 as documented in the *2015 Supplemental Contaminant Source Area Investigation at the Former East Helena Smelter* (Hydrometrics, 2015) and in the *Summary of Supplemental RFI Soil Sampling Results for Undeveloped Lands* (CH2M, 2016a).
  - Soil and groundwater source area investigations (SAIs) conducted as part of the CMS, including:
    - 2014 Source Area Investigation (Hydrometrics, 2014b)
    - 2015 Supplemental Source Area Investigation (Hydrometrics, 2015)
    - Data review and evaluation of the slag pile (Hydrometrics, 2016b)
  - Groundwater monitoring results collected through fall of 2016
- IMs conducted by the Custodial Trust, pursuant to Section 12 of the First Modification.

The current CSM is presented in Section 3.4.

3.1 Site Operations and History

ASARCO's East Helena smelting operations from 1888 to 2001 released significant contamination to the environment. The majority, if not all, of the operations occurred within the boundaries of Parcels 16 and 19 (**Figure 1-1).** Raw materials delivered to the Facility via rail or truck included crude ore, and ore concentrates with recoverable metals concentrations. Although lead bullion was the primary product, the Smelter also produced zinc (from 1927 to 1982), sulfuric acid, and copper-enriched speiss and matte. Products were shipped offsite by rail.

Over 100 years of operation changed the landscape. Ponds, pits, and pads were processing features that remained after site operations ceased. Upper Lake received flow from a diversion on PPC immediately south of the Facility, and provided plant make-up water and irrigation water to Wilson Ditch on a seasonal basis. There were no discharges to Upper Lake from Smelter operations. Lower Lake was a man-made pond formed in the 1940s by cutting off the northern portion of Upper Lake with an earthen berm. Prior to 1990, Lower Lake served as a storage/recirculation pond for process waters. In 1990, two

1-million-gallon steel storage tanks and associated concrete secondary liner were constructed to replace Lower Lake in the process water circuit.

In the early years of operation, contaminants were released directly to the air and soil. Air emissions from the operating Facility included stack emissions and fugitive emissions from smelting operations. Waste products collected and disposed onsite included fumed and unfumed slag, acid plant sludge, flue dust, and process waters including wastewater from scrubber systems. With the promulgation of environmental regulations, waste management practices changed and included air and water treatment. Bag filters were added to process stacks in the 70s (Sinter Plant), 80s (Ore Storage), and 90s (Dross Plant) to reduce air emissions. A water treatment plant was constructed in 1994 and the Lower Lake served as the permitted discharge point for treated water.

Figure 3-1 presents a conceptual drawing of the historical operations and illustrates how contaminants were released due to operations. Primary transport mechanisms to surface soil on the Facility and other properties were windblown stack emissions and fugitive dust. Transport of contaminants to subsurface soils and groundwater occurred through leaks from process water circuits, use of unlined ponds (such as Lower Lake) where contaminated sediments were in contact with groundwater, and materials handling on the ground surface that leached through soil to groundwater (**Figure 3-1**). Operational sources (process water circuits, stack emissions and fugitive emissions) were eliminated when Smelter operations ceased in 2001. However, ongoing use of some operational elements such as Upper Lake and Wilson Ditch for irrigation supply water, and Lower Lake for discharge of treated surface water continued to influence COC distribution in groundwater.

Between 1989 and 2009, IMs were conducted by ASARCO as either voluntary actions or actions implemented pursuant to the *Consent Decree between EPA and Asarco and Anaconda Minerals Company Regarding the Removal of Hazardous Substances and Reporting Requirements for OU1* (USEPA, 1990), and the *Consent Decree between Asarco and US EPA regarding violations of the Clean Water Act and RCRA* (USEPA, 1998). A brief description of the IMs (process updates and source removal and containment activities) is included in the following bullets. A comprehensive list of additional remedial investigations and activities performed by ASARCO before and after shutdown is provided in **Table 3-1;** a summary of remediation waste volumes and management is provided in **Table 3-2**.

- Process Updates
  - Replacement of selected process ponds, pits, or lakes with storage tanks
  - Sealing of a concrete pad used for temporary storage of sediments to be dredged from Lower Lake
  - Construction of stormwater and process water collection systems and process water treatment facilities
  - Replacement of the Former Acid Plant settling pond with a new water reclamation facility
- Source Material Removal
  - Dredging of Lower Lake sediments performed during site operations
  - Removal of the Acid Plant sediment drying pads and underlying soil
  - Removal of bottom sediments from a portion of Wilson Ditch and replacement of the plant site segment of the ditch with underground HDPE that was rerouted around the Facility
  - Excavation of contaminated soil from Thornock Lake, the Speiss settling pond, the Speiss granulating pit, and the former Acid Plant
- Source containment

- Construction of the RCRA Corrective Action Management Unit (CAMU) for storage and containment of contaminated sediment and stockpile soil
- Smelting of a portion of stored sludges and sediments in the smelter process, with the remaining material placed in the CAMU
- Construction of slurry walls around two areas of contaminated soil, the APSD Source Area, and the Former Speiss-Dross Source Area

3.2 RCRA Facility Investigation

In 1990, Hydrometrics prepared a *Comprehensive Remedial Investigation/Feasibility Study for the Asarco East Helena Smelter* (hereafter *Comprehensive RI/FS*) (Hydrometrics, 1990), which summarized and documented site conditions in OU-2 through OU-5. In 1998, supplemental RCRA Facility Investigations (RFIs) were performed by Hydrometrics as summarized in the *Current Conditions/Release Assessment, East Helena Facility* (CC/RA) (Hydrometrics, 1999). The focus of the CC/RA was to evaluate onsite releases to groundwater, surface water, and soils for the geographic area encompassing the Facility and offsite areas affected by the migration of contaminants from the Facility (excluding air emissions). Because the focus of the CC/RA was on evaluation of existing data, no new samples were collected as part of development of the CC/RA report.

In 2000, Hydrometrics prepared a (Phase I) *RCRA Facility Investigation Work Plan* (Phase I RFI) (Hydrometrics, 2000a), and a related (Phase I) *RCRA Facility Investigation Quality Assurance Project Plan* (Hydrometrics, 2000b). The goal of the Phase I RFI was to collect supplemental soil, surface water, and groundwater data to develop alternative corrective measures for the Facility in areas that had not been addressed by previous investigations. Findings from the Phase I RFI were summarized in the *Phase I RCRA Facility Investigation Site Characterization Report, East Helena Facility* (Asarco Consulting, Inc., 2005).

One of the first major environmental actions taken by the Custodial Trust was preparation of a *Phase II RCRA Former Smelter Site Investigation Site Characterization Work Plan* (Phase II RFI Work Plan) [Hydrometrics, 2010] and implementation of the Phase II RFI. This work was done pursuant to Section VI, item 19 of the First Modification and provided the basis for CMS work planning. The Phase II RFI incorporated data collected from previous investigations conducted by ASARCO, most notably the *Comprehensive RI/FS*; the CC/RA, and the *Phase I RFI*, and relied heavily on data and information obtained through these previous efforts conducted by ASARCO. The results of the investigations conducted by ASARCO are incorporated into this discussion of the Phase II RFI activities.

Specific objectives of the Phase II RFI included:

- Describing the nature and extent of contaminants (i.e., releases of hazardous wastes, hazardous constituents, or both) in soil, groundwater, surface water, sediment, and stormwater
- Identifying COPCs
- Identifying areas of potential concern
- Evaluating the fate and transport of contaminants related to the Facility
- Supporting the completion of the Human Health Risk Assessment (HHRA), BERA, CMS, and the groundwater flow and contaminant transport model
- Supporting the identification of areas that may be suitable for implementing IMs

Sampling and investigation activities conducted during the Phase II RFI focused on the Facility and areas directly adjacent, and are summarized as follows:

- Soil samples were collected from multiple depth intervals at 48 locations (**Figure 3-2**), and surface soil only was collected from 31 locations to support the BERA. The samples were analyzed for total metals, and adsorption and leaching potential for arsenic and selenium (the COCs in groundwater).
- At total of 17 stormwater samples were collected at the outfall of five basins (Basins 12, 13, 15, 16, and 27) and analyzed for total suspended solids, pH, and total metals. Nine of the samples represented main sumps or stormwater collection points and eight represented subdrainage areas.
- Semiannual surface water monitoring was conducted at seven surface water locations for analysis of major anions (such as chloride and sulfate), cations (such as calcium, sodium, and potassium), and metals along with stage and discharge measurements. Thirty-three surface water quality samples were also collected to support the BERA.
- Nine monitoring wells were installed (**Figure 3-3**) and sampled for analysis of major anions (such as chloride and sulfate), cations (such as calcium, sodium, and potassium), and metals, and used to estimate aquifer transmissivity through pneumatic slug testing.
- A groundwater to surface water interaction study was conducted using synoptic streamflow monitoring along PPC, surface water/groundwater level monitoring, and installation of piezometers near the creek bank and within the active channel above Smelter Dam (**Figure 3-4**).
- Semiannual groundwater (including 76 domestic wells, 125 project monitoring wells, 7 public utility wells, and 5 unclassified wells; **Figure 3-3**) and surface water monitoring (**Figure 3-5**) that assessed water quality (major anions such as chloride and sulfate, cations such as calcium, sodium, and potassium, and metals) and water levels across the study area was incorporated into the Phase II RFI.
- A supplemental groundwater level monitoring program was performed by installing transducers to collect groundwater level and temperature measurements at seven wells.

A summary of relevant conclusions that informed the CSM and corrective measures evaluations, by media, is provided below.

3.2.1 Soil Investigation Results

Results of the Phase II RFI investigation concluded that soil contamination is significant and widespread throughout the Facility. Arsenic and selenium were identified as the metals that have the greatest impact on downgradient groundwater quality, in particular, saturated soil was identified as the most significant ongoing source of arsenic loading to groundwater from the Former Acid Plant, Former Speiss-Dross Source Area, and Tito Park Area (TPA). Both saturated and unsaturated soils were identified as potential sources of selenium to groundwater. Also, slag was identified as capable of leaching selenium at concentrations that exceed groundwater screening levels. The COPCs identified for soil included: antimony, arsenic, barium, beryllium (subsurface soil only) cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, selenium, silver, thallium, vanadium, and zinc.

3.2.2 Stormwater Investigation Results

Stormwater samples were identified with concentrations of arsenic, cadmium, and lead that are commonly greater than screening levels. Copper and selenium concentrations in stormwater from the Ore Storage Yard were greater than screening levels in one sample. The water treatment facility was identified as effective for most metals, except for periodic concentrations of selenium greater than discharge limits. At the time of the Phase II RFI and until July 2016, stormwater from the Facility was collected and treated onsite at the High-density Sludge (HDS) Plant, when the HDS Plant was decommissioned. Treated stormwater was discharged to Lower Lake under the Facility's Montana Pollutant Discharge Elimination System permit. Note that after completion of the ET Cover system (described in Section 3.3.4.4), stormwater is no longer exposed to contaminants at concentrations greater than MCSs.

3.2.3 Surface Water Investigation Results

Dissolved concentrations of arsenic, cadmium, iron, lead, selenium, and zinc were detected in one or more of the Phase II BERA surface water samples at concentrations above Phase II RFI screening levels (the lower of the MDEQ human health standard or BERA benchmark for chronic effects), but concentrations from Upper Lake, Lower Lake, and adjacent to Tito Park, were significantly elevated in dissolved arsenic, cadmium, lead, and zinc (Gradient, 2011). Concentrations from Wilson Ditch samples (**Figure 3-5**) were generally less than screening levels. Note that DEQ-7 surface water standards are based on total recoverable concentrations (i.e., total metals) and the Phase II BERA results are in dissolved phase per the BERA protocol, so the results are not directly comparable to the DEQ-7 standards, but provide a general comparison to assess relative concentrations in surface water. Since completion of the Phase II RFI, surface water samples have been and will continue to be analyzed for the total recoverable fraction and directly compared to DEQ-7 standards, in accordance with the Corrective Action Monitoring Plan (CAMP) (see Section 3.3.6).

Upper and Lower Lake were identified as significant recharge sources to groundwater. Surface water in Lower Lake was estimated to continuously contribute 0.1 milligrams per liter (mg/L) of arsenic to groundwater.

The PPC was identified as a losing stream above and below the Facility, but is a gaining stream in the area near Lower Lake. Owing to elevated arsenic concentrations in groundwater in this area, groundwater from the Lower Lake area was identified as a potential source of contamination to PPC. A connection between Wilson Ditch and groundwater was also noted; the ditch was reported to lose between 0.6 and 1.4 cubic feet per second to groundwater during the summer months.

3.2.4 Groundwater Investigation Results

Groundwater investigation results are summarized as follows:

- Aluminum, antimony, arsenic, cadmium, lead, manganese, mercury, selenium, thallium, vanadium, and zinc were identified in groundwater at concentrations above screening levels. However, offsite exceedances were limited to antimony, arsenic, manganese, and selenium. Arsenic and selenium were reported with the greatest number of exceedances. The vertical extent of contamination appeared restricted to the Upper Aquifer and the COEH's public water supply wells downgradient of the Facility have not been impacted.
- Because arsenic and selenium were identified as the COCs in groundwater (due to their aerial extent, which encompassed the other COPC exceedances), a more detailed analysis of the sources, and fate and transport of these metals was conducted as part of the Phase II RFI. Conclusions in 2011 were:
  - The lateral extent of the arsenic plume was relatively stable primarily due to geochemical attenuation at the plume margins (adsorption, mineral sequestration, or both).
  - The primary source of selenium was historical discharges of site process water.
  - The primary source of arsenic to groundwater was ongoing leaching of arsenic from saturated zone soils; arsenic was previously loaded on to these soils via process water releases and leaching and infiltration of arsenic from smelter-related material stored in various areas.
  - Selenium was found to be more mobile than arsenic in groundwater under oxidizing conditions, and, therefore, the footprint of the downgradient plume was larger than arsenic (extending more than 2 miles downgradient of the Facility) and would be consistent with the predominant

chemical form of selenium in groundwater being selenium (VI), the most mobile redox species. In addition, the vertical extent of the selenium plume was also more expansive than arsenic.

- Insufficient historical selenium data downgradient of the Facility were available to draw conclusions about long-term trends in concentrations at the downgradient plume margin.

3.2.5 2011 Conceptual Site Model

The 2011 CSM was used to develop the CMS Work Plan (CH2M HILL, 2015a) and is illustrated on **Figure 3-6.** The 2011 CSM was based on the Phase II RFI results, and reflected site conditions after operations ceased and the initial IMs had been implemented by ASARCO**.** Key elements of the 2011 CSM were as follows:

- In Facility Parcels 16 and 19, surface and subsurface soil was contaminated by the releases throughout much of the Facility, with COPC concentrations orders of magnitude higher than levels considered protective of human health, ecological receptors, and groundwater.
- Arsenic and lead were identified as the COCs in soil. Although other inorganic constituents have been detected in soil at concentrations higher than risk-based screening levels, the elevated concentrations are co-located with elevated arsenic and lead. Consistent with the conclusion in the OU-2 ROD, the Phase II RFI concluded that once areas are cleaned up to address lead and arsenic, risks from other COPCs are similarly reduced (USEPA, 2009).
- Arsenic and selenium were identified as the two COCs in groundwater and represent effective surrogates for identifying the distribution, fate, and transport of all COPCs in groundwater.
- Groundwater impacts (arsenic and selenium above MCLs) were identified both under the Facility and beyond the COEH. Arsenic in groundwater is present from historical releases of process water in the Former Acid Plant and Speiss-Dross Handling areas, and via Lower Lake. Since arsenic is highly attenuated in the subsurface, these releases contributed to elevated arsenic in both groundwater, and saturated and unsaturated soil. Given that the upper end of the arsenic plume is upgradient of Lower Lake and the former Acid Plant, storage of high arsenic concentration materials in the TPA also were historical sources to both soil and groundwater.
- Similar to arsenic, elevated concentrations of selenium in site media were attributed to historical process water releases. However, unlike arsenic, selenium is much less easily attenuated, therefore impacts to soil from these releases were expected to be less significant.
- On the other parcels (**Figure 1-1**), the COPCs were present in surface soil due to airborne deposition. The COPCs in surface soil were then likely redistributed through tillage in agricultural lands and other human land disturbance. Due to the larger particle size and higher density of the slag material, physical transport of slag (larger than dust-sized particles) is likely to have occurred only onto properties directly adjacent to the slag pile and historically downstream through surface water flow in PPC (**Figure 3-6)**.

3.3 Corrective Measures Study Investigations

This section presents a summary of the CMS investigations and results to support the source control groundwater remedy evaluation.

3.3.1 Source Area Investigations to Support CMS

A source area inventory (Hydrometrics, 2014a) was compiled to identify potential source areas to support the SAI approach. **Table 3-3** summarizes the general source areas, subareas, and soil and groundwater conditions at the time of the inventory. This inventory supported the subsequent SAIs, which were done as part of the CMS to refine the understanding of remaining source areas believed to have the highest ongoing contribution of contaminants to groundwater, as shown on **Figure 3-7**. Key uncertainties for these areas were noted in the preliminary CSMs presented in the CMS Work Plan (CH2M, 2015a) and were used to inform the SAI objectives and scopes. The resulting data from the SAIs have been incorporated into the current CSM presented in Section 3.4 and used during the CMS to evaluate remedial options (Section 5).

3.3.1.1 2014 Source Area Investigation

The 2014 SAI (Hydrometrics, 2014a) was conducted to further characterize the occurrence and distribution of contaminants in the West Selenium and North Plant Arsenic source areas (**Figure 3-7**), support ongoing development of the groundwater flow and contaminant transport model, and evaluate groundwater remedies as summarized in Section 5. A total of eight soil borings were completed within these areas (**Figure 3-8)**. Two of the borings in the West Selenium Source Area were completed as monitoring wells (**Figure 3-8**).

West Selenium Source Area. Six soil borings (**Figure 3-8**) were completed during the SAI and 33 soil samples were collected and analyzed, as summarized in **Table 3-4**. The results indicate the following:

- The estimated areal extent of source material ranges from about 0.25 to 0.75 acre, with a vertical saturated thickness of about 3 to 7 feet that is at a depth of 40 to 45 feet bgs.
- Total metals concentrations indicate selenium and cadmium are enriched relative to background.
- Elevated cadmium concentrations at borings EHSB-1, EHSB-6, and EHSB-7 (**Figure 3-8**) are a signature of the former Acid Plant process water circuit, indicating that the area is recharged by groundwater from the former Acid Plant Source Area (consistent with current and historical potentiometric data).
- Leachability tests showed that the highest leachate concentrations of selenium (up to 33 mg/L) were derived from unsaturated zone soil; however, the apparent lack of infiltration in this area (due to the combination of the former asphalt/concrete cover and the installation of the Interim Cover of the Evapotranspiration (ET) Cover System that was in place when the SAI sampling was done) combined with the lowering of groundwater levels through process lake removals and initial relocation of the PPC, suggests that in the West Selenium Source Area the unsaturated zone soils are not a significant current source of selenium loading to groundwater.
- Leachability tests from saturated zone soil samples generated leachate concentrations up to 9.3 mg/L; these concentrations and the relatively high leachability for selenium (25 to 44 percent of the total selenium mass in the samples was removed via leaching) indicates that the most likely source of selenium loading to groundwater is within saturated soils.
- Total and leachable arsenic concentrations in the source area soil samples are low, suggesting a limited potential for remobilization of arsenic from soil under changing geochemical conditions in groundwater.

North Plant Arsenic Source Area. Two soil borings were completed for this SAI as shown on **Figure 3-8**, and nine samples were collected and analyzed as summarized in **Table 3-4**. The results of the 2014 SAI and previous investigations indicate the following:

- The active source area may be up to 450 feet or more in length (north-south along the arsenic groundwater plume axis) and 150 to 250 feet in width, with the extent defined by groundwater geochemical conditions (lower redox) as well as soil arsenic concentrations.
- Saturated thickness ranges from 10 to 15 feet with the depth to groundwater at 30 to 35 feet.
- Based on total metals testing, arsenic and zinc concentrations are above MCSs in the North Plant Arsenic Source Area soil.

- Leachability testing showed that the unsaturated zone soil is not a current significant source of arsenic loading to groundwater; however, saturated zone soil is capable of generating leachate concentrations similar to local groundwater concentrations and are likely the source of the arsenic plume.
- Total arsenic concentrations in saturated soil were lower in 2014 compared to samples collected in adjacent borings in 1986, possibly indicating release of arsenic from saturated zone soil over time and supporting the conclusion that saturated zone soil is an ongoing finite source of arsenic loading to groundwater.
- The combined selenium leaching results from 2014 SAI borings EHSB-8, EHSB-9, and similar information collected during the Phase II RFI, indicate that selenium remobilization under changing geochemical conditions is possible in this source area, and was considered when evaluating potential groundwater remedies.

The data collected during the 2014 SAI were used to estimate the West Selenium and North Plant Arsenic source area dimensions (as described above) and improved the understanding of the current relationship between leachable arsenic and selenium in soil and the groundwater plumes; however, the data collected did not fully define a potential localized high concentration soil source in the West Selenium Source Area, or the potential northward extent of the North Plant Arsenic Source Area. Therefore, the 2014 SAI Report noted that additional investigation would be needed in both the West Selenium and North Plant Arsenic source areas before selection, design, and implementation of any potential groundwater remedies (Hydrometrics, 2015).

3.3.1.2 2015 Source Area Investigation

The 2015 SAI was done to complete CMS evaluations for the West Selenium, North Plant Arsenic, Former Acid Plant, and Former Speiss-Dross (**Figure 3-7**) source areas. The 2015 SAI consisted of the sampling and analysis of soil and groundwater from each source area as summarized in **Table 3-5**. In addition, one pumping test was conducted at the Former Speiss-Dross Source Area to evaluate the integrity of the Speiss-Dross slurry wall as documented in the *2016 Speiss-Dross Slurry Wall Evaluation Technical Memorandum* (Hydrometrics, 2016a). Boring locations for each source area were selected based on the 2014 SAI results, monitoring well network data, Phase II RFI data, and the observed distribution of arsenic and selenium in groundwater (Hydrometrics, 2016b). The objectives of the 2015 SAI were as follows:

- Define the lateral and vertical source material boundaries along with the nature of the source material (concentrations, distribution, and possibly phase associations/mineral forms). In addition, define the total mass of selenium present in soil within the West Selenium Source Area.
- Collect information and data necessary to complete groundwater remedy engineering design, including information on the hydrologic and geochemical characteristics of the basal ash/clay unit underlying the shallow aquifer, and the geotechnical properties of unconsolidated soil.
- Refine estimates of total and leachable arsenic concentrations and northern extent of arsenic source material (saturated zone soil with elevated arsenic concentrations) downgradient of the North Plant Arsenic Source Area, in soil historically contaminated by high groundwater arsenic concentrations.
- Provide information necessary to evaluate whether additional groundwater remedies may be warranted by informing the predictive fate and transport groundwater modeling and subsequently running appropriate alternative simulations.
- Validate the predictive fate and transport groundwater model assumptions and predictive model results regarding groundwater loading rates from the Former Acid Plant Source Area and Former Speiss-Dross Source Area.

- Provide information necessary to further enhance the predictive fate and transport groundwater model and complete the assessment of proposed corrective measures as described in Section 6.

The following provides a summary of activities completed and results at each investigation source area. Application of SAI data to remedy evaluations is summarized in Section 5.2.

West Selenium Source Area. Seven borings were drilled in 2015 (EHSB-10 through EHSB-15, and EHSB-17) as shown on **Figure 3-9**, with two of the borings completed as monitoring wells. Leach testing of 2015 West Selenium Source Area soil samples showed results consistent with the 2014 SAI results, indicating that selenium in the area is highly leachable in both unsaturated and saturated soil. Based on both the 2014 and 2015 SAI results, soil generating the highest leachate selenium concentrations are located near well DH-8 (**Figure 3-9**). Results of the investigation indicated the following:

- The estimated selenium mass in the unsaturated zone is approximately three to seven times higher than in the saturated zone. The ET Cover is limiting infiltration of precipitation into the unsaturated zone, and groundwater levels are suppressed via relocation of the PPC, there is no identified mechanism for transport of this mass to groundwater.
- Saturated zone soil appears to be the primary contributor of selenium loading to groundwater; however:
  - There is not sufficient mass within the saturated zone soil to account for the areal extent of the downgradient selenium plume on a long-term (multidecade) timeframe. Historically there may have been another source or the source has been depleted.
  - The area of saturated zone soil is limited in lateral extent based on both groundwater plume geometry and soil analytical results for total and leachable selenium.
- Groundwater elevations and selenium concentrations are currently decreasing, based on trends observed throughout 2015. Given the limited total selenium mass present and the observed highly leachable nature of the total selenium, the groundwater trends suggest that the saturated zone source contributing to the plume may be rapidly decreasing over time.

North Plant Arsenic Source Area. The North Plant Arsenic 2015 SAI consisted of two soil borings completed within the COEH, in the area historically contaminated by the groundwater arsenic plume (EHSB-18 and EHSB-19), as shown on **Figure 3-9**. Samples were analyzed as summarized in **Table 3-5**. Laboratory testing was designed to evaluate the northern extent of the arsenic source area, estimate remaining arsenic adsorptive capacity, and evaluate groundwater model assumptions regarding the effect of a potential remedial action on the downgradient arsenic plume. Batch adsorption tests were conducted on soil with varying total arsenic concentrations using site groundwater with different dissolved concentrations, to investigate arsenic adsorption under a variety of conditions. The data indicate the following:

- Total metals analysis indicated that all selenium and cadmium concentrations were below detection limits.
- Batch adsorption testing showed that downgradient soil samples adsorbed arsenic, with most data showing good fits to Langmuir-type adsorption isotherms, similar to previous adsorption data collected from both on- and off-plant areas. Arsenic adsorption constants derived from these isotherms confirmed values used in the groundwater fate and transport model to analyze groundwater remedy alternatives (Section 5) for the Facility.
- Arsenic partitioning to soil from groundwater (adsorption or coprecipitation) has occurred as total soil arsenic concentrations have generally increased since the mid-1980s. Total arsenic concentrations remain lower downgradient of the source area suggesting additional adsorption capacity may exist in soils downgradient of the North Plant Source Area.

Former Acid Plant Source Area. The former Acid Plant 2015 SAI consisted of four soil borings (EHSB-22 through EHSB-25) with two of the borings completed as monitoring wells as shown on **Figure 3-9**. Results of the investigation indicated the following:

- Groundwater in the area was approximately 20 feet bgs, generally 5 feet lower than groundwater levels measured prior to implementation of the South Plant Hydraulic Control (SPHC) IM.
- Results were consistent with previous investigations, showing total arsenic, cadmium, and selenium concentrations in soil above screening levels concentrations as a result of historical plant activities. Average total arsenic, cadmium, and selenium concentrations were the highest of any of the four source areas evaluated in 2015.
- The leachability study indicated that cadmium in soil in this area is highly leachable, with total concentrations up to 857 mg/kg in saturated soil, average leachate concentrations of 19.3 mg/L, and maximum leachate concentrations of 120 mg/L. Groundwater cadmium concentrations of 2 to 4 mg/L are observed in some wells indicating leaching of cadmium to groundwater has occurred.
- Groundwater arsenic concentrations were observed to increase through the former Acid Plant settling pond area, with no apparent arsenic groundwater concentration increase beneath the HDS water treatment building immediately north of the former settling pond**,** supporting the CSM of the former settling pond area soils being a primary localized source area.

Former Speiss-Dross Source Area. The Speiss-Dross 2015 SAI consisted of two soil borings located just outside the slurry wall (EHSB-26 and EHSB-27; **Figure 3-9**), completion of one soil boring as a monitoring well, and a pumping test conducted within the slurry wall to evaluate potential hydraulic response to groundwater outside the slurry wall in support of determining slurry wall performance. Soil samples were analyzed as summarized in **Table 3-5**. Key results of this SAI are as follows:

- Total arsenic and selenium concentrations in soil were similar to concentration ranges observed in 2014 North Plant Arsenic SAI samples (note that the North Plant Arsenic Source Area is located immediately downgradient of the Former Speiss-Dross Source Area).
- Total cadmium concentrations in soil were low (fewer than 1 to 4 mg/kg) in the boring north of the slurry wall, but relatively high in the boring west of the slurry wall (in the former Speiss Handling area) at 2 to 780 mg/kg. Higher cadmium concentrations in the Speiss Handling area are likely due to historical groundwater flow from the former Acid Plant, as cadmium is an indicator of impacts from the former Acid Plant.
- Arsenic and cadmium concentrations in groundwater collected from a borehole west of the slurry wall (former Speiss Handling area) exceed respective MCLs, but are low compared to upgradient (former Acid Plant) concentrations, and downgradient concentrations (arsenic only); therefore, the former Speiss Handling area does not appear to be a significant source of arsenic loading to groundwater.
- Selenium leaching behavior in samples from the boring north of the slurry wall were consistent with historical results that indicate there is a potential for soil to leach selenium to groundwater if conditions become more oxidizing.

The 2015 Speiss-Dross SAI and slurry wall pumping test results demonstrated that the wall is performing as intended and greatly limits flow through the enclosed highly contaminated soil to less than one gpm. Based on the SAI results, potential leakage from the north end of the downgradient wall (or beneath the wall) appears to have negligible impacts to downgradient water levels and quality. Although no water-level response was recorded at DH-79 (downgradient of the wall) during the slurry wall pumping test, some flux through or under the wall is known to occur as evidenced by the seasonal and longer-term water-level fluctuations documented within the slurry wall wells.

3.3.1.3 2016 Slag Pile Evaluation

Available data from slag pile construction records, historical maps and photos, and investigations conducted by ASARCO were compiled and evaluated to (1) update the CSM of the slag pile, and (2) inform the groundwater flow and fate and transport model to compare remedial alternatives (Hydrometrics, 2016b). The CMS evaluations included data from the historical sampling locations shown on **Figure 3-10**.

The slag pile evaluation focused on data showing available concentrations of total metals in slag and slag leachate, and infiltration/percolation rates. Summary statistics (minimum, maximum, and average concentrations) for total arsenic, copper, lead, selenium, and zinc are presented in **Table 3-6** for older (pre-1940s) unfumed slag, younger (post-1982) unfumed slag, and fumed slag. Key observations from this evaluation are summarized as follows:

- The concentrations of inorganic contaminants in the slag pile is widely variable. The data summarized in **Table 3-6** indicate that total concentrations in slag vary over orders of magnitude among different boring locations (laterally), within a single boring (vertically), and among the various types of slag. Average concentrations of arsenic, copper, selenium, and zinc, are highest in the upper unfumed slag lift, lower in the older (deeper) unfumed slag layer, and lowest in fumed slag (**Table 3-6**).
- Slag pile leachability test results indicate that the unfumed slag has the highest potential for impacting groundwater. Leachate concentrations generated from leachability tests are summarized in **Table 3-6**. Leach tests of unfumed slag have generated up to 0.529 mg/L arsenic and 0.4 mg/L selenium (**Table 3-6**). Limited leach test results for unfumed slag are available for arsenic and selenium (one to three samples of the older and younger unfumed slag); and no leaching tests have been conducted on fumed slag for selenium

Initial analyses performed by Hydrometrics using the HELP model yielded percolation rates of 2.36 inches/year (20 percent of annual precipitation) through a slag thickness of 100 feet, with the majority of precipitation assumed to be lost to evaporation. However, subsequent evaluation efforts performed by the Custodial Trust as part of this updated study for fate and transport model calibration have revised the estimates of percolation upwards from this value as described in more detail in Section 3.3.2.

Slag composition and leachability data collected were used in conjunction with subsurface information from borings through the slag pile to recalibrate the groundwater fate and transport model. This was done by removing saturated sources beneath the slag pile from the model, and adjusting percolation rates, hydraulic conductivity values and recharge zones until the flow and fate and transport models were calibrated to 2011 and 2014 data. The sensitivity of the groundwater fate and transport model to slag pile recharge rate was then assessed, with the best calibration achieved with a 50 percent annual precipitation recharge rate. Calibration of the recharge rate at 50 percent was considered reasonable and supported the overall CSM for groundwater flow conditions in the slag pile area. The summary of modeling activities presented in **Appendix A** contains additional detail about the slag pile modeling.

3.3.2 Groundwater Flow Model

The groundwater flow and hydrogeologic setting have been used to establish a groundwater model for the Facility site as initiated by AMEC (2012), who prepared a work plan for a phased approach to groundwater modeling designed to meet the general modeling objectives listed in the Phase II RFI Work Plan (Hydrometrics, 2010). The general objective of the model was to support evaluation of construction activities (i.e., IMs) and decision making regarding selection of groundwater remedies. **Appendix A** contains the document titled *Summary of Groundwater Modeling Supporting Corrective Measures Study, Former ASARCO East Helena Smelter, East Helena, Montana* (NewFields, 2016a), which describes the hydrogeologic CSM, numerical model design and calibration, and predictive simulations used in the modeling effort. The groundwater flow model was developed to support ongoing decision making and evaluation of proposed hydrogeologic scenarios.

Numerical models were developed based on the conceptual hydrogeologic setting including development of steady-state groundwater flow and transient groundwater flow for historical conditions, changes in existing conditions, and evaluation of potential changes in the hydrogeology due to IMs and remedies. The model was updated based on data collected during groundwater monitoring, additional site investigations, and ongoing observations during construction activities. These updates included refinement of model calibration to historical groundwater elevations and in response to changes in hydrogeologic conditions implemented at the site.

The groundwater model was used to support the following activities:

- Evaluation of the groundwater response to the three interrelated IMs (discussed in Section 3.3.4) at the site, such as changes in hydraulic gradients and groundwater flow rates, groundwater flow paths, and groundwater/surface water interactions along PPC
- Evaluation of groundwater remedy alternatives including source removal, permeable/passive reactive barriers (PRBs), slurry walls, and focused pump and treat (presented in Section 5)
- Preparation of petition for the EVCGWA through the DNRC (presented in Hydrometrics, 2014, of the EVCGWA support document)
- Evaluation of slag pile grading and cover alternatives (presented in Section 5)

The groundwater model domain encompasses an area of approximately 45 square miles as shown on **Figure 3-11**. The model domain is designed to use naturally occurring hydrologic and geologic boundaries, and to encompass an area that includes the documented arsenic and selenium plumes with appropriate buffer area around the plume boundaries. The model grid was developed with 6 horizontal layers to represent the primary hydrostratigraphic units observed at the site, and variable grid spacing to provide enhanced detail near the source areas, and broader grid spacing was created in areas downgradient of and around the perimeter of the model domain (i.e., outside the Facility boundary but within the model domain). Boundary conditions, hydraulic properties, and the groundwater elevations were based on site-specific information from published sources, and site-specific investigations performed for this study as described in Section 3.3. The computer code MODFLOW-NWT (Niswonger et al., 2011) was used for flow modeling, and MT3DMS (Zheng and Wang, 1999) used for the contaminant fate and transport modeling (discussed in Section 5).

The steady-state flow model calibrated to the 2014 groundwater conditions was used to support the evaluation of IMs and initial groundwater remedy evaluations as described in the report included in **Appendix B** and summarized in Section 5. The groundwater flow model represents the working conceptual groundwater model numerically for the site. This allows review of existing conditions and evaluation of what changes to existing conditions would do to groundwater.

Model results and site-specific groundwater data were used to support the SAIs conducted in 2014 and 2015. Based on the results of these investigations, the model was recalibrated. The groundwater flow model was revised to represent changes in the existing system and refined to better represent historical groundwater monitoring results. Having multiple points of calibration, representing changes to the groundwater due to interim activities, provided more detailed information to make the model more accurate for predictive analysis. The recalibrated models were used to support successive phases of predictive analyses as described in Section 5.

Relative to IM development and performance, groundwater flow modeling results supported predictions? of anticipated changes to the hydraulic profile of groundwater beneath the site, as well as changes to groundwater elevations resulting primarily from implementation of SPHC. Results of groundwater level predictions from the flow model and actual decreases measured through 2016 are presented and discussed in Section 5.

3.3.3 Mass Distribution Model

To better understand the potential distribution and estimated mass of inorganic contaminants in soil, and support CMS evaluations, soil contamination at the Facility was modeled three-dimensionally using Mining Visualization System (MVS; C Tech Development Corporation, 2006) software. The MVS is a tool for visualizing soil data in three dimensions and calculating volumes of soil within defined concentration zones of inorganic contaminants. The model was used to estimate the lateral and vertical inorganic contaminant distributions based on existing data (through the Phase II RFI) within the area of the Facility, and as a screening-level tool to support IM development. A summary of the MVS model development, data inputs, model boundaries, and data processing is provided in **Appendix C.**

The MVS model provided graphical illustrations and mass estimates of arsenic and selenium in surface and near-surface soil (**Figures 3-12 and 3-13**, respectively), as well as soil from ground surface to the top of the Tertiary ash/clay layer along select cross-sectional lines through the Facility (**Figures 3-14 and 3-15**, respectively). These data were used to better inform the CSM developed at that time, and perform screening-level analyses of source removal options for select areas as IMs.

For the purpose of performing a screening-level evaluation, "source" was defined as soil with inorganic COC concentrations that exceed levels protective of groundwater, in other words, soil that could leach COCs to groundwater at levels that would exceed an established screening level. The proposed approach to the evaluation is summarized as follows:

1. Estimate the source control expected to be achieved through lowering of groundwater levels and control of infiltration (such as by implementing the SPHC IM and the ET Cover System IM).
2. Evaluate the potential benefit and practicability of removing materials that are not addressed by the SPHC and ET Cover System IMs and have the potential to be significant ongoing sources of contamination to groundwater.

3.3.3.1 Estimated Source Control Provided by the SPHC IM and ET Cover System IM

To estimate the total volume of source material (i.e., inorganic contaminants in soil) at the Facility, predicted post-SPHC groundwater elevations, and volume and distribution of contaminant mass to be addressed by each IM, the Custodial Trust used the three-dimensional MVS software, data in the existing soil database, and the results of the Upper Lake drawdown test (Hydrometrics, 2012). The soil data, developed during the Phase II RFI and previous site investigations (**Table 1-1**), were biased toward locations of known source areas.

The source mass volumes were based on the estimated volumes of soil that contain arsenic at greater than 40 mg/kg (the generic action level concentration for arsenic in the Helena Valley per MDEQ, 2013) or selenium greater than 0.26 mg/kg (the SSL protective of the MCL). The results of this first evaluation showed that up to 90 percent of the source mass of arsenic and selenium in contact with groundwater or subject to leaching contaminants to groundwater as precipitation infiltrates, could be controlled by the SPHC and ET Cover System IMs. In summary:

- The majority of contaminant mass (estimated as 60 percent of total arsenic and 75 percent of total selenium) at the Facility is present in the vadose zone and would be addressed by the ET Cover System. The ET Cover system would isolate mass in the vadose zone that is subject to contaminant leaching from infiltration of precipitation and other water sources.
- The model estimated that the remaining 40 percent of the total arsenic mass is present in saturated soil and subject to leaching from direct contact with groundwater, which would be partially addressed by the SPHC IM. Implementation of the SPHC IM will lower existing groundwater levels,

and reduce the amount of contaminant mass in contact with (and therefore leaching to) groundwater. Based on model estimates, approximately 30 percent of total arsenic and 15 percent of total selenium below the pre-IM water table would no longer be in contact with groundwater.

- The model concluded that the ET Cover System in combination with the SPHC IM would control approximately 90 percent each of arsenic and selenium in soil that are currently a potential source to groundwater, leaving approximately 10 percent of total arsenic and selenium in the saturated zone subject to leaching to groundwater.

To evaluate the potential benefit and practicability of source removal as an IM, the MVS model was used to estimate the locations, volumes, and contaminant mass in soil. Different removal scenarios were considered:

1) Removal options for TPA soil (with consideration of Upper Ore Storage Area and APSD soil) and Lower Lake sediment
2) Shallow soil that could be excavated and consolidated in order to reduce source areas and potentially the size of the ET Cover System IM

3.3.3.2 Removal of Tito Park Area Soil and Lower Lake Sediment

Three alternatives for removal of TPA soil and Lower Lake sediment were evaluated to estimate their potential benefits and practicability. Each of the three alternatives could meet the grading requirements associated with the PPC Realignment and considered a range of removals:

- Option 1 evaluated removing the least amount of material from TPA, an estimated 33,000 cubic yards (yd^3). This included removal of the upper 1 foot of sediment in Lower Lake, but did not address soil in the Upper Ore Storage Area or the APSD Area.
- Option 2 evaluated removing approximately 124,000 yd^3 of soil including the upper 10 feet from TPA, the upper 1 foot of sediment from Lower Lake, and the Upper Ore Storage Area material. The APSD Area soil would remain within the slurry wall.
- Option 3 evaluated removing the most material, approximately 238,000 yd^3 including the upper 2 feet of sediment from Lower Lake and all soil in the TPA, the Upper Ore Storage Area, and the APSD Area to the projected post-SPHC groundwater level.

On June 18, 2013, the Custodial Trust recommended implementation of Option 3 to USEPA. After consideration of input by other beneficiaries, USEPA transmitted its approval to the Trust by e-mail communication on July 29, 2013. The recommendation for Option 3 was based on the following estimated benefits:

- Removal of the largest volume of source materials from the floodplain
- Reduced potential for erosion and leaching of contaminated soil during flood events
- Elimination of the need to extend the ET Cover System over the TPA, the Upper Ore Storage Area, and the APSD Area

3.3.3.3 Shallow Soil Excavation

The MVS model was used to identify candidate areas for shallow soil excavation and consolidation, based on the estimated depth and volume of soil with COC concentrations that exceed SSLs. Results indicated that the only candidate area for shallow excavation and consolidation was approximately 5.5 acres located at the western portion of the former Lower Ore Storage Area (CH2M HILL, 2013a) (details are presented in the MVS TM located in **Appendix C**). This was the only area where COCs exceeding SSLs were present at depths less than 6 feet bgs. This alternative was considered technically feasible because the excavation, consolidation, and backfill activities would employ readily available earthwork techniques. Because the work involved soil at depths generally less than 6 feet bgs, only minor construction dewatering and treatment of the water would be necessary.

However, groundwater data in this portion of the Lower Ore Storage Area indicated concentrations of selenium higher than expected based on the near-surface soil data. Given the uncertainty regarding the source of selenium, controlling infiltration in this area with the ET Cover System was considered to be a more protective action than a shallow soil removal.

3.3.4 Interim Measures

Pursuant to Section 12 of the First Modification, the Custodial Trust has implemented IMs at the Facility to prevent and minimize the spread of hazardous waste and hazardous constituents while long-term corrective measures were being evaluated. Based on the 2011 CSM, three interrelated, interdependent, and sustainable IMs (source removal, SPHC, and the ET Cover System) were proposed in the *Former ASARCO East Helena Facility Interim Measures Work Plan – Conceptual Overview of Proposed Interim Measures and Details of 2012 Activities* (CH2M HILL, 2012) and conceptually approved by USEPA on August 28, 2012. After the overall IM objectives and approach were approved, the specific objectives, plans, and designs for each phase of construction were provided as IM Work Plans in accordance with the First Modification (CH2M HILL, 2012, 2013b, 2014, 2015b) by the Custodial Trust to the Beneficiaries and public for review and input before implementation. The three IMs are designed to work together to protect human health and the environment, take actions towards tangible environmental improvements, and achieve efficiencies and cost savings during implementation. The IMs work together to control potential human and ecological exposure to contaminated soils and reduce mass loading and subsequent migration of Facility derived contaminants in groundwater. The performance goals for the IMs are as follows:

- Lower groundwater levels across the Facility to reduce the amount of groundwater in contact with contaminated media and lower the hydraulic gradient across the site thereby reducing the mass flux and concentration of contaminants migrating offsite
- Reduce mass loading of inorganic contaminants to groundwater by excavating accessible areas with elevated levels of inorganic contamination that act as an ongoing localized, high concentration sources to groundwater (localized source areas)
- Eliminate or substantially reduce the amount of precipitation that infiltrates through contaminated media that can then leach and further impact groundwater.
- Establish surface soil concentrations within the Facility that are protective of human health and ecological receptors.

These IMs also work together to eliminate potential exposures for human and ecological receptors and stormwater runoff by covering and protectively placing contaminated soil beneath the ET Cover System footprint. The USEPA approved the Custodial Trust's proposal to establish an Area of Contamination (AOC) **(Figure 2-1)** within which hazardous waste and contaminated soil would be consolidated, reducing the implementation risks, environmental impacts, and cost of the remedial construction by eliminating the need for offsite transportation and disposal of the excavated soil.

3.3.4.1 Sustainability of IMs

The IMs were developed to be both protective and sustainable, requiring minimal long-term maintenance, and providing ongoing environmental benefits to COEH residents and animals that live in wetlands or PPC. Key elements of the IM's sustainability are summarized as follows:

- The natural grass surface layer of the ET Cover System stores stormwater and provides a clean surface for the limited amount of surface water runoff. This obviates the need for stormwater containment treatment, storage, and disposal. Perpetual monitoring and maintenance of the ET Cover System is reduced as the vegetative surface is self-sustaining.

- The relocated PPC channel has been restored to a natural meandering pattern over 1.25 miles. Relocation of the PPC channel has created more than 100 acres of new floodplain and provides significant additional riparian habitat and flood storage capacity to mitigate flooding in the downstream, flood-prone areas of the COEH. New, enhanced wetlands have replaced the manmade Upper and Lower Lakes. Smelter Dam, installed to keep water in Upper and Lower Lakes, has been removed as an impediment to fish passage between the PPC headwaters and Lake Helena.
- Contaminated soils and sediments located within the riparian zone of the creek were removed, consolidated, and isolated beneath the ET Cover System. These areas have now been restored to a viable and protective wetland habitat.

3.3.4.2 Source Removal IM

The purpose of the Source Removal IM was to excavate accessible areas of highly contaminated soil that presented an ongoing source of inorganic contamination to groundwater. These accessible source areas were the TPA, which consists of Tito Park, Upper Ore Storage Area, Acid Plant Sediment Drying Area (APSD Area), Lower Lake Sediment and the Speiss Disposal Area, and the former sulfuric acid plant (former Acid Plant Source Area) (**Figure 3-16**). Excavation of the TPA materials was originally proposed by the CERCLA program in USEPA's ROD for Operable Unit 1 (OU-1 ROD; USEPA, 1989) and the 1993 Explanations of Significant Differences. However, the original TPA excavation plan was not implemented by Asarco as the area was capped with low-permeability soil and removal was deferred to future remedial actions under RCRA.

Source Removal IMs were implemented concurrent with the SPHC and ET Cover System IM construction phases. In October 2014, soil in the TPA was removed to eliminate the potential for inundation and erosion from potential PPC flooding, meet the functional needs of the PPC Realignment, support the development of wetland habitat in the PPC floodplain, and reduce the overall footprint of the ET Cover System. The TPA removal provided flexibility during construction of the PPC Realignment, which was critical to the implementation of the SPHC IM, and is expected to improve long-term SPHC performance by reducing the volume of source material that could come in contact with groundwater during future flooding events. The TPA removal also improved on the work conducted by ASARCO, by further dredging sediment from Lower Lake and by excavating the APSD slurry wall and associated contaminated soil that was left in place under the former APSD pad. The volume of contaminated source material removed is summarized in **Table 3-2**.

The former Acid Plant Source Removal IM was completed as part of the ET Cover Construction Project in May/June 2016 in the southern area of the site where conventional excavation equipment could reach and remove materials within the entire saturated zone down to the ash-clay layer (approximately 30 feet bgs). The excavated area included the former Acid Plant process water settling facility (later the location of the Sludge Recovery Building, HERO Building, Lime Silo, and Equipment Wash Facility, removed in 2016; **Figure 3-17**). The former settling facility consisted primarily of an epoxy-coated concrete tank (settling pond, also called settling tank), measuring approximately 68 feet by 35 feet by 9 feet deep, as well as neutralization dumpsters and a temporary sediment drying area (**Figure 3-17**). The volume of contaminated source material removed is summarized in **Table 3-2**.

Additional source removal was completed as part of the IM construction projects when accessible source materials were encountered. These included:

- Speiss Disposal Area, consisting of approximately 8,000 yd^3 of Speiss contaminated soil located adjacent to and within the APSD slurry wall (**Figure 3-16**)

- Upper Lake Marsh Sediments, consisting of approximately 21,000 yd^3 of contaminated shallow soil adjacent to former Upper Ore Storage Area within wetland grading areas of the PPC (**Figure 3-17**).

These materials were removed and placed within the subgrade fill beneath the ET Cover System and the volumes are included on **Table 3-2**.

3.3.4.3 SPHC IM

The overall goal of the SPHC IM was to reduce both the mass and the rate of migration of inorganic contaminants (primarily arsenic and selenium) in groundwater leaving the Facility. The SPHC IM reduces the mass loading of inorganic contaminants to groundwater, lowering the groundwater table to reduce the volume of groundwater in contact with contaminants in soils. This also lowers the groundwater flux leaving the Facility, thus reducing the contaminant mass migrating off site and concentrations in both onsite and downgradient groundwater.

The SPHC IM changed the hydraulics on the south end of the site by eliminating the hydraulic head created by the impounded surface water bodies in the former Lower Lake, Tito Park, and Upper Lake areas (referred to as South Plant Source Area). Groundwater flow was historically driven by the recharge from Upper Lake in the South Plant Source Area and groundwater elevations on the Facility were highest in the South Plant Source Area (**Figure 3-18**). The impounded surface water infiltrated through contaminated sediments and soil and then moved as groundwater through and off the Facility downgradient (to the north and northwest).

The SPHC included the following major components:

- The temporary PPC Bypass was constructed in 2013 to route creek flow away from the south portion of the Facility and future work areas and to allow the Upper and Lower Lakes to drain. This immediately lowered the groundwater table, and allowed TPA removal and the new PPC Realignment construction projects to be completed in the driest conditions feasible (**Figure 3-18)**.
- The Wilson Ditch Diversion dam was removed from PPC in 2013 and the diversion point was relocated to a new location.
- Smelter Dam was removed in April 2016 to eliminate the primary means of impounding water and to allow realignment and reconstruction of PPC at a lower elevation to further reduce groundwater levels at the facility.
- Reservoir sediments and other contaminated materials were removed from the South Plant Source Area in 2014 through 2016 to lower the floodplain closer to predevelopment site conditions. Excavated sediments and soils were used as subgrade materials for the ET Cover System.
- Reconstruction of 1.25 miles of the PPC meandering stream in 2015-2016 has created the following:
  - More natural grade to provide passage for aquatic organisms.
  - Nondeformable stream channel with migration controls north of the former Smelter Dam to construct a stable channel and prevent future erosion of slag by PPC.
  - Broader floodplain and stream channel south of the former dam to replace wetlands lost from removal of the dam and lake complex, and to provide a stable and natural transition for undisturbed upstream areas.
- Improved wetland areas were built within and adjacent to the floodplain areas.
- The PPC Temporary Bypass will be maintained for a period of time after channel reconstruction to protect the recovering deformable channel segment south of the former smelter dam.

The PPC Realignment reconstruction is illustrated on **Figure 3-18.** The final PPC channel and floodplain are designed to function as a self-sustaining “natural system.” To meet this objective, smelter dam was removed and the new PPC channel (PPC Realignment) was constructed to lower the PPC channel elevation by approximately 12 feet near the dam (permanently eliminating the dam complex), reduce leakage to groundwater, and reestablish a more natural and stable channel configuration throughout the length of PPC adjacent to the site. The project also moved the PPC channel 100 to 300 feet to the east of the toe of the slag pile to eliminate further undercutting of the eastern edge of the slag pile. The PPC Realignment results in a more natural configuration and grade of PPC, facilitated by the removal of approximately 800,000 yd^3 of material, and will equilibrate with the adjacent, lowered groundwater table. As a result, it requires only minimal engineered structures necessary to ensure long-term stability, and no active pumping or in-situ treatment installations. The wetlands developed as part of the PPC Realignment provide habitat restoration or replacement to at least a 1:1 ratio (impacted to mitigated) to comply with natural resource protection permitting requirements for remediation work (**Figure 3-19**). Surface soil concentrations established by the PPC regrading and wetland development meet MCSs established for ecological receptors and potential recreational users of the area.

3.3.4.4 ET Cover System IM

The ET Cover System was constructed to reduce the infiltration of precipitation and subsequent leaching of inorganic contaminants in unsaturated zone soil to groundwater, eliminate the potential for people and ecological receptors to have direct contact with contaminated surface soil, control potential migration of contaminated media through aerial deposition or surface flooding, and reduce the volume of contaminated stormwater that was being collected and treated by the onsite HDS treatment system. Cover system surface soils meet MCSs established for ecological and potential future recreational or industrial/commercial users of the property. The ET Cover System also provides a protective cover system for the contaminated materials consolidated within the USEPA-approved AOC during IM implementation. It covers a large portion (57 acres) of the Facility, as shown on **Figure 3-20**.

The layers in the ET Cover System are shown on **Figure 3-21**. ET Cover Systems are self-sustaining, using the water storage capacity of the layers to hold infiltration within the soil pores via capillary action for access by root ET and solar evaporation in warm weather months, rather than the physical impermeability of traditional cover materials like clays, asphalt, or geomembranes, to minimize percolation. To promote water storage and evapotranspiration, the surface layer is vegetated and amended with organics to support native grass growth; the vegetation also stabilizes the cover surface against wind and water erosion. This provides a more cost-effective and sustainable method of minimizing infiltration when compared to traditional engineered cover designs. Material used in cover construction came from onsite borrow or onsite construction projects, maximizing the cost-benefit of cover construction and allowing complete integration of IM construction projects. Only a small quantity (10,000 yd^3 out of over 1 million yd^3 of soil used in cover construction) of material was imported from offsite pits. Use of onsite borrow and reuse of surplus materials generated from the PPC construction projects provided beneficial recycling of these materials and the most cost-effective development approach for the ET Cover System.

The ET Cover System IM was installed in stages. Demolition of existing buildings occurred in phases during 2013, 2014, 2015, and 2016. Interim cover systems (referred to as ICS 1 and ICS 2) were constructed to temporarily protect soil and sediment removed from the source removal and PPC Realignment activities, typically during the winter season shutdown, until the overlying ET Cover System could be constructed. The ICS 1, installed in 2014, covered approximately 34 acres over the southwestern portion of the Facility that was constructed as part of the TPA source removal. The ET Cover System was installed over the ICS 1 in 2015, referred to as ET Cover West. The ICS 2 was installed in 2015 covering approximately 10 acres over the northeastern portion of the site. The ET Cover System was installed over the ICS 2 and Central Corridor in 2016, referred to as ET Cover East, covering approximately 23 acres.

The Central Corridor (approximately 13 acres; **Figure 3-20**) was left open between the ICS 1 and ICS 2 to conduct supplemental investigations at groundwater source areas as described in Section 3.2 and keep the HDS treatment plant operational during construction. Upon completion of the investigations and construction activities (source removal excavations) requiring the HDS Plant, this area was closed and covered, which included:

- Treatment of approximately 300,000 gallons of stormwater and wastewater in July 2016
- HDS Plant decommissioning including cleanout of chemical lines and tanks, removal and disposal of residual chemicals and materials, and removal of salvageable materials, completed on August 1, 2016
- HDS Plant demolition completed on August 11, 2016
- Post-demolition closure of the area, completed on October 28, 2016

Termination of Facility operations permits for wastewater and stormwater discharges from the site was submitted by the Custodial Trust to MDEQ upon completion of these activities, and was approved by MDEQ on December 30, 2016.

3.3.4.5 Remediation Waste Management during IM Implementation

As previously noted, an AOC was designated prior to implementation of remediation activities (**Figure 2-1),** to allow consolidation of hazardous remediation waste in a protective, efficient, sustainable, and cost-effective manner. Designation of the AOC allowed the remaining, limited capacity of Corrective Action Management Unit 2 (CAMU 2) to be used for the management of other hazardous remediation waste. The volume and type of the wastes managed within the AOC and CAMUs, and their ultimate disposal location is summarized in **Table 3-2**. CAMU 1 was constructed and closed with a final cover in 2001. CAMU 2 was constructed in 2008 with a final cover placed in November 2014. A description and construction details of the ET Cover System are provided in Section 3.3.4.

The management of remediation waste generated during Custodial Trust IM implementation is also summarized in **Table 3-2** and described briefly as follows:

- Much of the subsurface soil from PPC Realignment was identified as not contaminated and not considered a remediation waste; however, investigation work indicated that soils from surface areas close to the Facility had high concentrations of COC metals. Most of the excavated material was consolidated within the AOC as ET Cover System subgrade fill. Topsoil from southern portions of the former Upper Lake Marsh was tested for chemical and agronomic properties and found suitable for reuse as topsoil on the ET Cover System.
- Building demolition materials, where appropriate, were reused or recycled; nonrecyclable concrete rubble and similar debris was consolidated within the AOC and used as fill for the ET Cover System subgrade.
- Heavily soiled personal protective equipment (PPE), soil and slurry wall material from the APSD area, buried Speiss, mixed soil, and drum debris from the TPA Source Removal was placed in CAMU 2.
- Asbestos-containing material (ACM), materials contaminated with biological waste, lead-based paint materials, and nonliquid/solidified chemicals were consolidated into CAMU 2 prior to closure.
- After CAMU 2 was closed, PPE, decontamination waste, lead-based paint materials, nonliquid/solidified chemicals, ACM, universal waste, substation materials with polychlorinated biphenyls, and residual process sludge were transported to an offsite disposal facility.
- Stormwater runoff from active construction and industrial source areas, along with dewatering water generated during source removal activities, was collected and contained throughout the demolition and construction/remediation activities, and managed (treated and discharged) as

permitted under the HDS water treatment plant Montana Pollutant Discharge Elimination System permit. Clean stormwater runoff from the interim cover systems and ET Cover System was being managed in accordance with the Stormwater Pollution Prevention Plan developed in accordance with the Montana Multi-Sector Permit for Stormwater Discharges Associated with Industrial Activity, as well as General Permits for Construction Activities for each construction project. Once construction was completed and the site stabilized, these permits were terminated by the MDEQ on December 30, 2016.

3.3.5 Supplemental RFI Soil Sampling

Supplemental soil and sediment sampling was conducted on the CMS Parcels surrounding the Facility, pursuant to USEPA's conditional approval of the Phase II RFI Report (April 29, 2014), to meet the requirements identified in Paragraph 37 of the First Modification. Specifically, the sampling objectives for the CMS Parcels (Parcels 15, 23, and portions of 2 near PPC [Parcel 2a]) (**Figure 3-22**) were as follows:

- Identify the nature and extent of COPCs.
- Assess the current conditions and risk sufficient to support CMS evaluations.
- Evaluate lead concentrations in soil protective of ecological receptors (specifically passerine birds) and cattle to address USEPA comment on the BERA as described in Section 5.2 of this report.

In accordance with the USEPA-approved work plans (*Supplemental RFI Sampling and Analysis Plan* [Supplemental RFI] [CH2M HILL, 2015c] and *Addendum to East Helena Facility Supplemental RFI Sampling and Analysis Plan* [CH2M, 2016b]), Parcels 8W, 10, 11, 12, 16, 18, and 19 were not sampled because the IM work done at Parcels 8W, 10, 11, 12, 16, 18, and 19 as part of the SPHC IM or ET Cover System IM, constructed a new exposure surface, designed to meet the MCSs defined in the *Former ASARCO East Helena Facility Corrective Measures Study Work Plan* (CMS Work Plan) (CH2M, 2015a) (**Table 2-1**). Parcel 17 was not sampled because it is a part of the CERCLA residential soil repository (West Field Disposal Area – southern portion; West Field Direct Haul Area – northern portion), that received soils between 1991 and 1992 (southern portion) and 1996 and 2000 (northern portion). The contaminated soils were blended into existing soils and capped and seeded in 1999 to 2000.

Sampling of Parcels 15, 23, and a portion of Parcel 2 was conducted as outlined in the *Supplemental RFI Sampling and Analysis Plan* (CH2M HILL, 2015c). Soil samples were collected following the incremental sampling methodology (ISM) adopted by the Interstate Technology and Regulatory Council (ITRC) as described in the *Incremental Sampling Methodology* guidance document (ISM Guidance) (ITRC, 2012). Arsenic and lead results were compared to the MCSs presented in **Table 2-1**, and the other metal COPCs were compared to USEPA RSLs. Results of the comparisons are presented in Section 3.4.1 (Soil Conditions), **Table 3-7**, and the figures referenced in Section 3.4.1 (Figures 3-27 through 3-29). In general, supplemental soil sampling results support there is widespread surface soil contamination in these parcels for multiple metals in comparison to residential MCSs, and more limited contamination for a single metal, lead, in comparison to industrial MCSs. Generally higher concentrations were observed in areas closer to the Facility. The nature and extent of the sampling results were used to develop the current CSM (Section 3.4), understand current conditions (Sections 3.4.1, 3.4.2, 3.4.3 and 3.4.5), and assess risk (Section 4).

In addition to the surface soil sampling conducted to meet the CMS requirements defined in the First Modification, Undeveloped Land Parcels 7, 8E, 13, and 14 were sampled to assess whether conditions remain consistent with the understanding developed when the OU-2 ROD was signed. The analytical results confirmed that the remedy defined in the OU-2 ROD is still appropriate. A summary of the results of the sampling relative to the cleanup levels defined in the OU-2 ROD is presented in the *Summary of Supplemental RFI Soil Sampling Results for Undeveloped Lands* (CH2M, 2016a) provided in **Appendix D**.

3.3.6 Corrective Action Monitoring Program

Groundwater and surface water monitoring activities have been conducted at the Facility and adjacent areas since investigation activities began in the mid-1980s as part of the RI/FS (Hydrometrics, 1990) conducted by ASARCO under CERCLA. Post-RI/FS groundwater and surface water monitoring (referred to generally as "long-term monitoring") was initiated by ASARCO in 1991 and supplemental groundwater and surface water monitoring activities were conducted to address specific objectives related to various site activities. The data generated through these monitoring programs were used to determine the nature and extent of contamination present in groundwater beneath and downgradient of the Facility, and to evaluate groundwater quality trends.

In 2011, the Custodial Trust revised the monitoring program to complete groundwater characterization and support the development of the groundwater flow and fate and transport models; potential groundwater remedial designs; ongoing evaluation of offsite groundwater contamination at potentially affected residential and public water supply wells to ensure protection of groundwater users (nearby residents); and development of the CMS. Subsequent monitoring plans (2012 and 2013) were updated as needed, with consideration of results to date, to further support the project objectives.

In 2014, a CAMP was prepared to transition the focus of groundwater monitoring from investigation and characterization (plume extent and characteristics), to a focus on CMS remedy evaluations and to evaluate the effectiveness of implemented IMs. The 2014 CAMP also provided for continued monitoring of residential/public water supply wells within the COEH, near Lamping Field, and near Canyon Ferry Road (**Figure 3-23**) to ensure protection of groundwater users (nearby residents) and support planning for the proposed EVCGWA.

Updated CAMPs for groundwater and surface water monitoring were prepared in 2015 and 2016. The 2016 CAMP has an increased emphasis on performance monitoring appropriate to the CMS (Hydrometrics, 2016c). The primary objective of the 2016 CAMP was to collect adequate and appropriate groundwater and surface water data to evaluate the effectiveness of the IMs implemented to date. The 2016 CAMP also provided for data collection to monitor residential/water supply wells within the study area to ensure protection of groundwater users; support development of a remedy performance monitoring program; evaluate groundwater/surface water interactions and potential effects on groundwater plumes; and evaluation of the CAMUs and West Arsenic Source Area.

The USEPA recommends evaluating groundwater data and information on a well-by-well basis to monitor remedial action effectiveness during two distinct phases of groundwater restoration activities (USEPA, 2013), including:

- The remediation phase, referring to the phase of the remedy where remedial activities are being actively implemented and groundwater data are used to monitor progress toward groundwater cleanup levels specified in a remedy decision document; and
- The attainment monitoring phase, occurring after the remediation monitoring phase is complete.

The Facility is currently in the remediation phase. The remediation phase monitoring approach outlined in the 2016 CAMP includes three data evaluation methods:

- Trend analyses of water levels, COC concentrations, and indicator geochemical parameters to assess changes in concentration and groundwater elevations over time.
- Plume stability analysis to evaluate fluctuations in the spatial extent of the COC plumes downgradient of Facility.
- Calculation of contaminant mass fluxes at select plume transects using the calibrated groundwater model to aid in evaluating changes in contaminant loading and downgradient attenuation processes.

Monitoring locations included in the 2016 CAMP are shown on **Figure 3-23**. The scope of monitoring in the 2016 CAMP included:

- Monthly water level measurements at 193 wells to evaluate the effectiveness of the SPHC IM and to evaluate groundwater potentiometric surfaces, flow directions, and gradients;
- Semiannual groundwater quality monitoring at 60 wells, quarterly monitoring at 18 wells, and annual monitoring at 17 wells to support the trend analysis, plume stability, and mass flux performance evaluation;
- Semiannual groundwater quality monitoring at 19 water supply wells (residential and municipal) and annual monitoring at 15 additional wells west and north of the groundwater plumes to provide ongoing data on residential/public water supply well water quality contaminated by the Facility, and in rural residential areas peripheral to the main groundwater plumes (Seaver Park west of the former smelter and the area downgradient of the selenium plume), to provide protection of potential water users;
- Monthly surface water elevation measurements at 19 locations along PPC and other local surface water bodies, and semiannual surface water flow measurements and surface water quality sampling at 10 locations to evaluate groundwater/surface water interaction, specifically any effects of surface water recharge on groundwater flow and plume migration, and potential surface water quality or flow effects in the PPC Realignment area.

Data generated from all groundwater sampling and monitoring performed through 2016 have been incorporated into the current CSM presented in Section 3.4.

3.4 Current Conceptual Site Model

This CSM presents the understanding of site conditions based on information available through prior site investigations and monitoring data collected through 2016. The CSM integrates current information on the sources of COCs identified and their migration pathways, as well as information on the IMs, current and anticipated future land uses, and potential human and ecological receptors. The CSM provides a holistic picture of the site that is used to develop and evaluate remedial alternatives.

Figure 3-24 illustrates current conditions at the Facility, including the effect of the IMs:

- Source Removal IMs have consolidated some of the most highly contaminated soils above the groundwater table and under the ET Cover. This IM has reduced the amount of contaminated soil in contact with groundwater by over 100,000 yd^3 (**Table 3-2**).
- Since 2012, the SPHC IM has lowered the groundwater table on the Facility between 4 and over 10 feet, significantly reducing the amount of contaminated soil in contact with groundwater.
- The ET Cover System IM is minimizing the infiltration of precipitation through contaminated soil to prevent leaching to groundwater and reduces the amount of stormwater generated minimizing ongoing maintenance costs and eliminating stormwater treatment. The ET Cover System IM also prevents direct contact of contaminated soil to human and ecological receptors.
- Surficial soil risks have been addressed through the implementation of the Source Removal IMs and the ET Cover System IM.

Conceptual site model illustrations from post-operational smelter conditions as of 2011 (**Figure 3-25**) and operational smelter conditions prior to 2001 (**Figure 3-26**) are repeated here for comparison.

The observed distribution of contaminants in groundwater over multiple years, along with results from investigations of the adsorption/attenuation behavior of arsenic and selenium have been used to calibrate the groundwater contaminant transport model to site conditions. Thus, the groundwater contaminant fate and transport model reflects the current CSM for groundwater, and has been used as one of the tools to evaluate the potential benefits of remedial alternatives on groundwater (as presented in Section 5).

3.4.1 Soil Conditions

The current understanding of soil conditions at the Facility and the surrounding former ASARCO properties has been refined through the CMS and IM activities, and is summarized as follows:

- Surface soil has been contaminated from active processes on the Facility and via windborne deposition onto the CMS Parcels, Undeveloped Lands, and residential areas. However, as shown previously on **Figure 3-22**, implementation of the IMs has altered surface soils across over 400 acres:
  - Construction of the ET Cover and realignment of PPC has replaced over 220 acres of contaminated surface soil with soils meeting soil cleanup criteria imported from the West Borrow Area (Parcels 15 and 19) and portions of the Upper Lake Marsh Area (Parcel 19).
  - Use of approximately 40 acres of Parcel 15 as a borrow area (West Borrow Area) for soils used in IM construction for ET cover and PPC Realignment construction projects.
- The supplemental RFI soil sampling conducted in 2015-2016 (Section 3.3.5) confirmed the previous general understanding of surface soils on the CMS Parcel areas outside the IM construction:
  - Surface soil in most areas exceeds the residential MCS for one or more metals (**Figure 3-27**).
  - Lead was the only contaminant observed at concentrations above Industrial/Commercial criterion; these areas are generally limited to north of PPC in Parcel 2a, Parcel 21, and west of the Facility (**Figure 3-28**).
  - Lead was also the only contaminant identified at levels above the MCS protective of ecological receptors (passerine insectivores) at the locations shown on **Figure 3-29**.

  Refer to Appendix D for supplemental soil sampling completed on the Undeveloped Lands (*Summary of Supplemental RFI Soil Sampling Results for Undeveloped Lands* [CH2M, 2016a]).
- Subsurface soils at the Facility have been contaminated by historical operations and remain a potential ongoing source of contamination to groundwater:
  - Primary subsurface soil source areas at the Facility were identified in previous investigations and refined during investigations performed as part of this CMS. Prior to IM implementation, source areas contributing to the most significant groundwater impacts both onsite and offsite include: North Plant Site Area Saturated Soils; the West Selenium Area; the Former Speiss-Dross Area; the Former Acid Plant Area; and the Tito Park Area (including sediments within Upper and Lower Lake, and the Acid Plant Sediment Drying Area).
  - Implementation of the ET Cover System and SPHC IMs will isolate an estimated 90 percent of the contaminant mass within the original saturated and unsaturated zones within the Facility area once the ET cap vegetative cover is fully established. This includes an estimated 775,000 pounds of contaminant mass that will no longer be in direct contact with groundwater or precipitation infiltration once the SPHC drops groundwater levels to projected levels.
  - Subsurface soils to the north of the Facility have accumulated a substantial amount of arsenic contamination over decades of smelter operations. Arsenic concentrations exceed MCSs for soil and contribute to groundwater impacts observed in the offsite arsenic plumes. However, the arsenic plume remains relatively stable offsite as demonstrated by ongoing CAMP monitoring (described below in Section 3.4.3.3) as a result of attenuation conditions within the soil in this area. Soil adsorption testing conducted during the 2015 SAI (Hydrometrics, 2015) indicates that

subsurface soils within the saturated zone north of the Facility have adequate arsenic adsorptive capacity remaining to continue to sequester arsenic from groundwater into the future.

Soil COC concentrations are summarized in **Table 3-7**. **Figures 3-27, 3-28**, and **3-29** compare surface soil results to residential, industrial/commercial, and ecological MCSs (arsenic and lead) and RSLs (other COC metals), respectively.

3.4.2 Sediment and Surface Water Conditions

Implementation of IMs has addressed all of the areas on the Facility where contaminants have been observed in sediment. These areas include several former process areas (the Acid Plant settling pond, Speiss granulating pond and Speiss pit, Thornock Lake, and Lower Lake, Upper Lake, Upper Lake Marsh, Lower Lake, and the reach of PPC adjacent to Lower Lake).

The only area where sediments have been identified with contaminant concentrations exceeding a wildlife screening value that has not been remediated is Parcel 2a, which was sampled as part of the supplemental RFI sampling summarized in Section 3.3.5 (**Figure 3-30**). Parcel 23, which is located upstream of the Facility, was also sampled as part of the supplemental RFI sampling to provide baseline concentrations representative of upstream/background conditions (**Table 3-8).** To evaluate the results, the upstream (Parcel 23) concentrations of lead were compared to the wildlife screening value of 123 mg/kg developed in the BERA, and this direct comparison shows that 2 of the 5 upstream samples (as shown on **Figure 3-30**) exceed the screening level with lead values of 150 to 152 mg/kg (respectively samples 23-4-SD and 23-1-SD). Six of the 11 samples reported higher arsenic concentrations in the downstream samples compared to the maximum upstream/background concentration (**Figure 3-30 and Table 3-8**). Four of the 11 samples reported higher lead concentrations in the downstream samples compared to the maximum upstream/background concentration. Although this indicates potential increase in concentrations downstream relative to upstream, the maximum upstream lead concentration exceeds the wildlife screening value of 123 mg/kg developed in the BERA (**Figure 3-30**), and demonstrates impacts that are only partially related to the Facility. Human health and ecological risk assessments of the sediment results are presented in Sections 4.1 and 4.2, respectively.

For surface water, all of the areas previously identified as having concentrations of metals above surface water protection screening levels or background concentrations have been addressed by the IMs. Historically, concentrations of metals in surface water exceeding screening levels were identified in Upper Lake, Upper Lake Marsh, Lower Lake, and the reach of PPC adjacent to Lower Lake (GSI, 2011). The lakes and Upper Lake Marsh have been removed as part of the SPHC IM and are being replaced with wetlands as described in Section 3.3.4. In addition to the removal of Lower Lake (thought to be the cause of higher concentrations of arsenic and zinc in PPC during low flow periods), the portion of the PPC channel adjacent to the Facility is being completely regraded and relocated as part of the SPHC IM. Contaminated sediments from the Upper Lake Marsh area have been removed and placed beneath the ET Cover System as described previously under Section 3.3.4.

3.4.3 Groundwater Conditions

This section describes the current understanding of groundwater conditions with respect to flow characteristics, changes in groundwater elevations inferred as a result of IM implementation, and groundwater quality with respect to the COC (i.e., arsenic and selenium). The *Phase II RFI* (METG, 2011) provides a detailed description of the hydrogeologic CSM with respect to site geology, hydrostratigraphic units, and the groundwater occurrence and flow; this information is not reiterated in the CMS Report. The focus of this section is the supplemental groundwater data collected during and following IM implementation through the 2016 period, with an emphasis on current groundwater flow characteristics and recent groundwater quality observations for arsenic and selenium to support remedy evaluations.

3.4.3.1 Groundwater Flow

Figure 3-31 is the groundwater elevation contour and inferred flow map for the Upper Aquifer using June 2016 groundwater level measurements. Consistent with the groundwater flow characteristics described in the Phase II RFI, groundwater flow follows two general paths, consisting of a northwesterly flow direction from Upper Lake through the source areas on the west side of the Facility and west of PPC, and then a predominant northerly flow direction beneath the slag pile and east of PPC. The groundwater flow patterns are influenced by several features, most notably (1) groundwater mounding created by leakage (losses to groundwater) from PPC, which displays a groundwater divide extending as far north as Lamping Field, (2) the presence of relatively low-permeability Tertiary sediment bounding the base and west side of the Upper Aquifer, (3) a buried paleochannel incised into the clayey ash layer (underlying aquitard), creating a zone of higher permeability, and (4) mounding/losses from former Wilson Ditch.

Table 3-9 shows the hydraulic parameters by source area. The parameters were used in the groundwater model for the former sources areas (such as West Selenium, North Plant, Speiss-Dross, Acid Plant) and for model setup in the contaminant fate and transport model in groundwater, as discussed in Section 5.

3.4.3.2 Groundwater Elevation Changes

As part of the CMS, changes in groundwater levels (and changes in contaminant concentrations, as presented in subsequent sections) have been monitored to determine if the inferred hydraulic influence from IMs were meeting their performance objectives. As noted in Section 3.3.4, the SPHC IM was designed to reduce the mass loading of inorganic contaminants to groundwater and the groundwater flux leaving the Facility, thus reducing the contaminant mass migrating off site and eventually reducing COC concentrations in both onsite and downgradient groundwater. This reduction was to be accomplished by lowering lower water levels across the Facility, and particularly in the southern part of the Facility. To evaluate the SPHC performance to date, average water levels measured from 2002 to 2010 were compared to average water levels measured in 2016 as shown on **Figure 3-32.** Overall plant site water level decreases to date have ranged from approximately 1 to 6 feet beneath the slag pile on the northeastern part of the Facility, and from 4 to 9 feet on the west half of the Facility. The PPC Realignment work in 2016 resulted in notable water level decreases, particularly in the slag pile and Former Acid Plant source areas. These changes compare favorably to predicted groundwater level changes developed during IM design and forecasted by the groundwater modeling results discussed in Section 5.

3.4.3.3 Contaminant Transport

The occurrence and distribution of arsenic and selenium within and downgradient of the Facility is correlated to former source areas leaching contaminants into the Upper Aquifer, and then the advective flow properties mobilizing contaminants generally northward as shown in the respective arsenic and selenium plume maps (**Figures 3-33 and 3-34**, respectively). Historically, process water from the former Acid Plant contained low pH and process water from the production and handling of speiss contained high pH; releases attributed to each of these areas impact groundwater in distinct ways, such that multiple source areas of contaminant loading to groundwater were active at different times throughout the plant site history. Once released to groundwater, the redox conditions in the aquifer and aquifer matrix controlled contaminant leaching and mobility. This is noted in the central part of the plant site, where diesel or fuel-oil type organics were identified in soil near the water table. The presence of organic compounds caused reducing conditions that coincide with the highest concentrations of arsenic (**Figure 3-33**). Additionally, **Figure 3-33** shows the West Arsenic Source Area located to the south and west of the Facility that typically shows arsenic concentrations in the 0.005 to 0.025 mg/L range. Although some of these concentrations are at or above the MCL, the arsenic is believed to be derived from groundwater interactions with naturally occurring, arsenic-bearing sediments and is not Facility-related.

Analysis of arsenic speciation indicates that the high concentration arsenic plume consists primarily of arsenic (III), and that with increasing distance downgradient and toward the lateral edges of the plume, arsenic (V) becomes predominant. Selenium speciation in groundwater indicates that the predominant form of selenium in groundwater is the oxidized form, selenate or selenium (VI). This form is mobile in groundwater and has resulted in the migration of the selenium plume over 2 miles beyond the Facility boundary (**Figure 3-34**). The relationship of groundwater redox state and plume geometry is noted where the arsenic plume concentrations are highest in the highly reducing (organic-impacted) environment and the selenium concentrations are low. Additionally, where arsenic concentrations are lower in the more oxidizing areas (lateral and downgradient edges of arsenic plume), selenium concentrations are higher.

The geometry of the October 2016 arsenic plume extends approximately 2,500 feet downgradient (northwest) of the Facility with a more diffuse (lower concentration) plume extending north from the slag pile approximately the same distance (**Figure 3-33**). Maximum arsenic concentrations occur within the Speiss-Dross slurry wall and just downgradient of the wall where pH is high. The lateral extent of arsenic greater than MCL of 0.01 mg/L has remained relatively consistent since plant shutdown in 2002. The area of groundwater HHS exceedances to the south and west of the Facility, generally 0.005 to 0.025 mg/L, is believed to be derived primarily from groundwater interactions with naturally occurring, arsenic-bearing sediments.

The selenium plume (**Figure 3-34**) extends offsite significantly further than the arsenic plume, due to a lower rate of geochemical attenuation (adsorption or coprecipitation) and conservative transport behavior of selenate. The primary current selenium source areas to groundwater are the West Selenium Source Area in the vicinity of wells DH-66 and DH-8 (west lobe), and the slag pile (east lobe) (**Figure 3-34**). Current information indicates that the primary source of selenium in the slag pile may be an area of unfumed slag (upgradient of well DH-56, see well labels shown in **Figure 3-32**) generated following shutdown of the zinc plant in the early 1980s. Current maximum groundwater selenium concentrations occur in the West Selenium Source Area (1 to 2 mg/L range), and in the northwest slag pile area (near 0.5 mg/L). The plumes emanating from these areas merge in Lamping Field approximately 0.6 miles downgradient (northwest) of the Facility. North of PPC, the groundwater flow and selenium plume direction shifts to the north. Lower selenium concentrations (less than the 0.05 mg/L groundwater HHS) extend north of Canyon Ferry Road, with concentrations of 0.023 to 0.029 mg/L observed at one of the northernmost monitoring wells (EH-144D). Well EH-144D is about 0.3 mile north of Canyon Ferry Road (about 2.6 miles north of the former smelter) and is completed at a depth of 169 feet. Two adjacent shallower wells, EH-144M (128 feet) and EH-144S (103 feet), exhibit lower selenium concentrations, about 0.013 and 0.007 mg/L, respectively, than EH-144D.

3.4.3.4 Changes in Groundwater Concentration

To evaluate changes in groundwater quality subsequent to implementation of IMs, temporal trends for arsenic and selenium were evaluated as shown on **Figures 3-35 through 3-38**. These figures show selenium trends near the plant site and in the downgradient area (**Figures 3-35 and 3-36**, respectively) and arsenic trends near the plant site and in the downgradient area (**Figures 3-37 and 3-38**, respectively). The trend plots summarize data collected since 2002, after the Facility ceased operations. To evaluate trends pre- and post-IM implementation, the data are evaluated using a linear regression trend line from 2002 through October 2011 (pre-IM) and November 2011 through October 2016 (post-IM).

Changes in Selenium Concentration in Groundwater

Facility area wells have generally shown an overall decrease in selenium concentration since IM implementation (**Figure 3-35**). In West Selenium Source Area wells DH-66 and DH-8, seasonal variability observed in the pre-IM period has gradually decreased. Prior to October 2011, selenium concentrations in both wells varied; after October 2011, the semiannual seasonal changes at well DH-66 ceased, and concentrations increased until 2015, and have shown a significant decreasing trend since. At DH-8, seasonal variability was noted until 2015 then concentrations remain stable. Selenium concentrations at DH-66 and DH-8 are currently at or near historical minimum values near 1 mg/L. Wells DH-82 and DH-67 also show decreasing trends, particularly over the last two years (**Figure 3-35**). Similarly, trends are decreasing at DH-42 and DH-30 in the South Plant Source Area since implementation of IMs. In addition, in the slag pile area, selenium concentrations are generally stable, or trending downward as noted at DH-56 (**Figure 3-35**).

Downgradient of the Facility, in the COEH and further downgradient in Lamping Field where the two lobes of the selenium plume merge, selenium trends vary (**Figure 3-36**). The selenium plumes (both west and east lobes, and the merged plume) have shown a westward shift since implementation of the SPHC IM and as a result of reduced infiltration from Wilson Ditch (since eliminating the use of the ditch as an irrigation supply source in 2013) resulting in increasing trends at some wells (on the west), and decreasing trends at others (to the east). For example, at paired wells EH-50 and EH-100, concentrations have decreased near the reporting limit of 0.001 mg/L post-IM. Selenium concentrations at EH-104 have increased (**Figure 3-36**) as a result of the plume shift to the west. On the east side of the selenium plume, at EH-51/EH-101 and EH-52/EH-102, the shift can be seen as the eastern boundary of the 0.05 mg/L (groundwater HHS) selenium plume is now located west of PPC, whereas it previously exceeded the HHS at EH-102 and occasionally at EH-52 (**Figure 3-36**). Downgradient of the COEH, the shift is also noted by decreasing trends at EH-62, EH-130, and EH-138, and increasing trends at EH-118, EH-124, and EH-126. Although these downgradient wells have not shown overall decreasing trends to date, the effects of generally decreasing concentrations observed in the Facility area are expected to propagate downgradient over the coming years as forecasted by the groundwater modeling results discussed in Section 5. In addition, the limited extent of source material found in the SAIs, as well as the decrease in groundwater flux through the area resulting from the SPHC IM, is expected to limit the future downgradient and westward migration of the selenium plume.

None of the private or public water supply wells have been affected by the westward shift of the plumes. The westward shift has caused the selenium plume to move from the East Helena residential area where a number of private water supply wells exist, into Lamping Field where water wells are absent. The Custodial Trust will continue its residential well monitoring program into the future to document and track groundwater conditions outside of the plume areas.

Changes in Arsenic Concentrations in Groundwater

With the exception of three wells, DH-77, DH-42, and TW-1, groundwater arsenic concentrations in the Facility area (**Figure 3-37**) show decreasing trends post-IM; trends at DH-42, DH-77, and TW-1 are generally stable although it should be noted that TW-01 is located inside of the S/D slurry wall, where groundwater concentrations are not expected to decrease, and DH-77 was only installed in fall 2014. Although some wells indicate concentrations were decreasing pre-IM implementation, the post-IM rate of decrease is greater than the pre-IM rate of decrease; this is most apparent at wells DH-47, DH-59, DH-17, and DH-64. Arsenic concentrations at DH-17 and DH-64 are currently at the lowest levels observed in the post-operational period and indicate an average concentration decrease of 24 and 34 percent since 2011, respectively. In addition, well DH-80 downgradient of the former Acid Plant (**Figure 3-37**) showed a 35 percent decrease in October 2016 compared to average concentrations observed from July 2015 through June 2016; this is likely due to the former Acid Plant 2016 source removal.

Similar to selenium, variable arsenic concentration trends are observed downgradient of the Facility in the COEH (**Figure 3-38**). Wells in the eastern part of the arsenic plume have shown relatively little change in concentration post-IM compared to pre-IM, except at EH-51, where the average arsenic concentration has decreased from about 0.18 to 0.09 mg/L. Just downgradient of the Facility, decreasing trends are noted both pre- and post-IM at EH-60, at a similar rate; however, adjacent to EH-60, increasing trends post-IM are noted at well pair EH-50 and EH-100. Downgradient of this well pair, arsenic concentrations at EH-106 decreased to an average of 1.0 mg/L, but post-IM trends at EH-115 indicate increasing concentrations. However, groundwater monitoring indicates a high degree of attenuation at the leading edge of the arsenic plume, with groundwater concentrations decreasing by several orders of magnitude over distances of a few hundred feet. Well EH-111 in northwest East Helena shows arsenic concentrations in the 2 to 4 mg/L range, while wells EH-113, EH-114, EH-116, and EH-117, 300 to 500 feet downgradient, have historically shown concentrations ranging from <0.002 to 0.013 mg/L. In addition to the attenuation occurring at the plume front, the effects of the decreasing arsenic trends observed in the Facility area are expected to propagate downgradient. From this information, the arsenic plume is anticipated to remain stable and equilibrium conditions continue to adjust, decreasing plume mass primarily, based on decreasing arsenic loading from the site as a result of IM implementation.

3.4.4 Groundwater/Surface Water Interaction

The current CSM for groundwater/surface water interaction is consistent with the previous understanding, even though the PPC channel was relocated as part of the SPHC IM. Instantaneous flow measurements taken in 2015 along PPC upstream, adjacent to, and downstream of the Facility have consistently shown that creek flows remain relatively unchanged from upstream to downstream under both high flow and low flow conditions. This suggests there continues to be minimal interaction between PPC and the local groundwater system through the Facility area. Downstream of the Facility, however, creek flow rates decrease indicating leakage from PPC to groundwater. Accounting for irrigation diversions, streamflow decreased by a total of 9.25 cubic feet per second (cfs) in June and 11.7 cfs in October between sites PPC-7 near Highway 12 and SG-16 near Canyon Ferry Road. Monitoring locations are shown on **Figure 3-23**. Based on an approximate distance of 16,000 feet, this equates to an average leakage rate of 2.6 to 3.3 gallons per minute (gpm) per 100 feet of channel, seasonally.

Investigations to date have not identified changes in contaminant concentrations in PPC surface water adjacent to, and downstream of the Facility that would indicate significant recharge of contaminated groundwater to the PPC. These investigations noted that PPC upstream of the Facility is contaminated to some degree by upstream sources (historical mining), with low to moderate concentrations of mining-related constituents such as arsenic, cadmium, and zinc present in samples from upstream site PPC-3A (**Figure 3-23**). The PPC is identified as impaired on the State 303D list due to historical mining activities in the headwaters (USEPA, 2004b).

Although PPC water quality and flow data from 2011-2015 do not suggest a groundwater/surface water interaction, the data do show small instream load increases which are attributed to creek interaction with the slag pile. To evaluate potential ongoing impacts from the slag pile, PPC water quality changes for selected metals (arsenic, copper, lead, and zinc) from PPC-3A (upstream) to PPC-7 (**Figure 3-23**) were evaluated (Hydrometrics, 2016b). Calculated instream loads of arsenic, copper, lead, and zinc showed downstream increases in arsenic, copper, and lead loads from sites PPC-3A to PPC-5, respectively, and again from sites PPC-5 to PPC-7, from 0.04 to 0.18 pound per day (lb/day). Zinc loads showed a net decrease on average from PPC-3A to PPC-5, but an increase of 3.1 lb/day from PPC-5 to PPC-7. These average load increases are about 10 percent of the average measured instream loads of 1.7 lb/day arsenic, 1.4 lb/day copper, 1.8 lb/day lead, and 20.7 lb/day zinc; thus, while the observed load increases appear relatively consistent, they are based on calculated loads that are within the error of field flow measurements and laboratory analytical measurements.

3.4.5 Slag Pile Conditions

In 2016, the slag pile covered about 45 acres, was 120 feet tall at its highest point, and contained approximately 3,560,000 yd^3 of slag (**Figure 3-39)**. The pile had steep side slopes (1.5H:1V or steeper) and the top of the pile was uneven. Mounds of stockpiled slag were circumscribed with access roads around the pile (**Figure 3-39**). The blocky nature of the slag and the undulating surface caused precipitation to infiltrate, rather than run off the slag pile.

The slag is present as solidified, granular material (gravel to cobble size) or in large blocks, depending on how it was originally formed (generating process of the smelter operation) and then placed on the pile. The pile currently consists of two types of slag, fumed and unfumed slag, that are generally segregated in the pile due to the distinct production and disposal time periods. Differentiation of the fumed and unfumed slag is important to the understanding of the extent to which the slag pile is an ongoing source of contamination to groundwater because the unfumed slag contains higher metals concentrations than the fumed slag and has the potential to leach COPCs (primarily metals) to groundwater. Therefore, the unfumed slag is considered the likely source of contaminants entering the groundwater beneath the slag pile.

Although the leachate data (**Table 3-6**) indicate that slag could impact groundwater quality beneath and downgradient of the pile, concentration trends for arsenic and selenium at most slag area wells are currently stable or slightly decreasing. Current information indicates that precipitation infiltration and associated leaching of contaminants from slag to groundwater does occur; however, the current decreasing groundwater concentrations correlating with the declining groundwater levels suggest that seasonal saturation of the base of the slag pile may be an additional contaminant migration pathway from slag to groundwater. Water quality monitoring will continue in 2018 to further assess water quality trends beneath and downgradient of the slag pile. This improved understanding of the contribution of slag to arsenic and selenium in groundwater was used to recalibrate the groundwater fate and transport model for the slag pile area, as discussed in **Appendix A**.

SECTION 4

Risk Assessment

This section summarizes the final assessment for human health and ecological risks, conducted in accordance with Section VI of the First Modification. This final risk assessment consolidates the results from the screening-level HHRA presented in the CMS Work Plan (CH2M, 2015a) and final BERA (Gradient, 2011), and updates the assessments based on data collected during the CMS.

4.1 Human Health Risk Assessment

The final HHRA draws on information presented in the screening-level HHRA (CH2M HILL, 2011) and incorporates the supplemental RFI soil and sediment sampling data presented in Section 3.3. The final HHRA was prepared using USEPA's Risk Assessment Guidance for Superfund, including recent USEPA guidance for assessing lead in soil at Superfund sites and guidance for RSLs in soil (USEPA, 1989; USEPA, 1996; USEPA, 2003; USEPA, 2016a; USEPA, 2016b; USEPA, 2016c). Portions of the quantitative risk assessment prepared for the Facility were incorporated into MCSs. A detailed description of that methodology is presented in the OU-2 ROD (USEPA, 2009). Information presented in the OU-2 ROD also was used to support identification of COCs in soil and sediment. The methodology for preparation of the HHRA was consistent with the guidelines for preparing site-specific risk assessments as described in USEPA's ANPR (USEPA, 1996).

4.1.1 Groundwater

Risks from constituents in groundwater have been evaluated by comparing concentrations in groundwater with drinking water standards such as MCLs; therefore, risk was not quantified for groundwater COCs. Arsenic and selenium have contaminated groundwater and were compared to the MCLs. Concentrations of arsenic and selenium in groundwater beneath and downgradient of the Facility are higher than the respective MCLs of 10 µg/L for arsenic and 50 µg/L for selenium. As described in USEPA guidance (USEPA, 1996), one objective of corrective action is to clean up groundwater to drinking water standards such as MCLs. As shown on **Figures 3-35 through 3-38**, portions of the selenium and arsenic groundwater plumes with concentrations higher than MCLs are beneath private properties and under portions of the COEH. Potential exposure pathways to concentrations of arsenic and selenium in groundwater that are higher than MCLs are present where existing wells are providing water for drinking or other uses from those plume areas. The proposed corrective action for this exposure route is described in Section 6. The EVCGWA was implemented in 2016 to preclude future groundwater developments in and around the plume areas.

4.1.2 Soil and Sediment

The COCs in soil and sediment for assessing risks to human health are arsenic and lead. Although both the screening-level HHRA and OU-2 ROD identified several constituents in soil or sediment with concentrations higher than screening levels, these COPCs were co-located with arsenic and lead, which had the widest distribution in soil or sediment and the highest concentrations. USEPA concluded for the OU-2 ROD that lead was the primary COC; arsenic was also identified as a COC but considered to pose lower risk (USEPA, 2009). USEPA also noted that once areas were cleaned up to remove arsenic and lead, potential exposures to the other constituents were further minimized.

Only three of the CMS Parcels identified as having COCs exceeding screening levels in surface soil and sediment have not been addressed by the IMs. Parcels 8W, 10, 11, 12, 17, and 18 were remediated as part of the SPHC IM; significant excavation was needed to relocate PPC and excavated areas outside the new creek channel were backfilled using soil with concentrations below the MCSs. Potential human exposures to concentrations in soil higher than MCSs are therefore not expected to occur at these parcels.

In the future, there may be potentially complete exposure pathways to humans from COCs in soil in Parcels 2a, portions of Parcel 15, and Parcel 23. Exposure scenarios for these CMS Parcels were developed to provide estimates of Reasonable Maximum Exposure (RME) to constituents in soil or sediment. Exposure scenarios based on RME assumptions estimate potential exposures that are above average but less than maximum exposures (USEPA, 1989). The risk assessment for these parcels considered the current and reasonably anticipated future land uses and human activities. The reasonably anticipated future land use was based on the current COEH zoning ordinance (COEH, 2016). For purposes of this HHRA, current and future land uses are assumed to be the same.

The HHRA exposure scenarios for CMS Parcels 2A, 15, and 23 are as follows:

- Parcel 2a: commercial/industrial use for soil; recreational use for soil and sediment along the PPC corridor through the parcel
- Parcel 15: commercial/industrial use for soil
- Parcel 23: commercial/industrial use for soil; recreational use for sediment

For both commercial/industrial and recreational uses, the potential exposure pathways considered were soil ingestion (direct contact) and inhalation of dust suspended into the air. Conceptual models of exposure pathways for these three parcels are presented in the final HHRA technical memorandum (**Appendix E)**; these conceptual exposure models provide a full description of the potential exposure pathways to humans from potentially affected media as well as the pathways considered to be complete pathways addressed quantitatively in the HHRA.

Quantitative assessment of human health risks was done by direct comparison of Exposure Point Concentrations (EPCs) in soil or sediment to the MCSs identified in Section 2.3.3. The EPCs were calculated as 95 percent Upper Confidence Limits (UCLs) of the arithmetic mean concentrations in soil or sediment across an entire parcel. Use of the UCL is consistent with the definition of a RME scenario (USEPA, 1989). The MCSs for arsenic presented in Section 2.3.3 and approved by USEPA in the CMS Work Plan (CH2M HILL, 2015a) were based on a target cancer risk deemed to fall within USEPA's target risk range of 1×10^{-6} to 1×10^{-4} (USEPA, 2009). The results of the final HHRA are summarized in **Table 4-1**.

The quantitative assessment for the three parcels resulted in an estimated lifetime cancer risk from arsenic in soil or sediment that did not exceed 2.5×10^{-5}. This falls within USEPA's target risk range of 1×10^{-6} to 1×10^{-4} for corrective action (USEPA, 1996). Lifetime cancer risks were calculated for arsenic for comparison with the target risk range (**Appendix E**).

As shown in **Table 4-1**, EPCs for lead in surface soil exceeded the MCS in Parcels 2a and 15 based on commercial/industrial land use. However, this result may not indicate that corrective actions are warranted in Parcel 2a and 15. The MCS for lead in a commercial/industrial scenario is 800 mg/kg, which corresponds to a target blood-lead level of 10 micrograms per deciliter (µg/dL) and was originally developed in 1996 using USEPA's Adult Lead Model (ALM) (USEPA, 2003). The RSL has not kept pace with revisions to the ALM model, which was updated in 2009 and provided a screening level of 2,240 mg/kg corresponding to a blood-lead level of 10 µg/dL. In 2016, USEPA published another revision to the ALM, which updates the screening level to 2,737 mg/kg corresponding to a 10 µg/dL blood-lead level

(USEPA, 2016c). EPCs for lead in surface soil fall well below the levels calculated based on the 2009 and 2016 ALM updates.

The OU-2 ROD established a commercial/industrial cleanup level for lead in soil of 1,482 mg/kg, also based on a blood-lead level of 10 µg/dL and calculated using the ALM. The protectiveness of the 1,482-mg/kg cleanup level was evaluated by USEPA using site-specific data collected as part of the OU-2 ROD. An analysis of paired blood lead/soil lead concentration data indicated that soil lead concentrations ranging from 1,000 to 1,500 mg/kg did not influence blood-lead levels (USEPA, 2009). Based on these multiple lines of evidence, it is likely that a lead concentration in soil higher than 800 mg/kg may not be associated with a blood-lead level higher than 10 µg/dL.

As shown in **Table 4-1**, the human health risks associated with arsenic in soil and sediment for recreational use along PPC, in Parcels 2a and 23, were within USEPA's target risk range. Table 4-1 also shows that lead concentrations in soil were within a range that does not appear to influence blood-lead levels based on site-specific studies. This concentration range (1,000 to 1,500 mg/kg) also encompasses the cleanup level for commercial/industrial land use presented in the OU-2 ROD.

4.1.3 East Field Assessment of Risks — Livestock Grazing

USEPA Region 8 prepared an assessment of the risks posed to individuals who might ingest beef from cattle that graze on the East Field Parcel (USEPA, 2017). **Appendix E** contains the memorandum summarizing the results of this assessment. The assessment focused on lead in East Field Parcel soils and used concentrations estimated as the 95 percent UCL, on average. An equation relating lead concentrations in vegetation to lead concentrations in soil was used to estimate concentrations in East Field grass that might be grazed by livestock. Ingestion of lead in grass was estimated using a livestock exposure factor, and a biotransfer model was used to estimate accumulation of lead in animal tissue from grass ingestion. Subsequent ingestion of lead in beef by adults and children less than 7 years of age was estimated using exposure factors published in USEPA guidance (see **Appendix E**). Blood-lead levels in young children were estimated using USEPA's Integrated Exposure/Uptake-Biokinetic Model, and blood-lead levels in adults were estimated using USEPA's ALM. Geometric mean blood-lead levels in adults and children were 2.8 and 1.9 µg/dL, respectively. A less-than-0.02-percent probability of blood-lead levels exceeding 10 µg/dL was found for adults and children. The memorandum notes that USEPA considers lead risks to be unacceptable if the probability of exceeding a blood-lead level of 10 µg/dL is greater than 5 percent. The memorandum concludes that, based on these calculations, the ingestion of beef from the cattle grazing on the East Field Parcel would not be expected to result in any adverse health effect from lead (USEPA, 2017).

4.2 Updated Ecological Risk Assessment

The conclusions of the final BERA, which was finalized in December 2011 (Gradient) and approved by USEPA on December 3, 2011, have been updated herein to reflect the current, post-IM site conditions. The 2011 BERA was designed to support risk management decisions and evaluate whether corrective measures are needed to protect the following ecological resources: benthic invertebrates, fish, amphibians, aquatic and terrestrial plants, soil invertebrates, birds, and mammals. The BERA was conducted to estimate the likelihood and magnitude of unacceptable risks to ecological receptors posed by current or likely future exposure to metals in soil, water, sediment, plants, and biota at and immediately surrounding the Facility as observed in the Phase II RFI (**Figure 4-1**).

This updated ecological risk assessment compared existing data on concentrations of lead in surface soil to the 650 mg/kg ecological MCS for passerine insectivores. This ecological benchmark level, developed from field studies performed at the former Anaconda smelter, was recommended for use by the USFWS in its comments on the BERA (Gradient, 2011). The MCS represents a benchmark below which there are no unacceptable risks to passerine from lead in soil. As discussed in this section and Appendix E, based on the methods used in deriving the MCS, that value does not represent a level triggering corrective measures for a particular parcel. As described in USEPA's guidelines for ecological risk management (USEPA, 1998), the need for corrective measures takes into consideration factors such as nature and severity of adverse effects to birds, the strength of the evidence used in deriving the benchmark value, and potential impacts from corrective measures (such as excavation or capping) to habitat or wildlife populations. Evaluations of concentrations greater than the MCS were assessed through a review of the Anaconda field study performed by Hoff (2002) and the studies of ecological risks to birds conducted at the Coeur d'Alene Basin site, as presented in **Appendix E**.

For surface soil, all of the exposure areas evaluated in the 2011 BERA except the West Perimeter (**Figure 4-1**) were remediated under the SPHC IM described in Section 6.2.2. The IMs were designed to provide surface soil conditions that would meet the ecological MCSs approved in the CMS Work Plan (CH2M, 2015a) and summarized in **Table 2-1**. Therefore, the only remaining potential ecological risks from the metal COPCs identified in the 2011 BERA are in the West Perimeter (located in the northwestern portion of Parcel 15 and Parcel 2a). The results of the final BERA are summarized in **Table 4-2**.

As part of the supplemental RFI performed in 2015-2016 (CH2M, 2015c, 2016b), the Custodial Trust sampled surface soil in portions of Parcel 15 located within the West Perimeter to update the Phase II RFI data used in the 2011 BERA. The sampling indicated elevated metal concentrations above reference areas in the West Perimeter samples indicative of historical smelting activities that were expected to pose high risk to terrestrial receptors. The 650 mg/kg MCS was compared to the lead concentrations in surface soil detected in the ISM sampling of Parcels 2a, 15, and 23. The lead EPC concentration in the areas sampled in Parcels 2a of 1,169 mg/kg and 15 of 1,028 mg/kg (**Table 4-1)** were higher than 650 mg/kg, a level considered a no observed effect concentration in soil for observable, adverse effects (red blood cell production and reproductive success). However, lead concentrations in soil higher than 650 mg/kg do not clearly represent unacceptable ecological risk. USEPA ecological risk management guidelines state that remediation should reduce unacceptable ecological risks where the risks represent reduced diversity, increased mortality, diminished growth, impaired reproduction, etc. (USEPA, 1998).

As discussed in **Appendix E**, the 650 mg/kg lead concentration in soil was the highest assessed in the Anaconda smelter site study (Hoff, 2002), and thus the study provides no information about risks above 650 mg/kg. The potential for lead in soil to represent unacceptable ecological risk was assessed by comparison with lowest observed effect concentrations (LOECs) from studies in birds conducted at the Coeur d'Alene Basin, Idaho site (Sample et al., 2011). LOECs represent a threshold at which there are concerns about adverse effects on populations or communities, with the level of concern proportional to the magnitude that exposure concentrations exceed the LOEC. The literature-based LOECs range from 1,900 to 2,700 mg/kg lead in soil. The lead EPCs in soil for Parcels 2a and 15 fall below LOECs. In addition to this literature-based comparison, site-specific soil/tissue relationships developed in the Anaconda study (Hoff, 2002) were used to assess the risk of lead concentrations above 650 mg/kg. This analysis showed that estimated liver tissue concentrations of lead with 1,029 to 1,169 mg/kg in soil suggest ecological risks, if present, are relatively small, do not represent potentially serious adverse effects, and are unlikely to have population or community-level effects. The small magnitude of ecological risk based on site-specific Anaconda smelter data is a factor for consideration in determining the need for risk reduction (if any) and the type of actions to be performed for this exposure pathway. The EPC for lead in Parcel 23 did not exceed the 650 mg/kg MCS.

A comment on the BERA was provided by USEPA and USFWS in order to evaluate risk to cattle grazing on agricultural lands (Gradient, 2011). To address this comment, a risk-based concentration (RBC) of 955 mg/kg was calculated based on the assumptions presented in Ford and Beyer (2014). The lead EPC concentration in Parcel 15 of 1,028 mg/kg (**Table 4-1**) was slightly higher than the 955 mg/kg ecological benchmark for livestock. The 955 mg/kg value had been calculated using a Toxicity Reference Value (TRV) of 3.2 mg/kg-day, which was derived by Ford and Beyer (2014) from the National Research

Council's "Mineral Tolerances of Animals" and represents "the dietary level that, when fed for a defined period of time, will not impair accepted indices of animal health or performance" (National Research Council, 2005). This TRV is lower than a no observed adverse effect level (NOAEL) (4.7 mg/kg/day) recommended by USEPA for mammalian species (USEPA, 2005b). Using USEPA's TRV raises the cattle benchmark for lead from 955 to 1,446 mg/kg. Based on this assessment, the 1,028 mg/kg lead concentration in Parcel 15 does not represent unacceptable ecological risks because these concentrations are below levels that might be associated with serious adverse effects. The small magnitude of ecological risk is a factor for consideration in determining the need for risk reduction (if any) and type of actions to be performed for this exposure pathway.

Sediment data collected in 2015-2016 along PPC in Parcels 23 and 2a as part of the supplemental RFI (CH2M, 2015c) were evaluated to determine whether the conclusion of the 2011 BERA that low-to-moderate risks occur along PPC is still valid. All sediment concentrations of arsenic from the 2015-2016 sampling were lower than the wildlife (bird and mammal) screening level of 321 mg/kg developed in the BERA (Gradient, 2011; Table C-11). Sediment results from Parcel 23 are considered to reflect influences from upstream mining activities and were therefore used to calculate a Background Threshold Value (BTV) for use in evaluating sediment concentrations of lead in PPC downstream in Parcel 2a. The BTV for lead in Parcel 23 was an Upper Tolerance Limit (UTL), or the 95 percent UCL on the 95th percentile concentration, calculated using USEPA's ProUCL software. The UTL was 296 mg/kg, which means that concentrations higher than 296 mg/kg might represent sediment quality affected by contaminants from the Facility. Individual sample results in Parcel 2a that were higher than the UTL were evaluated further. The evaluation compared sample results against a wildlife sediment screening value for lead of 123 mg/kg, based on a NOAEL in birds (Gradient, 2011; Table C-11). Lead concentrations in sediment at one localized sampling location were higher than this screening level but do not represent unacceptable ecological risk as described in USEPA's ecological risk management guidelines (USEPA, 1998), where unacceptable risks correspond to serious adverse effects (reduced diversity, increased mortality, diminished growth, impaired reproduction) on populations or communities. The limited nature of this sediment risk is a factor for consideration in determining the need for risk reduction (if any) and type of actions to be performed for this exposure pathway.

4.3 Areas with Identified Risk/Conditions Summary by Parcel

The CMS is required to develop and evaluate remedial action alternatives. The objective is to address areas where media is expected to pose a threat to human health and the environment that exceeds the upper bound of the CERCLA risk range. The general conclusions derived from risk data are pertinent to remedy selection and are organized by parcel in **Table 4-3**.

In summary, a potential unacceptable risk to human health from groundwater is present in areas where the MCLs are exceeded and private wells continue to be used to provide drinking water:

- Concentrations of arsenic and selenium in groundwater beneath and downgradient of the Facility are higher than the respective MCLs of 10 µg/L for arsenic and 50 µg/L for selenium.
- Potential exposure pathways to concentrations of arsenic and selenium in groundwater that are higher than MCLs are present where existing wells are providing water for drinking or other uses from those plume areas.
- As discussed in USEPA's corrective action guidance (USEPA, 1996), concentrations higher than MCLs establish a basis for potential action through groundwater corrective measures.

The results from the final HHRA and BERA demonstrate that current surface soil and sediment conditions do not pose an unacceptable risk to human health or the environment:

- The evaluation indicates that contamination and potential risk at the majority of the CMS Parcels are being addressed through IM implementation.
- Human health risks associated with arsenic in soil and sediment in areas not remediated as part of the IMs (Parcels 2a, 15, and 23) are estimated to fall within USEPA's target cancer risk range of 1×10^{-6} to 1×10^{-4}. Concentrations of lead in soil and sediment in these parcels are estimated to be lower than those associated with USEPA's current blood-lead target level of 10 µg/dL.
- Concentrations of lead in certain portions of soil in Parcels 2a and 15 were slightly higher than the MCS protective of passerine species. However, these results do not indicate an unacceptable ecological risk, when applying USEPA's principle of protecting populations or communities from ecological risks (USEPA, 1998), the nature of ecological risks at the site as presented in the BERA (Gradient, 2011), and the degree of conservatism in estimating potential exposures or effects to wildlife species incorporated into the MCSs. Concentrations in isolated locations in sediment downstream of the Facility do not pose an unacceptable ecological risk when taking into consideration the contribution of upstream sources. Although concentrations of lead in isolated locations in sediment downstream of the Facility exceed some ecological benchmarks, remediation is not warranted at these locations given the ongoing contribution of metals to sediment from sources upstream of the Facility.

Selection and Evaluation of Corrective Measures Alternatives

This section describes the process for selecting and evaluating the corrective measures alternatives that address unacceptable risk to human health and the environment, prevent or mitigate the continuing migration of or future release of hazardous waste or hazardous constituents at or from the former ASARCO properties, and facilitate restoration of contaminated media to standards acceptable to USEPA. Consistent with the USEPA-approved CMS Work Plan (CH2M HILL, 2015a) and USEPA guidance, the CMS alternatives analysis evaluated corrective measures appropriate for site-specific conditions, the performance of IMs for suitability as components of final corrective measures, and the predicted benefit of potential additional source control measures.

The first portion of this section provides an overview of the corrective measures alternative evaluation process. Following the overview, this section describes the initial source area removal evaluations conducted via mass distribution modeling, summarizes the groundwater contaminant fate and transport modeling, presents a comparative analysis of the alternatives against the threshold and balancing criteria, and outlines remedy alternative evaluation recommendations.

5.1 Overview of Corrective Measures Alternative Evaluation Process

This section provides an overview of the corrective measures alternative evaluation process and the results from the source control remedy evaluation, building on the summary of CMS goals, objectives, and scope presented in Section 2. **Figure 5-1** provides a visual depiction of the CMS evaluation program elements, which are summarized as follows and described in more detail in subsequent sections:

- In 2013 an initial screening effort was performed via the MVS tool (introduced in Section 3.3.3; and as detailed in Section 5.2) to evaluate whether it was practical or cost-effective to consider relatively large-scale source removal over the majority of the contaminated areas in the Facility to meet DEQ-7 groundwater quality standards. Results from this initial screening analysis using the MVS tool demonstrated/supported that is was impractical (or cost prohibitive) to consider large-scale source removal alternatives, and that development of more focused/smaller-scale source area remedy alternatives were needed to reduce risks to human health and the environment, and minimize or control the leaching of COCs into groundwater.
- In 2014, the source area inventory compiled by Hydrometrics (2014a) was used to help evaluate and prioritize key source areas as part of the source area evaluation process (source area inventory presented in Section 3, and summarized in **Table 3-3**). The source area inventory was based on results from previous investigations and IMs performed under Asarco, the Phase II RFI (2011), and 2014 investigations with respect to identifying potential source areas which could contribute leachable COCs to groundwater above DEQ-7 groundwater quality standards. The source area inventory identified the following general areas:
  - West Selenium Source Area, with subareas including the Rail Corridor Soils, Former Speiss-Dross Area, and Acid Plant
  - North Plant Source Area
  - Monier Flue

- Former Thornock Lake
- South Plant Source Area, with subareas including Upper Ore Storage area, Former Acid Plant Sediment Drying Area, and Lower Lake/Tito Park Area

- In 2014 and subsequently in 2015, focused SAIs were performed to provide data needed to support of the source area evaluation process. Section 3.3 describes the investigations to support CMS evaluations, which included information from the 2014 and 2015 SAIs, supplemental RFI soil sampling, and ongoing CAMP monitoring. Data obtained from these SAIs (as described in Section 3) were used to update the CSM with respect to the identification of the primary source areas, help understand the source mechanisms mobilizing and leaching COCs into groundwater, and to refine the groundwater flow and contaminant fate and transport model (as detailed in Section 5.3).
- IMs implemented over the period 2012 through 2016 (including SPHC, ET Cover, and focused source removal as described in Section 3.3.4) were monitored to assess IM performance and to support the source control remedy evaluation process. Performance of IMs, including the monitoring of changes or reductions in groundwater levels, and reductions in COCs in groundwater were used to update the CSM and to refine the groundwater contaminant fate and transport model.
- The groundwater flow model (presented in Section 3) was used as the framework to develop the contaminant fate and transport model to support predictions in IM effectiveness as a comparative baseline condition to evaluate the potential benefit from supplemental alternatives. Details of the contaminate fate and transport model are presented in Section 5.3, and supporting documentation is provided in **Appendix A**.
- In 2015, an initial screening-level source control alternative evaluation was performed on four primary source areas inferred to have the most effect on groundwater quality, including site-wide groundwater, West Selenium Source Area, North Plant Source Area, and the Former Speiss-Dross Area. For the screening-level evaluation, these four source areas were evaluated against three of the five USEPA balancing criteria introduced in Section 2, including long-term effectiveness, implementability, and cost. Details of the screening-evaluation are presented in Section 5.4.1, and supporting documentation is provided in **Appendix B**.
- In 2016, a focused source control remedy evaluation was performed on the retained source control areas and respective alternatives recommended from the screening-level evaluation (noted above). The source areas and respective alternatives were evaluated against the five USEPA balancing criteria noted in Section 2, including long-term effectiveness, reduction in toxicity, short term effectiveness, implementability, and cost. Details of the evaluation approach and results are presented in Section 5.4.2, and the evaluation included the following source areas and alternatives:
  - West Selenium Source Area and four potential source control alternatives, including:
    - Source Removal
    - PRB for selenium
    - Slurry Wall Enclosure (of primary source area COCs)
    - Focused Pump and Treat (extraction system spanning the width of selenium plume with onsite treatment)
  - North Plant Arsenic Source Area and three potential source control alternatives, including:
    - PRB for arsenic
    - Slurry Wall Enclosure (of primary source area COCs)
    - In-situ Injections of Ferric Iron (in conjunction with Slurry Wall Enclosure)

Subsequent sections describe details of these source control evaluation steps, and are the basis of final remedy recommendations presented in Section 6, Proposed Final Corrective Measures.

5.2 Initial Source Area Removal Evaluations via Mass Distribution Modeling

Mass distribution modeling via the MVS tool (described previously in Section 3.3.3 and **Appendix C**) was used as an initial screening tool to support source area saturated soil removal evaluations. For the purpose of performing a screening-level evaluation, "source" was defined as soil with inorganic COC concentrations that exceed levels protective of groundwater, in other words, soil that could leach COCs to groundwater at levels that would exceed an established screening level. The proposed approach to the initial evaluation considered the potential benefit and practicability of removing materials that are not addressed by the SPHC and ET Cover System IMs and have the potential to be significant ongoing sources of contamination to groundwater.

To evaluate the potential benefit and practicability of source removal, the MVS model was used to estimate the locations, volumes, and contaminant mass in soil. Different removal scenarios were considered for post-SPHC IM saturated soil removal (two alternatives evaluated):

1. Alternative 2 would address saturated soil generally underlying former process areas identified as the primary source areas and assumed to be where the highest soil COC concentrations are present. Alternative 2 would still leave a significant volume of soil with COC concentrations exceeding SSLs (i.e., would not eliminate the possible need for other source control measures and reduce long-term monitoring and stewardship requirements).
2. Alternative 3 would address saturated soil over a majority of the Facility to evaluate whether it was practicable to remove sufficient mass to meet DEQ-7 water quality criteria in groundwater.

A summary of the approach and conclusions of these evaluations is presented below.

5.2.1 Alternatives Evaluation Approach

The MVS model was used to estimate the volume and mass of contaminated saturated soil for excavation, as well as the volume of overburden soil to be excavated in order to reach the contaminated saturated soil. Based on the existing CSM, and to estimate total contaminant mass, arsenic was used to quantify contamination in soil. Recognizing that arsenic and selenium behavior in the subsurface is different, the soil removal evaluation assumed that the volumes identified for removal based on arsenic estimates would be adequate to address selenium at an initial screening level. The model estimated the volumes and constructability issues related to the two saturated soil removal alternatives. The results indicated that both alternatives would involve extensive excavation of overburden to reach the underlying saturated soil and were therefore not practicable. The initial evaluations can be summarized as follows (details are provided in **Appendix C**):

- Alternative 1 addressed shallow soil removal as an IM, discussed in Section 3.3.3.
- Alternative 2, the localized removal of saturated soil beneath six areas based on soil concentrations of arsenic >290 mg/kg (MDEQ action level for arsenic in subsurface soil is 300 mg/kg, which was based on MDEQ, 2009), would require excavation of approximately 400,000 yd^3 of overburden to remove 78,000 yd^3 of contaminated saturated soil. Removal of these areas was estimated to result in a 1 percent reduction in total arsenic mass at an estimated cost of $30 million.
- Alternative 3, removal of all post-SPHC saturated soil exceeding 40 mg/kg of arsenic, would require excavation of a minimum of approximately 1,500,000 yd^3 of overburden to remove 600,000 yd^3 of

contaminated saturated soil. This removal alternative would result in an estimated additional 8 percent reduction in total arsenic mass at an estimated cost of $162 million.

5.2.2 Summary of Conclusions

The screening-level source removal evaluations completed using MVS modeling indicated the following:

- There is tangible economic benefit in the removal of TPA soil and Lower Lake sediment beyond the minimum necessary to facilitate the realignment of PPC, but evaluations indicate that additional large-scale removal of materials from the post-SPHC saturated zone (20 to 40 feet bgs) within the Facility area (outside of the TPA) is not practicable as it would require significant construction work, with risk and cost increasing with depth.
- Characterization data are sufficient to support the evaluation and design of remedies. However, current data were not sufficient to evaluate localized source removal alternatives, particularly at shallower (less than 20-foot) depths. Decisions on localized source removal would require additional characterization (which was accomplished as part of the CMS).
- The incremental benefit to groundwater of source removal in addition to the IMs was difficult to quantify, given the uncertainties associated with the site characterization data and complex geochemistry. Additional site investigations, evaluation, and modeling efforts were proposed and completed (as described below).

5.3 Groundwater Contaminant Fate and Transport Modeling

The groundwater flow model described in Section 3.3.2 provided a numerical representation of the hydrogeologic conditions used to represent hydraulic (groundwater elevations and flow directions) alternatives at the site. Contaminant fate and transport modeling was used to represent the contaminant conceptual model for the source areas and transportation mechanisms. The fate and transport modeling utilizes the groundwater flow model and includes source area contaminant concentrations and evaluates their impact on groundwater over time. This modeling supported evaluation of source area remedy alternatives (**Appendix A**).

The fate and transport modeling was used to evaluate existing and predicted groundwater contaminant concentrations in response to changes in groundwater elevations, flow directions, and groundwater recharge from the PPC and surface infiltration. Alternatives including source removal, source containment, and source cover were evaluated based on the predicted mobilization and migration of contaminants based on the changes in surface water infiltration, source saturation, and groundwater flow through contaminated areas resulting in the predictive groundwater concentrations and plumes on- and offsite.

The objectives of the fate and transport modeling was to support screening and evaluation of selected potential corrective measures and retain those found to have the highest potential to meet RAOs. The predicted groundwater concentrations were used to assess primary sources of ongoing contamination to groundwater, anticipated conditions after implementation of IMs, and using the anticipated IMs conditions as a “baseline condition,” evaluation of which remedies in addition to the IMs would be necessary.

The fate and transport modeling results were used to support remedy evaluation by comparing plume maps of arsenic and selenium and quantitatively looking at the following metrics:

- Predicted changes in concentration over time at individual monitoring wells
- Predicted change in plume volume based on DEQ-7 groundwater quality criteria values

- Predicted change of total mass of arsenic and selenium in groundwater
- Predicted change in mass flux (rate of contaminants released) of arsenic and selenium across the Facility boundary

This approach provided both a qualitative and quantitative method of comparing, evaluating, and recommending source control remedy alternatives. Comparisons were made in a phased approach, with additional information and implementation of IMs incorporated into subsequent refined models and fate and transport predictive evaluations. Section 5.4.2 presents the predictive model results estimating the changes in groundwater levels and influences on contaminant metrics (such as concentrations over time, plume volume, total mass, and flux rate as noted in bullets above) for the selected source control remedy alternatives.

Modeling results were presented to the Groundwater Technical Working Group during regular team meetings. The Groundwater Working Group consisted of members from NewFields Companies, LLC (NewFields), Hydrometrics, CH2M, the Custodial Trust, USEPA, Montana Natural Resource Damage Program, MDEQ, Lewis and Clark County, COEH, and Montana Bureau of Mines and Geology.

Models are simplifications of complex systems, and in all modeling exercises, some model parameters are not well quantified or are poorly understood due to lack of site-specific data. The calibration results demonstrated that the model was capable of simulating groundwater flow within the model area under steady-state and transient conditions (Section 3.3.2 and **Appendix A)**, and was capable of simulating fate and transport of arsenic and selenium within most of the model area under steady-state conditions. It should be noted that achieving calibration does not guarantee the set of input parameters selected is unique and that other plausible inputs would not achieve similar calibration results. However, calibration and verification to several independent sets of both steady-state and transient target data increases confidence in the model’s capability to simulate groundwater flow under a variety of aquifer conditions. Refer to Section 9 in **Appendix A** for a summary of model limitations.

5.4 Source Area Alternatives Evaluation and Results

This section presents the results from the screening-level evaluation (Section 5.4.1), and subsequently, the more detailed source area evaluation (Section 5.4.2) which included a subset of the alternatives retained form the screening evaluation process.

5.4.1 Source Area Groundwater Screening-level Evaluation

The objective of the source area screening-level evaluation (Section 5.4.1) was to evaluate a broader list of potential source control alternatives to screen (exclude) and identify a subset of selected alternatives to meet RAOs, which were included in a subsequent more detailed evaluation (Section 5.4.2).The focus of the screening evaluation was on corrective measures to address the primary sources of ongoing contamination to groundwater, with consideration to anticipated conditions after implementation of IMs. As introduced in Section 2, potential source control remedies were screened and evaluated via USEPA balancing criteria following USEPA RCRA corrective action guidance (USEPA, 1994; USEPA, 2000). The initial screening process considered all information available in 2014, including data gathered by previous site investigation work compiled by Hydrometrics in Table 3-3 of the source area inventory (Hydrometrics, 2014a). The evaluations also considered the expected effects of the IMs as a “baseline condition,” in order to evaluate the extent to which remedies in addition to the IMs would be necessary.

Four source areas were expected to have the most significant effect on groundwater quality (**Figure 3-7)**:

- Affected Area – refers to locations where groundwater exceeds MCSs, including onsite and offsite groundwater plumes

- West Selenium Source Area
- North Plant Arsenic Source Area
- Former Speiss-Dross Source Area, including the Speiss Handling and Speiss-Dross slurry wall areas

The screening-level evaluation was performed for each primary source area against three of the balancing criteria introduced in Section 2. Following USEPA guidance (USEPA, 1994; USEPA, 2000), a description of the three balancing criteria applied to the screening-level evaluation are presented below:

1. **Effectiveness**: Three criteria were combined to evaluate effectiveness: (1) long-term effectiveness and permanence, (2) toxicity, mobility, and volume reduction, and (3) short-term effectiveness. The effectiveness was evaluated based on arsenic or selenium data, which are the COPCs in groundwater.
2. **Implementability:** To evaluate implementability, four criteria were considered: (1) construction and operation requirements, (2) technology reliability, (3) suitability to site conditions, and (4) onsite treatment options.
3. **Cost**: To evaluate cost, two criteria were considered: (1) capital costs that are fixed, one-time expenses incurred as a result of implementation or construction in 2014 dollars, and (2) net present worth (NPW) of capital costs, annual operations and maintenance, and site control costs. The NPW was estimated assuming a fixed 30-year period at 5 percent discount. Screening-level costs followed Rough Order of Magnitude 5 guidance (AACE, 2005), estimated at -50 percent to +100 percent accuracy and are intended for concept-level screening with 0 to 2 percent design assumptions. The screening-level costs relied on professional judgment, analogs from other projects, and published literature for unit costs.

Table 5-1 provides an overview of the source area screening-level evaluation and the results. Details of the screening-level evaluation are provided in the *Tier II Source Control Groundwater Remedy Evaluation – Phase 2 Results and Recommendations* (CH2M HILL, 2015d) provided in **Appendix B**. In summary, four alternatives for the West Selenium Source Area and three alternatives for the North Plant Arsenic Source Area were retained for more detailed evaluation as presented in Section 5.4.2.

As summarized in **Table 5-1** (and detailed in the **Appendix B** evaluation), the pump and treat alternative for on and offsite areas of the broader 'Affected Area' was not considered cost effective, with qualitative cost scoring of 'high' (more than $5 million), and quantified costs estimated at upwards of $40 million for operation and maintenance of a long-term pump and treat system to contain the onsite plume located along the north property boundary. In addition, there was uncertainty in the pump and treat alternative with respect to effectiveness and potential effects of downgradient plume stability. All of the alternatives for the Former Speiss-Dross area were recommended to be screened (excluded) for detailed evaluation due to the rationale/scoring notes summarized in **Table 5-1**.

5.4.2 Detailed Source Area Groundwater Remedy Evaluation

A detailed source area evaluation was performed on the two source areas and the respective alternatives retained from the screening-level evaluation, including:

- West Selenium Source Area and four potential source control alternatives, including:
  - Source Removal
  - PRB for selenium
  - Slurry Wall Enclosure (of primary source area COPCs)
  - Focused Pump and Treat (extraction system spanning the width of selenium plume with onsite treatment)

- North Plant Arsenic Source Area and three potential source control alternatives, including:
  - PRB for arsenic
  - Slurry Wall Enclosure (of primary source area COPCs)
  - In-situ Injections of Ferric Iron (in conjunction with Slurry Wall Enclosure)

These sources areas and potential source control remedial alternatives were evaluated against the following five balancing technical criteria: long-term effectiveness and permanence, reduction in toxicity, mobility, or volume through treatment, short-term effectiveness, implementability, and cost. The remaining two balancing criteria, including state, and community acceptance, were included and evaluated in Section 7 as part of the public involvement process. Details of the source control remedy evaluation are included in the *Tier II Source Control Groundwater Remedy Evaluation - Phase 2 Results and Recommendations* (CH2M HILL, 2015d) (**Appendix B**) and summarized below.

The source area evaluation followed RCRA guidance to evaluate each alternative. **Table 5-2** summarizes the RCRA balancing criteria, definitions, interpretation, and application of balancing criteria to remedy evaluation, and the scoring logic as they were applied to each alternative. Conceptual designs were developed for each alternative to perform the necessary technical evaluations and relative cost comparisons, and **Table 5-3** provides details on source areas, technology descriptions/assumptions, dimensions/unit quantities, and the construction approach for each alternative. **Table 5-4** presents the comparative evaluation summary and the combined balancing scores for each alternative. **Table 5-5** provides an overview of source area remedy evaluation results.

The groundwater remedy evaluation identified the highest scoring alternatives based on 2014 SAI results and associated 2015 groundwater flow model (NewFields, 2015). As summarized in **Table 5-4**, the highest scoring alternatives for West Selenium were slurry wall (combined balancing score [CBS] of +4), followed by source removal (CBS of +2); while the highest scoring alternative for North Plan Arsenic was slurry wall (CBS of +1). As shown in **Table 5-4**, the costs for West Selenium Source Area for slurry wall and source removal were the lowest of the four alternatives, estimated at $1.7 million and $2.8 million, respectively; and for North Plant, the cost for slurry wall (estimated at $2.1 million) was substantially lower than the PRB to treat arsenic (estimated at $20 million).

Results from the source control remedy evaluation supported a recommendation that additional source area characterization data were needed to support a final remedy recommendation. Additional site characterization data were collected as part of the 2015 SAI (described in Section 3) to better understand the nature and extent of source areas, assist in refining the groundwater flow model, recalibrate the groundwater flow model to post-IM 2014 groundwater conditions, and reduce uncertainty in model predictions (i.e., effectiveness). Based on the 2015 SAI results and recalibrated groundwater model (NewFields, 2016b), the subsections below include a summary by source area of: (1) observed groundwater level changes to show inferred initial hydraulic response to implementation of the IMs, (2) predicted changes in groundwater flow direction and groundwater elevations (i.e., decreases), and (3) the predicted effectiveness of IMs and additional potential benefit of highest scoring alternatives based on the recalibrated groundwater flow model.

5.4.2.1 West Selenium Source Area

Four alternatives were evaluated for West Selenium Source Area and compared to the modeled baseline IM condition; source removal, a PRB, a slurry wall enclosure, and a focused pump and treat system. The initial evaluation results performed prior to evaluation using the groundwater fate and transport model (**Table 5-4**) indicated that a slurry wall enclosure had the highest combined balancing criteria score and ranked the highest of remedy alternatives, followed by source removal. Because the other two alternatives, PRB and pump and treat, scored substantially lower in comparison, only the slurry wall and source removal were retained as scenarios for predictive groundwater modeling and comparison against the IM baseline condition.

The first parameter to be evaluated for the remedial alternatives was groundwater elevation. **Figure 5-2** is a groundwater elevation hydrograph of indicator wells, which shows that groundwater levels in the northwestern portion of the Facility (near the West Selenium Source Area via wells DH-8 and DH-66) have decreased in response to the SPHC (6 to 7 feet at DH-66, see **Figure 3-32**) phases completed by mid-2015. These water level reductions have decreased contaminant loading to groundwater by reducing the volume of source material below the water table. Additional contaminant loading reductions may be achieved in the future due to continued lowering of the water table and possibly from completion of the ET Cover System IM and reduction of percolation and mobilization of contaminants from impacted soil to groundwater. **Figure 5-3** illustrates the predicted potentiometric surface elevations for a 10-year simulation of the combined IMs, which predicts that groundwater elevations will continue to decrease and indicates a general flow direction to the northwest near the West Selenium Source Area, consistent with current conditions. **Figure 5-4** illustrates more clearly the predicted change in groundwater elevations for the same 10-year simulation, showing predicted decreases of groundwater elevation in the range of 2.5 to 5 feet in the West Selenium Source Area.

The groundwater flow, fate and transport model was also used to predict changes in contaminant volume and mass from IM implementation and to evaluate the incremental changes associated with either the slurry wall and source removal alternatives in comparison to 2014 IM baseline conditions. **Figure 5-5** shows the predicted changes in volume and mass of selenium with respect to the 2011 model calibration, the 2014 calibration for the baseline IM simulation, the respective slurry wall and source removal alternatives (assuming 100 percent removal of the source material). Note that the 2011 and 2014 calibration runs were based on observed data, so they represent conditions before (2011) and during (2014) IM implementation. The 2014 baseline IM simulation predicts conditions after the source removal, SPHC and ET Cover System IMs are completed. The finite source simulation represents leaving the saturated mass in place, and that mass gradually decreasing over time. The West Selenium Source Area 100 percent source removal model simulation is identical to the IM baseline simulation, except the saturated source for the West Selenium Source Area was completely removed from the model. **Figure 5-6** shows the mass flux of selenium across the Facility boundary is predicted to decrease by approximately 68 percent compared to the 2011 calibration, but only 1 percent decrease compared to IM implementation alone using the same simulations used on **Figure 5-5**. As shown on **Figures 5-5 and 5-6**, there is minimal difference in the predicted volume and mass of selenium from either a slurry wall or source removal alternative when compared to the baseline IM condition.

Figure 5-7 shows the predicted isoconcentration contours for the West Selenium Source Area removal simulation, which further illustrates that there is little additional effect predicted on the extent of the downgradient selenium plume compared to IM implementation alone.

As summarized in **Table 5-6**, the predicted decrease in mass flux for selenium is approximately 38 percent from 2011 to 2014 due to implementation of the first phases of the IMs. **Table 5-6** shows the 2011 and 2014 calibrations (which reflect observed data), and summarizes the predicted effectiveness of the IMs once complete and then shows the predicted added benefit of additional groundwater remedy alternative(s) (i.e., slurry wall or source removal). The model simulations predict that the completed IMs alone will reduce mass flux by 68 percent, and the changes in mass flux across the Facility boundary result from less groundwater flux and reduced saturated thickness due to implementation of the SPHC and ET Cover System IMs, and possibly from depletion of the finite mass of source material. As shown in **Table 5-6**, the additional estimated benefit (decrease) in the mass flux predicted from the addition of either a slurry wall or complete source removal is minimal, estimated at approximately 69 percent (that is, 1 percent more benefit than IMs alone).

With regard to forecasted selenium plume stability, **Figure 5-5** in combination with **Figure 5-7** illustrate that with the forecasted reduction in plume mass resulting from IMs, plume volume will decrease substantially, with plume area exceeding the 0.05-mg/L iso-contour (MCL) retracting toward the Facility from historical extents previously measured. Modeling illustrates that plume stabilization will remain controlled within existing groundwater control areas (as discussed in Section 6) and is not anticipated to impact groundwater supply wells for private or municipal users.

In summary, the groundwater remedy evaluation indicated that mobilization of selenium to groundwater is being significantly reduced by the implementation of the SPHC and ET Cover System IMs. This is due to the reduction in available saturated thickness in the West Selenium Source Area and infiltration rates, which combine to reduce leaching and selenium contributions to groundwater. Further, SAI investigations suggest that the selenium loading in this area is limited, i.e., a finite mass that is depleting over time. Based on the current CSM, and observed and predicted conditions, the recommendation for the West Selenium Source Area is to monitor the performance of the IMs.

5.4.2.2 North Plant Arsenic Source Area

Three alternatives, which could be implemented in addition to the baseline IM condition, were retained for further evaluation for the North Plant Arsenic Source Area; including a PRB, a slurry wall enclosure, and slurry wall with in-situ injections (**Table 5-4**). The discussion below summarizes the observed changes in groundwater levels and predicted changes in groundwater arsenic concentrations from the 2014 recalibrated groundwater flow model (NewFields, 2016b) for the North Plant Source Area.

Figure 5-2 is a groundwater elevation hydrograph of indicator wells, which shows that observed groundwater levels near the North Plant Source Area at wells DH-17, DH-24 and DH-64 have decreased 5 to 7 feet in response to the SPHC IM, resulting in decreases in groundwater arsenic concentrations, with anticipated future benefits after completion of the ET Cover System IM. **Figure 5-3** illustrates the predicted potentiometric (groundwater) surface elevations for a 10-year simulation of post-IM conditions, which continues to show a general flow direction to the northwest, consistent with current conditions. **Figure 5-4** presents the predicted change in groundwater elevations for the 10-year simulation, which shows future anticipated changes as decreases in the range of 2.5 to 5 feet. Current field measurements show groundwater levels continuing to decline (4 to 5 feet between 2014 and 2016), and are expected to decline further based on model predictions. Based on the updated CSM from the 2015 SAI, and the recalibrated groundwater flow and contaminant fate and transport model, the predicted groundwater flow direction in the North Plant Source Area is relatively unchanged based on the selected remedies with some additional decrease in groundwater elevations from current conditions.

The groundwater flow, fate and transport model predicted that implementation of the IMs alone would result in greater than 50 percent reduction of the total mass of arsenic in groundwater downgradient of the Facility, and that the volume of groundwater with arsenic concentrations above the DEQ-7 groundwater quality standard does not change appreciably with implementation of additional source control measures (such as source removal or slurry wall enclosure). **Figure 5-8** shows the predicted changes in the volume of groundwater above the arsenic MCL and total mass of arsenic in groundwater for the 2011 and 2014 calibrations (which reflect observed conditions), and predictive simulations for completion of the IMs, as well as 70 percent removals at both the Acid Plant and North Plant Site. **Figure 5-8** illustrates that there is minimal difference in model results between the use of relatively high or low retardation parameters, and minimal difference when predicting effectiveness beyond 30 years.

Figure 5-9 shows the mass flux of arsenic across the Facility, and modeling predicts very little additional reduction from implementation of source removal at the Acid Plant Area, with virtually all of the reduction attributable to the North Plant Site Source removal. The model predicts a 47 percent reduction in mass flux when 70 percent of the source is removed from both the North Plant and the Acid Plant.

As shown on **Figure 5-10**, the groundwater model predicts that 70 percent source removal in both the Acid Plant and North Plant Areas, in addition to the IMs, would have little additional effect on the area of the arsenic plume. This figure shows some predicted reductions in plume concentrations, particularly near the Facility, between the 2014 calibrated plume, the predicted 10-year (post-IM) condition and the 70 percent source removal alternative, however the predicted aerial extent of the plume does not change significantly.

The decrease in mass flux across the Facility boundary predicted from removal of 70 percent of the North Plant Arsenic Source Area is approximately 66 percent, which is the same as the percent reduction predicted for the IMs alone. **Table 5-6** summarizes the predicted effectiveness of the IMs and potential additional benefit of all remedial alternatives evaluated for the West Selenium, Acid Plant and, and North Plant Arsenic Source Areas. As summarized in **Table 5-6**, the observed mass flux has decreased by approximately 47 percent from 2011 to 2014 due to implementation of IMs completed through 2014. The model indicates that completion of all IMs is predicted to reduce mass flux by 66 percent over a 10-year period.

In summary, groundwater monitoring and predictive modeling demonstrates that mobilization of arsenic in North Plant Source Area to groundwater is being reduced by the SPHC and ET Cover System IMs, which are reducing the available saturated thickness and infiltration rates, respectively. The SAIs confirmed that the high concentration source materials are not readily accessible for removal, which makes source removal an expensive remedy. Further, SAI evaluations of adsorptive capacity of soils downgradient of the Facility indicate that there is additional capacity available to retain and control arsenic mass coming from the Facility within the existing impact area boundaries. Although containment (a slurry wall) provides some additional decrease in groundwater arsenic concentrations, predicted benefits are negligible for both plume extent and loading to already contaminated downgradient soils. Observed conditions are showing decreasing trends and full implementation effects of IMs should further stabilize the North Arsenic Source Area and the offsite arsenic plume. Therefore, based on the current CSM, and observed and predicted conditions, the recommended groundwater remedy to address the North Plant Arsenic Source Area is IM performance monitoring.

5.4.2.3 Former Speiss-Dross Source Area

As previously noted, the integrity and performance of the existing Speiss-Dross slurry wall was investigated during the 2015 SAI and modeled with the recalibrated groundwater flow and contaminant fate and transport model. Based on these data, the existing Speiss-Dross slurry wall enclosure was found to provide effective control of the elevated arsenic concentrations within the wall enclosure. Based on the original construction details and compatibility of the low-permeability slurry wall mixture with the existing groundwater chemistry, the existing slurry wall is expected to maintain structural integrity over the long-term. As with most slurry walls, there is an estimated low flux through the wall that serves as an ongoing source. However, reduced infiltration into the slurry wall enclosure area due to implementation of the ET Cover System is expected to reduce the potential for leakage from the wall.

Groundwater flow into and out of the contaminated area is limited and the slurry wall effectively decreases the flux rate of contaminants to saturated zones outside the wall. However, the long residence time and contact with the contaminated soil results in high groundwater concentrations within the slurry wall. Over time this creates the potential for contribution of contaminant mass to Facility groundwater via flux across the wall or through the underlying Tertiary confining layer. Although the slurry wall itself reduces the flux from this area by more than an order of magnitude, lowering groundwater elevations, and subsequently reducing saturated thickness and concentrations within the slurry wall, will also provide incremental reductions in the mass flux rate.

Predicted groundwater elevations within the Speiss-Dross slurry wall are lower by approximately 5 feet, resulting in a 50 percent reduction in groundwater seepage rate across the wall and decreased saturated thickness that is expected to further reduce the flux rate out of the wall.

In summary, the Speiss-Dross slurry wall continues to provide effective containment for the unsaturated and saturated contaminated soil in the Former Speiss-Dross Source Area. The wall encompasses an area of highly contaminated soil and provides a low hydraulic boundary, significantly reducing the release of contaminants to groundwater. The effectiveness of the Speiss-Dross slurry wall is expected to be enhanced due to reduced saturated thickness in response to the SPHC IM, and decreased infiltration and mobilization of contaminants by placement of the ET Cover System. Based on the CSM and predicted conditions, the recommendation for the Former Speiss-Dross Source Area is ongoing monitoring of the existing slurry wall performance.

5.4.2.4 Slag Pile

Based on the current CSM and understanding that the slag pile is an ongoing source of contamination to groundwater (as described in Section 3.4.5), three cover alternatives were screened. Offsite disposal was not considered a reasonable alternative given the size of the slag pile, the significant volume of material, and the potential asset value from mining the fumed slag. Since impacts from the slag pile to groundwater are believed to occur primarily from leaching through the upper lift of unfumed slag placed after 1982, potential remedies focused on reducing infiltration through this area. Additional information is provided in the technical memorandum titled *Slag Pile Cover Concepts* (CH2M and Hydrometrics, 2016) (**Appendix F**).

Three conceptual covers were developed for further evaluation, with consideration to environmental, structural, and aesthetic factors. A summary of each alternatives is provided below. It should be noted that these alternatives were selected to bracket a range of options and associated remedy benefits to assist in the selection of a recommended remedy (described in Section 6).

The Minimum Alternative consists of regrading/consolidating only the upper unfumed slag lift over the pre-1950 unfumed slag footprint, and covering the unfumed slag. Approximately 166,000 yd^3 of unfumed slag would be moved from the north to the south, and approximately 103,000 yd^3 would be moved for the remainder of the unfumed slag regrading, for a total of 269,000 yd^3 moved. The cover would encompass approximately 17.5 acres as shown on **Figures 5-11 and 5-12**. In this alternative, the cover would consist of a 12-inch-thick, vegetated soil cover obtained from Custodial Trust property east of State Highway 518. A 12-inch-thick cover was selected as a minimum to support cover surface vegetation and provide sufficient permeability reduction over existing conditions to substantially reduce infiltration through the pile to a target rate for deep percolation (that is groundwater recharge) of 10 percent.

The Intermediate Alternative consists of the Minimum Alternative work (regrading and covering the unfumed slag) plus with selective regrading of the east slope to address overhang/stability issues. This alternative also includes "sculpted" grading of the north slope to blend the slope with the existing Ash Grove fumed slag borrow pit and covering the slope to blend with the unfumed slag cover. Approximately 144,000 yd^3 of slag would be removed from the adjacent Chemet property to fill in the existing borrow pit and create a mounded stockpile for future recovery. An additional 106,000 yd^3 of slag would be moved in regrading the north slope and steeper slopes to the east and south. Including the amount from the minimum alternative, 519,300 yd^3 of slag would be moved. The cover would encompass approximately 25 acres as shown on **Figures 5-13 and 5-14**, and would consist of a 12-inch thick vegetated soil cover, similar to the minimum alternative.

The Maximum Alternative consists of the Minimum Alternative work (regrading and covering the unfumed slag) plus more extensive regrading of the east, north, and west slopes of the slag pile (flattening the slopes) to improve slope stability and to support cover placement in those locations. The cover would be placed over both fumed and unfumed slag areas. Grading the remaining slopes would add an additional 100,000 yd^3 to that of the intermediate alternative, resulting in approximately 620,300 yd^3 of slag to be moved. Cover extent of a 12-inch vegetated soil cover would increase to 28.2 acres on fumed slag areas and an ET cover of 9.2 acres would be used over flatter portions of the regraded unfumed slag area, as shown on **Figures 5-15 through 5-18**. A 3-foot-thick ET cover was selected for this alternative based on supporting modeling information from the ET Cover System IM, and considering that some slag materials can be used for components of the cover (capillary break and bio-barrier zones).

All three alternatives include removing the million-gallon water storage tanks and associated system components, along with consolidating the unfumed slag toward the southern end of the pile. The tank foundations would remain in place but would be broken up and covered with unfumed slag. Demolition debris other than concrete would be hauled offsite for either disposal or recycling.

Estimated costs for the Minimum, Intermediate, and Maximum Alternatives are $4.5 million, $8.0 million, and $9.9 million, respectively. The estimates were prepared using unit construction rates developed for the IM construction projects. Because the estimates are based on the conceptual designs, they contain uncertainties and variables, with an anticipated accuracy range of -30 percent to +50 percent (concept level). Costing assumptions are provided in **Appendix F**.

Evaluation of the three slag pile cover alternatives considered the following criteria, in order of importance:

1. Improvement to downgradient groundwater quality, through reductions in contaminant mobility.
2. Implementation cost, recognizing the cost of any slag pile remedy is a function of the significant size and contaminant mass volume.
3. Reduction of potential exposure risk to humans and ecological receptors.
4. Long-term slag pile stability.
5. Aesthetics, which the COEH has cited as an important factor, given the size and proximity of the slag pile to the City.

To estimate improvements in downgradient groundwater quality (as measured by downgradient selenium concentrations) for each alternative layout, an initial spreadsheet-based prediction model was developed by Hydrometrics using potential leachate generation estimates developed from leachability tests (presented and discussed previously in Section 3.3.1) to predict the impact of reducing annual infiltration through the slag pile from current conditions at 50 percent recharge, down to 10 percent through implementation of the slag pile cover alternatives. This initial model simulation distributed selenium loading across the entire pile and reduced recharge through the pile based on cover area and type. Key adjustments made to reflect the cover alternatives included:

- The spreadsheet model assumed all of the selenium loading source was concentrated in the upper, newer slag. In the spreadsheet model, 80 percent of the selenium load was assigned to the unfumed slag and 20 percent to the fumed slag based on total and leachable metals concentration data from the different slag types.
- In the spreadsheet model, different recharge rates were assigned to the different portions of the slag pile based on the proposed capping plans. Areas where a 1-foot soil cap was proposed were assigned a 10 percent recharge rate while the area proposed for an ET cap in the maximum regrading/capping alternative was assigned a recharge rate of 0 percent (that is, no deep percolation). For predicting groundwater quality in and downgradient of Lamping Field, where the slag pile and West Selenium Source Area selenium plumes merge, relative contributions of 67 percent and 33 percent of the total selenium load originating from the Facility were assigned to the slag pile and West Selenium Source Area, respectively. These relative proportions are based on both analytical and numerical (fate and transport) models of contaminant loading rates.

In addition to the initial spreadsheet modeling, the groundwater fate and transport model was used to simulate a scenario for covering the slag pile assuming only 10 percent of the precipitation infiltrated and recharged the source area after capping. The estimates generated by the spreadsheet-based model are provided in **Table 5-7** along with the 10 percent recharge results from the groundwater fate and transport model simulation; with the comparison being used to check the correlations of the cover alternatives against model simulations. Referring to **Table 5-7**, the estimated selenium reduction in groundwater from the groundwater fate and transport modeling correlate well with the spreadsheet model, falling between the intermediate and maximum cover alternative cover performance estimates of the spreadsheet model. This correlation supports use of the spreadsheet model as a tool for relative comparison of the different cover alternatives for assessing potential performance-based benefits to groundwater.

The groundwater fate and transport model predicts a significant decrease in the aerial extent of the selenium plume when the effects of the IMs are combined with a reduction in recharge at the slag pile. **Figure 5-19** shows the selenium isoconcentration contours predicted by the groundwater fate and transport model for the interrelated IMs over a 10-year timeframe, and also for the assumed reduction of recharge (from 50 to 10 percent of annual precipitation) in the slag pile over 10 years that would result from installation of the cover. This simulation suggests that the cover would reduce selenium concentrations in groundwater to levels below the MCL downgradient of the slag pile.

The spreadsheet model predicted that the minimum and intermediate cover alternatives would reduce selenium concentrations in groundwater under the slag pile by approximately 73 and 76 percent, respectively. The maximum alternative was estimated to reduce selenium concentrations in groundwater under the slag pile by approximately 94 percent. Further downgradient of the slag pile in the Lamping Field area, the estimated reduction in selenium concentrations are predicted to decrease between approximately 35 and 56 percent. These estimates were used for relative comparison purposes and represent rough estimates based on preliminary modeling and limited geochemical data from the slag pile. Additional characterization to better quantify these predictions would be required to refine the values, if needed.

Key conclusions based on the slag pile remedy modeling and cover alternative evaluation include the following:

- Groundwater fate and transport modeling demonstrates that covering the slag pile will further reduce contamination loading to groundwater. Over time, this will stabilize and reduce the downgradient selenium plume.
- Covering the unfumed slag provides the greatest load reduction to groundwater, with an ET cover providing the greatest benefit based on its higher efficiency in reducing infiltration.
- From a construction standpoint, slag regrading is the greatest component of cost. Slag excavation will require heavy, durable equipment, and working around the perimeter slopes will require careful execution planning and controls for excavation stability and safety.

5.5 Remedy Alternative Evaluation Recommendations

This section describes the remedial selection process, identifies and describes a range of remedial approaches, technologies, and process options that could be used to address contaminated media, and presents a detailed and comparative analysis of the alternatives against the threshold and balancing criteria. Remedy options focus on source areas identified through the development of an updated CSM for the site (Section 3), with impacted media that creates risk for human and ecological receptors (Section 4). The results of these source control remedy alternative evaluations have been incorporated into the final corrective measures proposal presented in Section 6.

Proposed Final Corrective Measures

This section describes the proposed final corrective measures for all properties formerly owned by ASARCO and any other properties where hazardous waste or hazardous constituents from the Facility have migrated, and summarizes how each proposed remedy element meets the three remedy performance standards (which are also the threshold criteria) established by USEPA under RCRA—protection of human health and the environment, source control, and media cleanup objective.

Tables 6-1 and 6-2 present a summary of the proposed remedy to demonstrate how the overall remedy and the remedy elements meet the goals, criteria, and standards defined in the First Modification. **Table 6-1** summarizes the proposed Corrective Measures and associated ICs proposed as the final remedy by the Custodial Trust. **Table 6-2** presents a summary of the proposed remedy and remedy performance standards by parcel for the former ASARCO properties. The following subsections describe each of the final remedy components presented in **Table 6-1**.

6.1 Non-CMS Parcels and Undeveloped Lands

As noted in the First Modification, the final corrective measures for the former ASARCO Properties currently owned by the Custodial Trust that are not enumerated as CMS Parcels, will be the measures set forth in the OU-2 ROD. Currently, no significant new information has been generated regarding the condition of these parcels to warrant USEPA reevaluation of the OU-2 ROD findings and decision; this decision applies to soil contamination.

6.2 Incorporation of Existing IMs

The IMs implemented between 2012 and 2016 by the Custodial Trust are engineered controls that have significantly changed physical site conditions (e.g., surface soil, groundwater elevations, flow rates, infiltration rates) for the better by reducing contaminant mass loading to groundwater. Pathways to receptors have been cut off for consolidated and covered soils and other remediation waste. The investigations, modeling and evaluations conducted under the CMS were designed to assess the initial performance of the IMs, to estimate their future effect relative to surface soil and on groundwater quality, and to determine whether additional corrective measures would be necessary to meet the remedy performance standards.

Based on the evaluations and groundwater modeling presented in Section 3, the IM implemented by ASARCO (Speiss-Dross slurry wall) and the interrelated IMs implemented by the Custodial Trust (ET Cover System, SPHC, Source Removal, and CAMUs) are starting to perform as intended and are predicted to significantly reduce contaminant mass loading to groundwater. The following sections summarize information observed to date on the effects of the IMs and how each IM contributes to the protection of human health and the environment, source control and attainment of MCSs.

6.2.1 ET Cover System

The ET Cover System IM is currently meeting several of the Remedy Performance Standards, briefly described as follows:

- Protection of human health and the environment. The clean surface layers of the ET Cover have already met this performance standard by preventing human and ecological receptors from having direct contact with contaminated media.
- Source control.

  - More than 225,000 yd^3 of contaminated soil have been consolidated under the ET Cover.
  - Offsite migration of contaminated soil through aerial (wind-blown) deposition or surface water erosion (via the cover) is prevented.
  - Additional source control objectives were achieved because subgrade fill for the ET Cover System was derived through the PPC Realignment and source removals (primarily from removal of the TPA, Acid Plant, Speiss disposal, and Upper Lake Marsh areas) that immediately reduced the contaminant load to groundwater and surface water, and reduced the amount of contaminated soil in contact with groundwater.

- Attainment of media cleanup objectives. The ET Cover System has met this performance standard for surface soil by using tested native materials with concentrations below the MCSs as topsoil. In addition, borrow soil from deeper excavation areas that also met MCSs was used for the remainder of the 4-foot thick cover isolating contaminated media buried below.

The ET Cover System IM also will meet the site-specific corrective action objectives. Because the ET Cover is natural and self-sustaining, operation and maintenance of the system will be minimal, in comparison to requirements for synthetic or paved covers. With appropriate maintenance, the cover is designed to store and shed clean stormwater, eliminating costs associated with cover maintenance and stormwater management. Thus, the ET Cover will remain a protective element of the final remedy indefinitely.

6.2.2 South Plant Hydraulic Controls

The SPHC IM meets the Remedy Performance Standards for protection of human health and the environment, and source control because contaminated media (primarily contaminated topsoil and marsh sediments) were excavated and placed under the ET Cover System and the surrounding wetland habitat was restored to more natural conditions. Surface water quality has improved through reduction of surface water flowing through contaminated surface soil and sediment, and groundwater has improved through isolation of contaminated subsurface media by lowering groundwater levels beneath the Facility. The mass of contaminants leaving the Facility via groundwater (mass flux) is substantially reduced by the lower water levels and reduced hydraulic gradients. The PPC Realignment moved the creek channel further from the slag pile and buttressed or reshaped the pile in areas to reduce the potential for slag migration into the creek.

Although a minor westward shift in the selenium plume has been measured in recent groundwater sampling events resulting from the SPHC IM (primarily from reduced infiltration to groundwater from Wilson Ditch), no new receptors, including the East Helena municipal wells, are expected to be impacted by the recent plume adjustments. Likewise, no new receptors are expected to be impacted west of the plumes due to adoption of the EVCGWA and the associated groundwater usage restrictions along the west side of Lamping Field (discussed in Section 6.4), and based on the future model-predicted extent of the plumes.

The PPC Realignment surface restoration materials meet MCSs, therefore the potential for direct contact with contaminated media has been removed. Sediment concentrations within PPC will be returning to a more natural state and reflect background (upstream) concentrations in its reestablished geomorphic setting. In addition, the SPHC IM supports meeting MCSs for groundwater as contaminant mass loads decline and groundwater quality improves. Based on groundwater fate and transport modeling of the IMs, the size (excepting arsenic) and mass of the downgradient contaminant plumes are expected to be reduced. However, attainment of DEQ-7 standards for groundwater quality will not be achieved in the short-term due to (1) the mass of historical contamination that has already migrated beyond the Facility boundary, and (2) elevated soil contaminant concentrations remaining throughout the majority of the Facility following removal of the higher-concentration localized sources.

Therefore, the SPHC IM will be maintained as part of the proposed remedy for the Facility. Because the PPC Realignment was designed for natural channel flow with the wetlands located to receive flood waters, limited long-term inspections or maintenance of PPC are anticipated once plant establishment criteria are met. Thus, the PPC Realignment is an essential component for the overall remedy to meet the RAOs for the site.

6.2.3 Speiss-Dross Slurry Wall

The Speiss-Dross slurry wall continues to operate as intended, containing and controlling the downgradient migration of the contamination present within the wall. In conjunction with the ET Cover System and SPHC IMs, the slurry wall contributes to the attainment of media cleanup objectives for groundwater by minimizing further migration of contaminants offsite, and supporting stability and attenuation of offsite contaminants. Based on groundwater fate and transport modeling, it is clear that the slurry wall promotes size and mass reduction of the downgradient contaminant plumes.

6.2.4 Source Removal IM and CAMUs

The excavation of the TPA, former Acid Plant Source Area, Upper Lake Marsh (as part of the PPC Realignment), and Speiss Disposal Area met one of the elements of the Source Control performance standard by immediately reducing the contaminant mass in soil in contact with groundwater (source control). These contaminated media are managed under the CAMU and ET Cover System, isolated from groundwater and infiltration. In addition, the CAMU and ET Cover System have eliminated the potential for direct contact, thereby protecting human health and the environment.

6.3 Slag Pile Cover

An engineered control in the form of a cover over at least the unfumed slag in the slag pile is proposed as one of the final corrective measures. A slag pile cover meets Remedy Performance Standards for protection of human health and the environment by preventing direct contact with contaminated media. It also meets performance standards for source control by reducing infiltration through contaminated slag (mitigating the migration to groundwater) and preventing offsite migration of contaminated slag through aerial deposition or surface water erosion (via the cover). In terms of MCSs, the slag pile cover will be designed to meet the Ecological standard for surface soil for lead, the same standard used for the ET cover constructed over the former building areas of the Facility. This standard will be attained by using tested native materials meeting soil concentration standards for the topsoil zone, and borrow from excavation areas on Custodial Trust property outside of the Facility (such as parcels east or south of the Facility) for the remainder of the estimated 3-foot thick cover thickness, thus isolating unfumed slag that is buried below.

A conceptual cover design is shown on **Figures 6-1, 6-2, and 6-3,** and a final design will be developed during Corrective Measures Implementation (CMI)**.** The conceptual design was developed to achieve maximum benefits of the three evaluated alternatives, combining elements of the cover options presented in **Appendix F** and summarized in Section 5.4.2.4, to maximize the performance benefit of covering the unfumed slag, with a minimum of regrading, that results in a cost-effective remedy for the slag pile. The conceptual cover layout proposed includes regrading and covering only the unfumed slag (the minimum cover option), placing an effective ET cover (initially only evaluated as part of the maximum cover option) over the regraded unfumed slag to eliminate infiltration into the highest leaching potential areas, and staged implementation of fumed slag removal that correspond with beneficial sale and use of the material by commercial purchasers. Fumed slag areas reaching final grades could be covered with a 12-inch vegetated soil cover on the side slopes for erosion control and to stabilize the edges, minimizing the future potential for slag to slough into PPC or onto adjacent properties.

The combination of the alternatives proposed in the conceptual design also improves the cost-effectiveness of the cover in the following areas:

- Reduces the overall volume of unfumed slag that needs regrading to achieve the proposed final cover grades
- Focuses the area of the ET soil cover over leachable unfumed slag
- Supports initial grading and installation of the cover over the higher leachability material, along with phased regrading and selected covering of less critical areas to support material recovery operations
- Prevents direct contact of human and ecological receptors with unfumed slag

Material volumes and cover areas for the conceptual cover design are shown on **Figure 6-1**. Comparing these quantities against those developed for the cover alternatives in **Appendix F,** the quantities are comparable but less than those developed for the minimum cover alternative. A cost estimate for the conceptual design using unit construction rates developed recently as part of the IM construction projects has been developed and is included as **Appendix F**. Referring to Table 1 in **Appendix F**, the cost estimate for the conceptual slag pile cover design is $3.7 million, with an anticipated accuracy range of -30 percent ($2.6 million) to +50 percent ($5.6 million) for this concept level design. Costing assumptions are provided in **Appendix F**, as well. The estimated construction cost for the recommended slag pile cover is significantly lower than the construction estimate for the minimum cover alternative ($4.5 million) as a result of the improvements applied to the concept described above. Details of the design for the slag pile cover system will be developed and refined as part of CMI.

The slag pile cover will be designed to allow continued asset recovery from the pile. Phased fumed slag removal can be tailored to move material volumes that correspond to demand by commercial purchasers who will pay a fee for the slag recovery, removal, and final grading of the work areas. A Slag Management Plan, similar to a soil management plan, will be developed as part of the final slag pile design during CMI. The Slag Management Plan will specify how future work at the slag pile will be done to maintain protective conditions over time. Grading plans will be developed to direct commercial users to areas where they can excavate fumed slag and establish required grades that correlate to final desired grades and cover areas. The regraded and covered unfumed slag can also be accessed for recovery in the future, if warranted by market conditions, by developing grading plans to specify removal (and stockpiling) of the ET cover, removal of the desired quantity of slag material, regrading of the remaining materials, and replacement of the ET cover.

Because the slag pile cover will be designed to be natural and self-sustaining, operation and maintenance of the system will be low once the cover is fully established. The cover is anticipated to store and shed clean stormwater, reducing costs associated with cover maintenance and stormwater management. Thus, the slag pile cover is an essential component of the proposed remedy to meet the RAOs for the site.

6.4 Institutional Controls

Institutional controls (ICs) (administrative and legal controls) will be implemented by the Custodial Trust on all Trust-owned parcels to further mitigate potential unacceptable risk and ensure conditions remain protective over time.

6.4.1 Well Abandonment Program

To eliminate a potential future route of exposure to groundwater with concentrations of COCs above MCSs, the Custodial Trust started a Well Abandonment Program in 2016. The Well Abandonment Program focuses on private property owners with existing water supply wells within the COEH where City water services are available, and the area affected by the groundwater contaminant plumes originating from the Facility. The program requests that residents authorize the Custodial Trust to abandon their wells or provide alternative water supplies or treatment systems. The Trust has developed a monetary reimbursement schedule as part of the program in order to compensate well owners for the cost of (1) abandoning their well in accordance with Montana State regulations; and (2) connecting to the COEH water system, where applicable. For well owners outside of the COEH, water treatment options such as the use of either whole-house or under-sink treatment systems, or delivery of bottled water are proposed. The compensation packages include funds sufficient to pay typical COEH water bills for approximately 10 years, as well as additional funds intended to compensate for the inconvenience of switching to an alternative water supply, installation of a treatment system, or delivery of bottled water. Formal documentation of the process is being performed as described below.

Implementation of the Well Abandonment Program will include written confirmation that all COEH residents or noncity residents with existing water supply wells located within the area where COPCs exceed MCSs in groundwater have received notification of the program. A certified letter will be prepared and mailed to each resident identified with a water supply well. Well abandonments are verified through submittal of an abandonment form (Montana Well Log Report), completed by the licensed contractor conducting the abandonment, and submitted to the Montana Department of Mines and Geology. To date, seven well owners have abandoned their wells out of 25 potentially affected residential wells located within the City water distribution area as part of the program. (One owner abandoned two wells.) Two additional residential wells were replaced (with the original wells currently used for water quality monitoring) at the northern end of the selenium plume as part of CMS investigations of plume extent.

It is important to note that the Custodial Trust currently is not aware of anyone obtaining drinking water from private wells that are located within the contamination plumes. The Well Abandonment Program is a continuation of efforts started by ASARCO and supported by USEPA in order to reach out to affected well owners. The primary objective of the program is to ensure that well owners were made aware of the water quality conditions and that alternative water supplies are available for their use.

6.4.2 Deeded Land Use Restrictions

On Trust-owned property, land use restrictions are in place and the property is confined to current and future use as commercial/industrial use only and to prohibit groundwater use.

On March 24, 2009, ASARCO executed a Record Notice of Hazardous Waste Management Unit (CAMU Site) for CAMUs 1 and 2, along with adjacent areas for potential future CAMUs (Units 3, 4, and 5). The Record Notice puts a deed restriction on these property areas for identification and protection of existing CAMUs.

6.4.3 Supplemental Institutional Controls Implemented by Others

Although not executed by the Custodial Trust, and therefore not considered final corrective measures proposed in this report, three programs are being implemented by Lewis and Clark County and the COEH to reduce the potential for human contact with contaminated groundwater and soil, discussed briefly in Section 2.3.2. These programs are described in this report because the Custodial Trust will monitor these programs over time and provide associated soil or groundwater data to support ongoing implementation and decision making.

6.4.3.1 East Valley Controlled Groundwater Area

The EVCGWA is a significant remedy element that contributes to the overall remedy protectiveness, meeting risk goals and supporting progress toward attaining cleanup goals. The purpose of the EVCGWA is to reduce potential for future human exposure to groundwater-borne contaminants and potential spreading of the plumes due to groundwater pumping, by managing future groundwater appropriations and usage. The EVCGWA was designated on February 6th, 2016, by the DNRC, in accordance with MCA (Montana Codes Annotated) 85-2-500, in response to a petition submitted to DNRC by the Lewis and Clark City-County Board of Health and Water Quality Protection District Board with technical support from the Custodial Trust.

The EVCGWA restricts future groundwater appropriations within and downgradient of the Facility where concentrations of COPCs in groundwater (primarily arsenic and selenium) exceed or approach the State of Montana Human Health Standards. The restricted area encompasses approximately 1,925 acres (3.1 square miles) as shown on **Figure 6-4** and extends vertically 200 to 300 feet in Zone 1 and unlimited in Zone 2. New groundwater developments (wells) and appropriations are restricted throughout the area, with the level of restriction varying with proximity to the current extent of the arsenic and selenium plumes both horizontally and vertically. The EVCGWA will remain in effect until such time that future ground monitoring data support modification or revocation of the applicable statute.

6.4.3.2 City of East Helena Well Restrictions

The COEH has adopted a municipal ordinance, Title 8, Chapter 3, Section 8.3.7, that prohibits the installation of new private water wells within the city limits to protect public health, safety, and general welfare. The ordinance prohibits the following:

- The drilling or activation of a private water well.
- The reactivation of an existing, inactive private water well.
- The change of use in any fashion of a preexisting private water well.
- The transfer, delivery, or distribution of water via a water transportation system or device into the East Helena water service area from a private water well located outside of the water service area.

The city definition of a "water well" is any digging, drilling, or excavation, by hand or by the use of machinery or equipment, whereby water is obtained from under the surface of the ground to be used on or above the ground surface for irrigation, manufacturing, commercial, noncommercial, human, or other consumption purposes, regardless of whether or not such proposed use is potable.

6.4.3.3 City of East Helena Lead Education and Abatement Program Soil Ordinance

The Lead Education and Abatement Program Soil Ordinance was implemented by Lewis and Clark County and the City Board of Health in June 2013. The ordinance was established as an Institutional Control as part of USEPA’s ongoing CERCLA work, primarily associated with residential properties and undeveloped lands in OU-2, to protect public health and control environmental lead and arsenic contamination within the Lewis and Clark County Administrative Boundary (**Appendix G**). The regulation applies to all persons engaging in soil displacement in excess of 1 yd^3 and requires that they obtain a permit and inspection upon completion of the project. All of the former ASARCO properties fall within the Administrative Boundary. Local disposal of small quantities of potentially contaminated soil removed by residents is available within the Institutional Control Program repository located off of Highway 518 near the Manlove Cabin.

6.5 Proposed Remedy Performance Monitoring and Evaluation

Groundwater monitoring will be conducted to evaluate the performance of the proposed corrective measures over time, and the details of the proposed monitoring, evaluation and reporting will be provided in an updated CAMP during CMI. Performance monitoring will be conducted through the CAMP until MCSs are met at the points of compliance. The anticipated components of the performance monitoring are summarized in **Table 6-3** and described in the following sections.

6.5.1 Corrective Action Monitoring Program

The CAMP will be developed and included in the CMI Work Plan as required by schedule in the First Modification. The CAMP will support performance monitoring of the final corrective measures implemented and collect data to support the evaluation of groundwater elevations, groundwater to surface water interaction, surface water quality, and groundwater quality. Specifically, the CAMP will collect water levels to confirm that the SPHC is meeting the RAOs for lowering the groundwater table, and reducing groundwater contact with contaminated subsurface soil and offsite flux. Groundwater quality data will be used to evaluate changes in concentrations beneath the Facility locally (source removal areas and Speiss-Dross slurry wall), throughout the Facility area due to reduced infiltration through slag (slag pile cover) and contaminated soil (ET Cover System, CAMUs), and offsite (source removal, Speiss-Dross slurry wall, ET Cover, slag pile cover, and SPHC). Offsite wells will be monitored to quantify the effectiveness of these corrective measures, in particular to evaluate configuration of the plumes, reduction of offsite mass-flux, and appropriateness of the boundaries of the EVCGWA. Downgradient residential wells and COEH water supply wells will be monitored to ensure that they are not contaminated by plume migration or shift. Water quality data collected through the remedy performance evaluation phase of the CAMP will ultimately be used to evaluate the success of the final corrective measures and determine whether additional corrective measures are warranted.

Surface water levels will be monitored to confirm that changes from the SPHC IM will not cause a change in groundwater to surface water interaction that could result in contaminated groundwater impacting PPC; this will be confirmed by collected surface water quality data. Surface water quality data will also be collected to confirm that PPC is not contaminated from slag sloughing in (slag pile regrading), stormwater runoff (ET Cover System and slag pile cover), or loading from tributary sources (SPHC and source removal).

CMI schedule, remedy performance evaluation, CAMP monitoring, and reporting requirements will be identified by USEPA in the USEPA Decision Document identifying the final corrective measures to be implemented. Those requirements will form the basis of the CMI Work Plan submittal as required by the First Modification.

6.5.2 Inspections and Maintenance

A site-wide inspection and maintenance plan will be developed for the PPC Realignment, ET Cover, and slag pile cover systems, and submitted with the CMI Work Plan. The plan will address routine and special inspections of IM engineering systems for confirmation of intended performance and implementation of maintenance elements. Currently these systems are under a 2-year construction warranty period through 2018. The Custodial Trust will coordinate with the Beneficiaries for funding long-term inspection and maintenance for the proposed final remedy.

Note that the CAMUs are regulated separately from the Corrective Actions under RCRA, and have an USEPA-approved inspection program, including an operations and maintenance plan developed as part of their closure plan *Post-Closure Care Plan, Asarco East Helena Corrective Action Management Unit* (Hydrometrics and Crowley Consultants, 2007). The existing plan for the CAMUs will be integrated into the site-wide plan for long-term implementation.

Ongoing site operations for the extraction of slag for commercial resale will be included in the inspection program to ensure that those processes are coordinated with the proposed final remedy performance requirements for the slag pile in terms of overall grading and covering of the unfumed slag areas.

6.6 Remedy Summary

The goals of a CMS are to identify, evaluate, and propose appropriate remedial actions that will protect human health and the environment. The Custodial Trust has developed this CMS Report for the former ASARCO East Helena site under the oversight of USEPA, as Lead Agency for the Facility and in consultation with the other Beneficiaries of the Custodial Trust to address Paragraph 39 of the First Modification, which states, "*…the primary purpose of a CMS is to investigate and evaluate potential alternative remedies to protect human health and the environment from the release or potential release of hazardous waste or hazardous constituents from the Facility and to restore contaminated media to standards acceptable to EPA.*"

The Facility has been the focus of environmental investigation, demolition, and remediation since closure of operations in 2001. Specific to those elements has been comprehensive efforts focused on understanding current site conditions, developing and updating the conceptual site model, collecting samples on an ongoing basis, modeling groundwater, and designing and constructing interim measures, in addition to continued public involvement comprising presentations, public notices, and groundwater technical work groups in the community.

As described in the USEPA-approved CMS Work Plan (CH2M HILL, 2015a) and consistent with USEPA guidance, the CMS alternatives analyses focused on evaluating corrective measures appropriate for site-specific conditions. The CMS included evaluating the performance of the IMs to determine their suitability as a component of final corrective measures. For the purposes of the CMS, current land and groundwater uses were assumed to be "reasonably anticipated future use" of the former ASARCO Properties (CMS Parcels and the Undeveloped Lands as defined by the First Modification).

This CMS Report identifies the need for and range of potential remedial alternatives, updates the assessment of the potential risk to human health and the environment caused by site contaminants, evaluates potential remedial alternatives that will meet RCRA corrective measure requirements, and recommends a preferred remedy consisting of several elements.

Accordingly, the CMS Report describes the process by which remedial action alternatives were developed and evaluated in order to identify a recommended alternative for addressing soil, groundwater, surface water, and sediment contaminated by the Facility, as well as unfumed slag remaining from site operations. The proposed final corrective measures consist of multiple elements that are expected to meet the remedy performance standards, balancing criteria, and RAOs. Monitoring will either confirm expectations or additional corrective measures will be evaluated and possibly implemented.

6.6.1 Summary of CMS Goals and Objectives

For this project, the primary CMS goals and objectives have been met with the proposed final corrective measures.

The primary CMS goals are summarized as follows:

- Meet requirements of the First Modification and other applicable regulatory and USEPA guidance.
- Evaluate each proposed action, or combination of actions, following the factors set forth in the 1996 ANPR.
- Analyze potential actions with consideration of known risks to actual or potential receptors.
- Evaluate potential actions that will create the greatest net environmental benefit and are compatible with expected future use, considering finite Custodial Trust funds.

The primary CMS objectives are summarized as follows:

- Minimize long-term stewardship.
- Eliminate the need to manage and treat stormwater.
- Maximize use of sustainable remediation approaches.
- Develop and evaluate alternatives that allow continued asset recovery from slag pile.
- Develop alternatives that are consistent with the Custodial Trust's purpose to manage or fund implementation of environmental actions, and, ultimately, to sell, transfer, facilitate the reuse of, or otherwise dispose of or provide for the long-term stewardship of the properties.

6.6.2 CMS Parcels—Summary of Proposed Corrective Measures

The proposed final corrective measures consist of multiple elements that work together to protect human health and the environment and meet the remedy performance standards – threshold criteria, balancing criteria, and RAOs. **Tables 6-1** and **6-2** provide a detailed summary of each proposed corrective measure. Key elements are summarized as follows:

- ET Cover System
  - Elements consisted of building demolition, utility abandonment, subgrade fill, and final ET Cover system to mitigate infiltration of precipitation at the Facility and control wind erosion and surface water runoff.
- SPHC
  - Elements consisted of Upper Lake and Lower Lake removal, PPC Bypass, and PPC Realignment. SPHC developed wetlands to reduce surface water loading to groundwater by removing Upper Lake and Lower Lake. SPHC also established natural stream channel flow at a reduced hydraulic profile from previous to lower groundwater elevations beneath the site, developed more natural geomorphic conditions within Smelter reach, and established natural wetland/riparian conditions.
- Source Removal and CAMUs
  - Actions consisted of excavation and removal of impacted media at Tito Park Area, former Acid Plant, and Upper Lake Marsh. These actions reduced areas of impacted soil and sediment that could potentially leach to groundwater or surface water. CAMUs were constructed and covered to contain impacted material and reduce infiltration to groundwater.
- Speiss-Dross Slurry Wall
  - The slurry wall isolates impacted soil and prevent impacts to groundwater.
- Slag Pile Cover
  - The slag pile cover will be graded and covered in the future. This will reduce infiltration through unfumed slag. The cover could include potential future reuse of slag materials.
- Institutional Controls implemented by the Custodial Trust
  - Deed Restrictions—The City of East Helena Zoning Commission adopted the proposed land uses for the Custodial Trust Parcels. Current uses of Custodial Trust land, such as agricultural, are legal, nonconforming uses until a property changes hands.
  - Well Abandonment Program—Residents with existing supply wells were contacted to abandon existing residential wells or provide alternative water supply.
- Supplemental Institutional Controls Implemented by Others

- Additional ordinances and ICs that impact land use include a soil ordinance adopted by Lewis and Clark County in June 2013 to control soil displacement and disposal activities.
- Restrict any modifications to groundwater use within the COEH and within the recently designated EVCGWA until cleanup standards are met.
    - The COEH municipal ordinance (Title 8, Chapter 3, Section 8.3.7) prohibits the installation of new private water wells in the City limits.
    - The EVCGWA was adopted by the DNRC on February 6, 2016, to temporarily restrict withdrawals until groundwater cleanup standards are attained.

Groundwater monitoring will be conducted to evaluate the performance of the proposed corrective measures over time, and the details of the proposed monitoring, evaluation and reporting will be provided in an updated CAMP during CMI. Performance monitoring will be conducted through the CAMP until MCSs are met at the points of compliance.

6.6.3 Undeveloped Lands—Summary of Proposed Corrective Measures

The remedy for the Undeveloped Lands will be consistent with the final agency decisions set forth in the OU-2 ROD. The final corrective measures for the parcels of real property transferred by ASARCO to the Custodial Trust will be the measures set forth in the OU-2 ROD. No new information has been identified as part of this CMS to impact the decision to use the OU-2 ROD corrective measures.

SECTION 7

Public Involvement Plan

Public involvement is a critical part of the RCRA corrective action process. General communication with the public continues to follow the *Draft Community Relations Plan, Former ASARCO Smelter Facility, East Helena, Montana* prepared by the Custodial Trust (2010), as well as the requirements of the First Modification. To date, the Custodial Trust has held or participated in more than 60 public events—town, city, and county meetings, stakeholder presentations, and workshops—to review investigations and cleanup plans and provide opportunities for community input on future development opportunities and ongoing activities.

The Custodial Trust holds regular meetings with the East Helena Team (formerly East Helena Entire Cleanup Team in Coordination) group to provide information to key local stakeholders and attends the East Helena City Council meetings. The Custodial Trust has also set up and maintained a Web site, containing links to news on cleanup progress, design documents, meeting materials, and future meeting dates.

The Custodial Trust has held technical review and information sessions with the beneficiaries throughout the IM implementation and CMS development process, including the following:

- Beneficiary review meetings for IM designs for the PPC Bypass, Tito Park removal, PPC Realignment, and ET cover
- Presentation of CAMP monitoring results
- Presentation of CMS evaluation processes

Presentations to the Groundwater Working Group (consisting of members from the Custodial Trust, CH2M, Hydrometrics, NewFields, USEPA, Montana Natural Resource Damage Program, MDEQ, Lewis and Clark County, COEH, and Montana Bureau of Mines and Geology) have occurred on an approximate quarterly basis since 2015 to keep interested parties updated on CMS development.

In addition, the Custodial Trust has held public meetings at its offices for the following key program elements since 2012:

- Presentation of preliminary development and land use plans for former Asarco properties
- Presentation of IM work plans for public comment on planned IM construction activities for the coming year (2012 through 2016)
- Design workshop for PPC Realignment
- IM construction progress overview and site tours

7.1 Contact Information

The Web site address for the Custodial Trust is: [http://www.mtenvironmentaltrust.org/east-helena.](http://www.mtenvironmentaltrust.org/east-helena)

Questions or comments regarding the Custodial Trust and its activities at the former ASARCO East Helena Facility may be directed to:

Cynthia Brooks
President
Greenfield Environmental Trust Group, Inc.
Montana Environmental Trust Group, LLC, Trustee of the Montana Environmental Custodial Trust
44 Shattuck Road

Watertown, MA 02472
e-mail: cb@g-etg.com

Written public comments on this document or ongoing activities may be submitted to the following contact and address:

Attn: Betsy Burns
USEPA Region 8 Montana Office
10 West 15th Street, Suite 3200
Helena, MT 59626

Submit electronic comments by e-mail to: burns.betsy@epa.gov.

7.2 Future Activities Planned by the Custodial Trust

The Custodial Trust and USEPA will continue to provide regular and timely updates on significant activities, including implementation of the CMS. Final formal public comment on the CMS Report will be solicited after USEPA as lead agency, and other Beneficiary reviews have been completed, prior to the final remedy selection. Based on the current delivery and review schedule for the CMS Report, public input on the proposed remedy is anticipated to begin in March 2018 and continue through May 2018. A public presentation of the CMS Report and an opportunity for formal public comment is anticipated to be scheduled for some time in mid-April 2018.

SECTION 8

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