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Anthony R. Brown
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February 28, 2017

Lynda Deschambault
Remedial Project Manager, Superfund Division
U.S. Environmental Protection Agency, Region 9
75 Hawthorne Street, 10th Floor (SFD 7-1)
San Francisco, California 94105

Subject: Response to U.S. EPA Comments dated December 29, 2016 and Final Baseline Human Health Risk Assessment Work Plan, Revision 2
Leviathan Mine Site
Alpine County, California

Dear Ms. Deschambault:

Atlantic Richfield Company (Atlantic Richfield) submits this letter in response to comments provided by the U.S. Environmental Protection Agency (U.S. EPA) in their letter dated December 29, 2016 and to transmit the Final Baseline Human Health Risk Assessment, Revision 2 (BHHRA Work Plan). The BHHRA Work Plan was submitted in partial fulfillment of the requirements of the Statement of Work attached to the Administrative Order for Remedial Investigation and Feasibility Study (Unilateral Administrative Order), Comprehensive Environmental Response, Compensation, and Liability Act Docket No. 2008-18 issued by the U.S. EPA on June 23, 2008.

In its letter, the U.S. EPA accepted the BHHRA Work Plan as outlined and also accepted Atlantic Richfield's final responses to comments from U.S. EPA and the Lahontan Regional Water Quality Control Board (LRWQCB) to the BHHRA Work Plan dated February 19, 2016 and revised Tables 4.1 and 4.2 dated June 27, 2016. The U.S. EPA noted one remaining Specific Comment and also provided six Additional Comments; Atlantic Richfield's responses to these comments are provided in the attached table (Table 1).

The BHHRA Work Plan, which is enclosed, has been revised to be consistent with the responses to comments agreed upon between Atlantic Richfield and U.S. EPA.

If you have any questions or comments, please feel free to contact me at (657) 5294537 or anthony.brown@bp.com.

Sincerely,

Anthony R. Brown
Project Manager, Mining

Enclosures:

Table – Responses to U.S. EPA Comments Dated December 29, 2016 on the Baseline Human Health Risk Assessment Work Plan

Final Baseline Human Health Risk Assessment Work Plan, Revision 2

cc: Gary Riley, U.S. Environmental Protection Agency, Region 9 – via electronic copy
John Hillenbrand, U.S. Environmental Protection Agency, Region 9 – via electronic copy
Douglas Carey, Lahontan Regional Water Quality Control Board – via electronic copy
Nathan Block, Esq., BP – via electronic copy
Adam Cohen, Esq., Davis Graham & Stubbs, LLP – via electronic copy
Sandy Riese, EnSci, Inc. – via electronic copy
Marc Lombardi, Amec Foster Wheeler – via electronic copy
Grant Ohland, Ohland HydroGeo, LLC – via electronic copy
Dave McCarthy, Copper Environmental Consulting – via electronic copy
Cory Koger, U.S. Army Corps of Engineers – via electronic copy
Greg Reller, Burleson Consulting – via electronic copy
Ken Maas, U.S. Forest Service, Humboldt-Toiyabe National Forest – via electronic copy and hard copy
Michelle Hochrein, Washoe Tribe of California and Nevada – via electronic copy
Fred Kirschner, AESE, Inc. – via electronic copy
Sophia Serda, U.S. Environmental Protection Agency, Region 9 – via electronic copy

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TABLE 1
RESPONSE TO U.S. EPA COMMENTS DATED DECEMBER 29, 2016 ON THE BASELINE HUMAN HEALTH RISK ASSESSMENT WORK PLAN
Leviathan Mine Site
Alpine County, California

Comment #	Comment	Response
March 13, 2015 letter: Gantt Chart for Revised RI/FS Schedule and Annotated Table of Contents		
S7	**S7: Comment #7 from the March 23, 2015 letter: Gantt Chart for Revised RI/FS Schedule and Annotated Table of Contents:** EPA requested an outline to include a paragraph under each heading and subheading to describe what information will be included in each section. And that both the ERA and HHRA risk assessments be completed in parallel, for inclusion in the final RIFS Report. **EPA Response:** ARC did not provide an updated Table of Contents and continues to argue that a reasonable sequence for completion of RI/FS, and risk assessment reporting, as set forth in the 2009 schedule, would require submission of the draft RI report approximately 15 months after completion of data collection (completion of data collection is projected for Q4 2016), followed by submittal of the draft HHRA and ERA reports approximately six months later, followed by the draft FS report six months after that. **EPA January 12, 2016 Response**: EPA disagrees. EPA has provided comments under a separate submittal and has set up a meeting on January 19, 2015. EPA feels its approach is reasonable, used at other sites such as the Anaconda Site (Yerington, Nevada), and consistent with the 2009 Proposed Work plan. **ARC February 19, 2016 Response:** U.S. EPA's comments on the RI/FS schedule have been noted and are being addressed in other discussions and related correspondence. The BHHRA Work Plan will not be modified to address this comment. A revised outline has not been provided. **EPA Response:** ARC shall provide an updated schedule, and annotated table of contents, per EPA comments on the RIFS TOC Format, Reporting and Schedule which were provided under separate cover.	The schedule for report submittals has been resolved through communications between U.S. EPA and Atlantic Richfield following the January 17, 2017 meeting in San Francisco. Atlantic Richfield offered to submit a high-level table of contents for the RI/FS Report reflecting the agreed upon reporting structure (Site Characterization; RI including baseline risk assessments, and FS). Atlantic Richfield was told on February 7, 2017 that U.S. EPA is satisfied with the Annotated Table of Contents (Volumes I – IV) submitted on March 13, 2015.
June 27, 2016 ARC revised versions of Tables 4.1 and 4.2 from the Baseline Human Health Risk Assessment Work Plan, Revision 1 (BHHRA Work Plan) [1]		
	EPA notes that the sediment ingestion rates may change depending on the extent of sediment contamination. The sediment and floodplain soil technical data summary report will be needed to determine this.	Atlantic Richfield does not agree that the sediment ingestion rates are dependent on the "extent of sediment contamination." As defined for this project and described in the BHHRA Work Plan, stream sediment is material present within the active surface water channels. Floodplain soil defines materials outside the active channel. The potential mechanisms of exposure to stream sediment and floodplain soils are different and influenced by the presence of water in the channels, topography of the floodplain, and the occurrence of soils within the floodplain; they are not influenced by concentrations of chemicals in sediment or floodplain soil.
	Chemicals of Potential Concern (COPC): EPA understands that the final COPC list considered data regarding organic compounds (e.g. PAHs, and PCBs) and uranium. These compounds, or any associated data gaps, should be addressed, at a minimum, in the uncertainties section of the risk assessment. Along with sound scientific rationale for why these are not included in the risk assessment.	Atlantic Richfield does not understand the basis for EPA's comment relative to the consideration of organic compounds (e.g., PAHs and PCBs) and uranium as COPCs. These chemicals are not explicitly mentioned in the Statement of Work (SOW) in the Administrative Order on Consent and have not been included as RI/FS analytes at Leviathan Mine over the past 6 years of RI sampling activities. Specifically, the potential COCs identified by the SOW include: - pH, - ferric and ferrous sulfate, total sulfate, and sulfuric acid, - metals and compounds: aluminum, arsenic, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, thallium, vanadium, and zinc. The SOW also stated that "other COCs may be identified during the Remedial Investigation." At the request of EPA, an RI/FS analyte list was developed in July 26, 2010, to identify other metals that should be considered as COPCs. A final list of 20 RI/FS metals was developed and approved by U.S. EPA in 2010/2011 to assess

[1] One adjustment to exposure rates was made subsequent to the submittal of Tables 4.1 and 4.2 to U.S. EPA. The rancher exposure to surface water is considered incidental to their activities in the irrigation ditches and/or Bryant Creek and surface water is not their source of drinking water. As such, the incidental ingestion rates from U.S. EPA's Exposure Factors Handbook (U.S. EPA, 2011c) will be used (0.053 L/day for an adult and 0.09 L/day for a child). Tables 4.1 and 4.2 have been renumbered and are attached in Revision 2 of the Baseline Human Health Risk Assessment Work Plan as Tables 3.1 and 3.2.

TABLE 1
RESPONSE TO U.S. EPA COMMENTS DATED DECEMBER 29, 2016 ON THE BASELINE HUMAN HEALTH RISK ASSESSMENT WORK PLAN
Leviathan Mine Site
Alpine County, California

Comment #	Comment	Response
		conditions at Leviathan Mine (silver, hexavalent chromium, antimony, and barium were added). The scientific rationale for this set of COPCs was rigorously developed by Atlantic Richfield and completed following verbal comments by U.S. EPA. Over the last 6 years that listing served as the basis for the subsequent development of data quality objectives, the QAPP, task-specific work plans, and other key technical materials. While the discussion of uncertainties in the risk assessments can acknowledge the potential that other non-evaluated compounds may affect risk in some limited way, Atlantic Richfield strongly disagrees that compounds not identified as COPCs through this rigorous process should be specifically addressed, even in the uncertainties analysis.
	Radiation Screening Survey: EPA has reviewed and considered the Regional Board radiation survey document dated July 29, 2004. Although data seem to conclude that Naturally Occurring Radioactive Material (NORM) is likely not an issue at Leviathan; EPA requests ARC conduct a screening level survey to provide RI/FS data that can fully support that conclusion and include with scientific rationale for why it is not included in the risk assessment. This work should be completed in sufficient time for inclusion in a first Draft RI/FS December 31, 2017.	Radionuclides were explicitly excluded based on the evaluation in the July 26, 2010, Proposed RI/FS Initial Analyte List letter. We subsequently submitted to EPA a screening survey published by the LRWQCB. Because the mine is not known to contain radioactive materials different from ambient conditions, and both the RI/FS analyte letter and screening survey support that assumption, additional radiation screening is not necessary. Similar to other compounds referenced in the previous response, the uncertainty analysis can generally acknowledge the potential for nominal exposure risk due to radionuclides, but Atlantic Richfield does not agree that additional survey work or compound-specific analysis are warranted. At a minimum, new data quality objectives, task-specific work plans, and modifications to the QAPP among other tasks, would need to be developed if U.S. EPA insists on requiring additional radionuclide surveys. The required planning and in-field survey work cannot be completed in time for any results to be included in the draft Site Characterization Report scheduled to be submitted by December 31, 2017.
	Figure 2 Assumption No.6 Please include and clarify why irrigation of plants for consumption excludes irrigation water from Bryant Creek.	While consumption of plants has been included as an exposure pathway, the use of water from Bryant Creek for irrigation of plants for human consumption is not considered to significantly change the approach for this pathway. Water diverted from Bryant Creek was used for flood irrigation of pastures. To our knowledge, Bryant Creek water has not been used for drinking water supply for the ranch or for watering a home-produce garden. Nonetheless, the potential affects to soil from water diverted from Bryant Creek and exposures to these soils and plants grown in these soils will be addressed using the results of soil sampling performed on the River Ranch property. Even if water from Bryant Creek was used to water home-produced garden plants, the residual concentrations in the soil are considered to be the primary source of COPCs for uptake by the plants. Specifically, plant uptake from concentrations of COPCs in soil will be evaluated, rather than direct uptake from Bryant Creek irrigation water.
	Figure 2 Assumption No.7 This assumption appears to exclude plants sustained by groundwater, such as might be found at springs or seeps that are not adjacent to creeks. Current information suggests that such conditions exist. Please ensure the CSM includes plants that may be sustained by seep or groundwater until the pathway is considered incomplete.	As part of the RI, plants and nearby soil have been sampled to develop uptake factors for metals in plants. These uptake factors will also address plants grown in areas where groundwater is near the surface or plants are adjacent to creeks. Soil samples were collected in these areas and the mass of dissolved metals in the pore water would be retained in the soil during the drying process prior to laboratory analysis. Consequently, the dry weight soil concentrations measured account for metals in both the absorbed and dissolved phases when assessing uptake into plants. Therefore, plant tissue concentrations will not be evaluated separately for soil and groundwater uptake, they will be evaluated using dry weight analytical results for soil.
	Figure 2 Assumption No.8 Please clearly define and clarify the term "…in the vicinity of the ranch property".	In this context, the phrase "in the vicinity of the ranch property" refers to the reach of Bryant Creek containing the points of diversion for the irrigation ditches that lead to the River Ranch property and/or the locations where Bryant Creek runs closest to the River Ranch property.

FINAL BASELINE HUMAN HEALTH RISK ASSESSMENT WORK PLAN
REVISION 2
Leviathan Mine Site
Alpine County, California

Prepared for:
Atlantic Richfield Company
La Palma, California

Prepared by:
Amec Foster Wheeler
Environment & Infrastructure, Inc.
Rancho Cordova, California

February 28, 2017

Project No. 0013091150

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Appendix A Specific Descriptions of the Exposure Scenarios

ACRONYMS AND ABBREVIATIONS

AAC	annual average concentration
AADD	annual average daily dose
ALM	Adult Lead Methodology
Amec Foster Wheeler	Amec Foster Wheeler Environment & Infrastructure, Inc.
AD	acid drainage
ATSDR	Agency for Toxic Substances and Disease Registry
BHHRA	baseline human health risk assessment
BKSF	biokinetic slope factor
BLM	Bureau of Land Management
Cal/EPA	California Environmental Protection Agency
COC	contaminant of concern (listed in the SOW)
COPC	chemical of potential concern
CSM	conceptual site model
CUD	Channel Underdrain
DQO	data quality objectives
DTSC	(California) Department of Toxic Substances Control
EFCR	East Fork Carson River
EPC	exposure point concentration
FRI	focused remedial investigation
FSP	field sampling plan
HHS	U.S. Department of Health and Human Services
IEUBK	integrated exposure-uptake biokinetic
IRIS	Integrated Risk Information Service
LAC	lifetime average concentration
LADD	lifetime average daily dose
LRWQCB	Lahontan Regional Water Quality Control Board
µg/dL	micrograms per deciliter
$\mu g/m^3$	micrograms per cubic meter
mg/kg-day	milligrams per kilogram per day
OEHHA	(California) Office of Environmental Health Hazard Assessment
PPRTV	provisional peer reviewed toxicity values
PUD	Pit Underdrain
PWP	program work plan
QAPP	quality assurance project plan
RAGS	Risk Assessment Guidance for Superfund
RfC	reference concentration
RfD	reference dose
RI/FS	Remedial Investigation / Feasibility Study
RME	reasonable maximum exposure
SMS	site management strategy
SOW	statement of work
TSAP	task sampling and analysis plan
UAO	unilateral administrative order
UCL	upper confidence limit
U.S. EPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey

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FINAL BASELINE HUMAN HEALTH RISK ASSESSMENT WORK PLAN REVISION 2

Leviathan Mine
Alpine County, California

1.0 INTRODUCTION

This Final Baseline Human Health Risk Assessment Work Plan, Revision 2 (the "Revised BHHRA Work Plan") has been prepared by Amec Foster Wheeler, Environment & Infrastructure, Inc. (Amec Foster Wheeler), on behalf of Atlantic Richfield Company (Atlantic Richfield) for the Leviathan Mine Site (site) in Alpine County, California (Figure 1). This Revised BHHRA Work Plan is being submitted in response to U.S. EPA's acceptance letter dated December 29, 2016.

A draft of the Baseline Human Health Risk Assessment Work Plan ("BHHRA Work Plan") was submitted to U.S. EPA in November 2009 (Atlantic Richfield, 2009c). Atlantic Richfield provided a written response to discussion points on June 15, 2010 (Atlantic Richfield, 2010a). The BHHRA Work Plan (Atlantic Richfield, 2010d) was submitted to the U.S. Environmental Protection Agency (U.S. EPA) on December 15, 2010 and approved in a letter dated March 10, 2011 "with full consideration of the comments provided by U.S. EPA pertaining to the BHHRA work plan and to other parts of the RI/FS" (U.S. EPA, 2011a). Revision 1 of the Final BHHRA Work Plan was developed based on comments transmitted in the March 10, 2011 approval letter and subsequent comment letters from U.S. EPA dated July 6, 2011 and March 23, 2015 (U.S. EPA, 2011b and 2015b) and responses to the March 2011 comments provided by Atlantic Richfield in a letter dated May 19, 2011 (Atlantic Richfield, 2011).[1] Following submittal of Revision 1 of the Final BHHRA Work Plan (Atlantic Richfield, 2015f), U.S. EPA provided a set of comments on October 13, 2015 (U.S. EPA, 2015b), which Atlantic Richfield responded to in writing on December 4, 2015 (Atlantic Richfield, 2015i). A second set of U.S. EPA comments were received on January 12, 2016 (U.S. EPA, 2016a), which were responded to on February 19, 2016 (Atlantic Richfield, 2016a). On June 27, 2016, Atlantic Richfield provided revised versions of Tables 3.1 and 3.2 (formerly Tables 4.1 and 4.2) and an update to the site conceptual model diagram from the BHHRA Work Plan (Atlantic Richfield, 2016i). On December 29, 2016, U.S. EPA issued an acceptance letter regarding Atlantic Richfield's previous

[1] In 2009, a Draft Baseline Human Health Risk Assessment Work Plan (Draft BHHRA Work Plan; Atlantic Richfield, 2009c) was submitted to U.S. EPA. The Draft BHHRA Work Plan was revised to address discussion points transmitted in a letter from U.S. EPA dated March 22, 2010 (U.S. EPA, 2010c), Atlantic Richfield's response to the discussion points (Atlantic Richfield, 2010a) and further discussion with U.S. EPA during a conference call on September 9, 2010. The revisions were documented in the BHHRA Work Plan.

responses to comments and requested a revised and final BHHRA Work Plan (U.S. EPA, 2016d). This Final BHHRA Work Plan, Revision 2 satisfies this request and addresses additional comments provided in the U.S. EPA's December 29, 2016 acceptance letter.

This Revised BHHRA Work Plan has been prepared as part of the phased approach to the Baseline Human Health Risk Assessment (BHHRA) described in the Statement of Work (SOW), which is Attachment 1 to the Administrative Order for Remedial Investigation and Feasibility Study ("Unilateral Administrative Order," or UAO), CERCLA Docket No. 2008-18 (U.S. EPA, 2008a). More detail regarding the overall Remedial Investigation and Feasibility Study (RI/FS) process for the Leviathan Mine site is provided in Section 1.1.

The Revised BHHRA Work Plan provides the methodology and primary assumptions for conducting the BHHRA for the site. The BHHRA will provide a quantitative assessment of the potential for adverse health effects that may result from exposure to chemicals of potential concern (COPCs) at the site. The objectives of the BHHRA are to determine whether site COPCs pose a current or future potential risk to human health in the absence of further remedial action and to identify the need for further study, if necessary. Consistent with U.S. EPA guidance[2], reasonably anticipated future land use should be considered during the baseline risk assessment. The BHHRA will also quantitatively assess potential exposure in reference areas for the same receptors evaluated for the Leviathan Mine site to provide a point of comparison with respect to ambient exposures to the COPCs in areas unaffected by Leviathan Mine.

This Revised BHHRA Work Plan outlines an initial conservative process for evaluating potential human health risks. If potential human health risks are below regulatory acceptance levels, no further actions would be required. If potential human health risks exceed regulatory acceptance levels, additional data or analysis may be required for some exposure pathways or receptors prior to preparing the Feasibility Study. Until the initial BHHRA is completed, the necessity and scope of these additional tasks cannot be determined.

Although specific interim BHHRA deliverables are not identified in the SOW, updates or revisions to information in this BHHRA Work Plan may be documented using interim BHHRA deliverables if requested by the U.S. EPA. For example, Technical Data Summary Reports (TDSRs) are being prepared for individual media to summarize the data collected to characterize the nature and extent of chemicals in the environment and to develop data evaluation units (i.e., exposure areas) and exposure point concentrations (EPCs) for each media for use in the BHHRA.

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[2] *"Considering Reasonably Anticipated Future Land Use and Reducing Barriers to Reuse at EPA-lead Superfund Remedial Sites*," OSWER Dir. 9355.7-19 at p. 5 (March 17, 2010).

1.1 O RDER REQUIREMENTS AND PROCEDURAL UPDATE

The RI/FS work to be performed under the UAO is described in Paragraphs 50 and 51 and Attachments 1 and 2 to the UAO. Paragraph 50 of the UAO requires performance of activities and submission of deliverables as provided by the SOW. General activities required to be performed are identified in the List of Major Submittals for the Leviathan Mine RI/FS (Attachment 2 to the UAO).

The SOW identifies the objectives of the project and presents a framework of activities for the RI/FS as appropriate. General requirements specified in the SOW include: "plan and conduct those investigations necessary to characterize the Leviathan Mine Site and actual or potential contaminant migration pathways (Environmental Setting and Pathway Characterization); define the source (Source Characterization); define the nature and extent of contamination (Contaminant Characterization); identify actual or potential receptors (Receptor Identification); and conduct an assessment of risks posed to actual or potential receptors (Risk Assessment)." The SOW requires that "all planning will be based on DQOs" (data quality objectives). The SOW also provides a general list of scope items "of which modifications may be required as the program proceeds." According to the RI/FS guidance, the actual scope and data collection needs of the RI/FS are based on the current and future risk assessment pathways and the need to assess remedial alternatives. The BHHRA evaluates human receptors as part of the RI.

1.1.1 Program Work Plan

The RI/FS Program Work Plan (PWP) (Atlantic Richfield, 2009b) was submitted to the U.S. EPA in July 2009. The PWP included a work breakdown structure with 51 site-wide and study-area RI tasks, outlines for the ecological and human health risk assessments, and an overview of the Feasibility Study, prioritization of tasks, and schedule. The PWP also included the RI/FS Sampling and Analysis Plan (SAP) and the RI/FS Task Specific Health and Safety Plan as required by the UAO. The RI/FS SAP contained an update to the initial RI/FS Quality Assurance Project Plan (QAPP) (Atlantic Richfield, 2009a) and the RI/FS Field Sampling Plan (FSP).

In a letter to Atlantic Richfield dated October 15, 2009 (U.S. EPA, 2009d), the U.S. EPA provided comments on the PWP. In the letter, the U.S. EPA requested that Atlantic Richfield combine the components of the RI/FS into three focused RI/FS work plans addressing On-Property, Off-Property, and Reference Study Areas. As requested by the U.S. EPA, Atlantic Richfield submitted an addendum to the PWP on November 16, 2009 (Atlantic Richfield, 2009d). U.S. EPA approved the PWP with comments in November 2010 (U.S. EPA, 2010e).

In 2016, the RI/FS QAPP was revised at the request of the U.S. EPA and presented as a stand-alone, site-wide document that replaces Appendix B of the RI/FS SAP presented in Appendix C

of the PWP in its entirety (Atlantic Richfield, 2016g). The most recent version of the RI/FS QAPP, Revision No. 2 was submitted to the U.S. EPA in January 2017 (Atlantic Richfield, 2017b).

1.1.2 Data Quality Objectives

Consistent with Paragraph 51 of the UAO, the Draft DQOs Report (Atlantic Richfield, 2008) was submitted to the U.S. EPA in October 2008. The Draft DQOs Report included objectives for the RI/FS, an evaluation of existing data, preliminary conceptual site models (CSMs), identified data gaps, and the site management strategy (SMS). The Draft DQOs Report was conditionally approved by the U.S. EPA on April 23, 2009 (U.S. EPA, 2009b). Over the last several years, an iterative process between the U.S. EPA and Atlantic Richfield ensued to more fully develop the Programmatic DQOs.

In a February 26, 2010, letter to Atlantic Richfield, the U.S. EPA (2010a) indicated that additional details were needed in the example Programmatic DQOs proposed for incorporation in the PWP that had been submitted on November 16, 2009 (Atlantic Richfield, 2009b). Over the course of the next several weeks, the U.S. EPA developed more detailed RI/FS Programmatic DQOs with input from Atlantic Richfield. On May 13, 2010, the U.S. EPA approved the RI/FS Programmatic DQOs (U.S. EPA, 2010d) for the PWP. These Programmatic DQOs were used as the basis for developing DQOs for the On-Property, Off-Property (including Supplemental Study Areas [SSAs]), and Reference Study Areas.

Consistent with U.S. EPA guidance for the development of DQOs (U.S. EPA, 2006), DQOs for various data collection activities described in the On-Property, Off-Property, and Reference Study Area Focused Remedial Investigation (FRI) work plans (including addenda and amendments) have been and continue to be refined. These refinements have occurred in collaboration with U.S. EPA representatives during the preparation and approval of the work plans. For example, on September 5 and 6, 2012, a meeting was convened with the U.S. EPA and its consultants in Sacramento, California, to refine DQOs for various environmental media in the Off-Property and Reference Study Areas. Following this meeting, Atlantic Richfield submitted revised DQOs for U.S. EPA review on November 19, 2012. The U.S. EPA provided comments on the revised DQOs in a letter dated December 26, 2012, and directed Atlantic Richfield to submit a revised Off-Property FRI Work Plan based on the revised DQOs.

On September 5, 2014, following a request from U.S. EPA, Atlantic Richfield submitted a compilation of DQOs from the On-Property FRI Work Plan (Atlantic Richfield, 2014e), Revised Off-Property FRI Work Plan Addendum No. 2 (Atlantic Richfield, 2013c), and the revised Reference Area FRI Work Plan (Atlantic Richfield, 2015a). A subsequent update to the DQOs

was provided on February 28, 2015 (Atlantic Richfield, 2015b) and again with the submittal of revisions to the QAPP (Atlantic Richfield, 2016g and 2017b). Because this revised BHHRA Work Plan describes the analysis and evaluation of data to be conducted after data collection is completed rather than describing plans for the collection of data, separate DQOs have not been incorporated herein.

1.1.3 Focused Remedial Investigation Work Plans

To facilitate efficient management of field activities, the Leviathan Mine site was divided into three main study areas:

- On-Property Study Area, consisting of the Aspen Creek Study Area (ACSA), Pit Study Area (PSA), and Leviathan Creek Study Area (LCSA);
- One Off-Property Study Area referred to as the Downstream Study Area (DSA); and
- The Reference Study Area (RSA).

In addition, the SOW and related correspondence by U.S. EPA identified four Supplemental Study Areas (SSAs):

- Portions of the River Ranch property,
- Two suspected ore piles located along Leviathan Mine Road,
- Potential use of mine waste to construct/maintain Leviathan Mine Road, and
- A reach of the East Fork Carson River below the confluence with Bryant Creek.

The locations of the On-Property Study Area, DSA, and SSAs are shown on Figure 1. The On-Property Study Areas were addressed in the On-Property FRI Work Plan (Atlantic Richfield, 2010c) and related amendments. The scopes of the FRIs to be implemented in the DSA and the SSAs are addressed in the Off-Property Area FRI Work Plan (Atlantic Richfield, 2012a) and related addenda (Atlantic Richfield, 2012d and 2013c). The scope of the FRI in the RSA is addressed in the Final Reference Area FRI Work Plan (Atlantic Richfield, 2017a), which was approved by U.S. EPA in a letter dated February 16, 2017 (U.S. EPA, 2017c). The FRI implemented in the RSA provides information on reference conditions independent of the FRIs to be implemented in the On- and Off-Property Study Areas.

1.1.4 Technical Data Summary Reports

Media-specific technical data summary reports (TDSRs) are being developed to document data collection, quality, and interpretation for various investigation efforts, including each of the media relevant to the BHHRA: surface water, mine waste, sediment, floodplain soil, River Ranch soil,

groundwater, plants, fish, Leviathan Mine Road, East Fork Carson River, and ore piles. The TDSRs will describe the nature and extent of RI/FS metals in these media, compare measured concentrations to screening levels and reference concentrations, develop data evaluation units for each receptor for each media, and quantify EPCs for use in the BHHRA. The results of the TDSRs will be summarized in a Site Characterization report that will be completed prior to completing the BHHRA.

1.2 SITE DESCRIPTION

The Leviathan Mine is a former open-pit and underground mine located in a remote mountainous area of northeastern Alpine County, California. The Leviathan Mine is located on the eastern slopes of the Central Sierra Nevada at an elevation of approximately 7,000 feet above mean sea level (Figure 1). The Leviathan Mine is located about 25 miles southeast of South Lake Tahoe and about 6 miles east of Markleeville, California and principally within Sections 14, 15, 22, and 23 Township 10 North, Range 21 East of the Topaz Lake and Mt. Siegel U.S. Geological Survey (USGS) quadrangles.

The Leviathan Mine property consists of 32 patented mineral claims and a patented mill site, which together total approximately 656 acres. The state-owned portion of the Leviathan Mine property is approximately 479 acres. Disturbance from historical mining activities is evident on approximately 253 acres, most of which are state-owned property. The SOW defines “Leviathan Mine” as “the area within the Leviathan Mine property boundaries and adjacent areas outside the property boundary which have been disturbed by mining activities, such as mine wastes, excavations, landslides and runoff of surface water and groundwater.” This includes the portions of the site that were actively mined and property down to the confluence of Leviathan and Aspen Creeks, and the DSA and the SSAs (Figure 1).

1.3 CURRENT SITE USE

Access to the area is dependent on the weather, but is provided by unpaved roads from State Route 89 east of Markleeville, California, and from U.S. Highway 395 from Gardnerville, Nevada. The California-Nevada border lies approximately three miles northeast of the Leviathan Mine. Additional details about on-property features, mine ownership, and mining history are provided in the UAO (U.S. EPA, 2008a) and in the PWP (Atlantic Richfield, 2009b).

The Leviathan Mine property is currently fenced, with locked gates at the entrances from the access roads to the north and south (Leviathan Mine Road). During the winter months, potential access is further limited because of snowpack, such that a standard four-wheel-drive vehicle typically cannot reach the mine property on the dirt access roads covered with snow. Access to the area, including the mine property, during the winter months typically requires the use of

snowcats, snowmobiles, or other alternative transportation. The recent historic drought in California (2012 to 2015) has resulted in reduced snowpack and extended the period when the area can be accessed; however, even if winter access is physically possible, temperatures are lower than summer months, which would reduce the potential for exposure (e.g., skin surfaces are covered and swimming and wading are less likely).

The Leviathan Mine On-Property area consists of the mine pit, areas covered by mine waste and overburden, areas where remediation systems are in operation, and natural habitat (e.g., riparian, forested). Current activities at the Leviathan Mine are related to remedial investigation and interim CERCLA response actions, which generally run from April/May, once the snow has melted and the likelihood of snowfall is reduced, through October, before snow begins to accumulate. Potential exposures to COPCs by site investigation and remediation workers and authorized visitors are addressed by site-specific health and safety plans. Unauthorized access by trespassers, which is effectively being controlled through site security measures, is the only potential current use by the general public of the on-property areas within the fence line. Evaluation of future exposure scenarios will assume public access for recreational purposes to these areas under ownership by the U.S. Forest Service or State of California although institutional controls that restrict access are likely.

As noted, the State of California owns the majority of the disturbed portion of the site. The Lahontan Regional Water Quality Control Board (LRWQCB) is currently performing interim CERCLA response actions and will be directly involved in future remedial activity and long-term operation and maintenance of the remedial action. The LRWQCB has stated that future public access to the Leviathan Mine On-Property Study Area for residential, recreational, and other uses will not be permitted because of potential hazards and because of the need to protect the long-term integrity of the remedial action. Restrictive covenants and other proprietary and institutional controls will likely be put in place to enforce these restrictions. Therefore, future exposure scenarios including unrestricted public access to the Leviathan Mine On-Property Study Area are not reasonably foreseeable.[3] However, U.S. EPA is requiring that the BHHRA assume potential future access to the On-Property Study Area for evaluation purposes.

Off-property areas potentially affected by releases of hazardous substances from the Leviathan Mine are primarily administered by the U.S. Forest Service. Physical or proprietary controls do not currently prohibit access to these areas, although access is typically restricted during the winter months by heavy snow accumulation and winter temperatures, and residential occupation

[3] *See "Land Use in the CERCLA Remedy Selection Process,"* OSWER Dir. 9355.7-04 at p. 6 (U.S. EPA, 1995a), which states that "[future land use assumptions allow the baseline risk assessment and the feasibility study to focus on the development of practicable and cost-effective remedial alternatives, leading to site activities which are consistent with the reasonably anticipated future land use."

is generally prohibited on federally managed Forest Service lands. The area is accessible to recreational users when heavy snow has not accumulated. The nearest private properties are parcels near the southern mine entrance.

As described in Section 1.1.2, four SSAs have been identified in addition to the On- and Off-Property Study Areas. The River Ranch property is a privately owned, former cattle ranch. Portions of the pastures at River Ranch were irrigated prior to approximately 2008 with water diverted from Bryant Creek and Cottonwood Creek (Figure 1). Mine-related materials may have been used to construct portions of Leviathan Mine Road and deposited at two suspected ore piles along the road. Lastly, the East Fork Carson River (EFCR) is being evaluated as a SSA below the confluence with Bryant Creek. Preliminary comparisons of sampling data collected in the SSAs to screening levels indicates that the River Ranch property and the ore piles warrant further evaluation in the BHHRA. Further screening of the Leviathan Mine Road and the EFCR will be performed when additional sampling data collected in 2016 including reference concentrations are available.

The nearest tribal community (the Washoe Tribe) is located approximately 12 miles north of the Leviathan Mine in Dresslerville, Nevada. Additionally, Washoe Tribe members hold Pine Nut Allotments in the Pinenut Mountain Range, including some allotments located along the California/Nevada border. The nearest of these is approximately 3 miles north of the Leviathan Mine (Figure 1). The “existing documentary record concerning Washoe history, culture, and their relationship with and services provided by the Bryant Creek drainage and the East Fork of the Carson River is extremely limited” (Walker Research, 2003). This BHHRA will evaluate reasonably likely current and future foraging use and future subsistence use of the Leviathan Mine site by Washoe Tribe members. The utility of these exposures scenarios in developing risk-based remedial decisions will depend to some extent on the implementation of proprietary controls for, and reasonable assumptions about, the future use of, the State-owned portion of the site.

Future land use is not anticipated to change materially in the area surrounding the site. As such, current and potential future exposure scenarios are assumed to be similar for purposes of the BHHRA. The primary differences are related to access. Future exposures will evaluate subsistence use of on- and off-property areas by Washoe Tribe members, foraging use of certain on-property areas by Washoe Tribe members and others, and recreational use of certain on-property areas by other members of the public. While U.S. EPA is requiring that these uses be evaluated quantitatively in the BHHRA, future public access to and subsistence use of on-property areas is not reasonably foreseeable for the reasons discussed above.

1.4 REGULATORY GUIDANCE

The BHHRA will be performed in accordance with U.S. EPA guidance and other regulatory guidance, including the documents listed below. Specific references to these documents where used are provided in the tables and text.

- *Risk Assessment Guidance for Superfund (RAGS): Volume I—Human Health Evaluation Manual (Part A)* (U.S. EPA, 1989);
- *Guidance for Data Usability in Risk Assessment* (U.S. EPA, 1992);
- *U.S. EPA Risk Characterization Program Memorandum* (U.S. EPA, 1995b);
- *Soil Screening Guidance: Users Guidance and Technical Background Document* (U.S. EPA, 1996); and
- *Risk Assessment Guidance for Superfund: Volume I—Human Health Evaluation Manual, Supplement to Part A: Community Involvement in Superfund Risk Assessments* (U.S. EPA, 1999);
- *Risk Assessment Guidance for Superfund: Volume I—Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments)* (U.S. EPA, 2001);
- *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites* (EPA 540-R-01-003; OSWER 9285.7-41) (U.S. EPA, 2002a);
- *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites* (U.S. EPA, 2002b);
- *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (U.S. EPA, 2002c).
- *Risk Assessment Guidance for Superfund: Volume I—Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)* (U.S. EPA, 2004);
- *Child-Specific Exposure Factors Handbook* (U.S. EPA, 2008b);
- *Risk Assessment Guidance for Superfund: Volume I—Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment)* (U.S. EPA, 2009a);
- *Exposure Factors Handbook* (U.S. EPA, 2011c); and
- *Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors* (U.S. EPA, 2014).

Additional guidance that addresses site-specific issues and chemical constituents will also be consulted where applicable, including relevant guidance published by California's Environmental Protection Agency (Cal/EPA) through the Office of Environmental Health Hazard Assessment (OEHHA), the Department of Toxic Substances Control (DTSC), and the LRWQCB.

Also, as directed by the SOW, the BHHRA will account for reasonable maximum exposure factors provided for members of the Washoe Tribe (Walker Research, 2003; AESE, 2005a, 2005b). As stated in the preamble to the National Contingency Plan, "EPA defines 'reasonable maximum' such that only potential exposures that are likely to occur will be included in the assessment of exposures." 55 Fed. Reg. 8666, 8710 (Mar. 8, 1990). "The reasonable maximum exposure scenario is 'reasonable' because it is a product of factors, such as concentration and exposure frequency and duration, that are an appropriate mix of values that represent averages and 95th percentile distributions (see the "Risk Assessment Guidance for Superfund: Human Health Evaluation Manual")." *Id.* The reasonable maximum exposure is not intended to represent purely hypothetical or maximally conservative exposure assumptions.

Regulatory guidance documents published after this Revised BHHRA Work Plan is submitted and before the BHHRA is completed will also be considered. In addition, information gathered from the latest scientific literature may be consulted and incorporated with the approval of the U.S. EPA.

1.5 PREVIOUS HUMAN HEALTH RISK EVALUATION

On behalf of the federal Agency for Toxic Substances and Disease Registry (ATSDR), a division of the U.S. Department of Health and Human Services (HHS), the California Department of Health Services (CDHS) performed a public health assessment for the Leviathan Mine site in the early 2000s (ATSDR, 2003). The evaluation focused on potential surface water and sediment exposure pathways because data was limited or unavailable to assess other potentially complete pathways. The report concluded that the closer one gets to Leviathan Mine, the greater the probability that concentrations of contaminants will present a health risk. CDHS recommended additional sampling of fish, sediments, and surface water to better understand potential health risks.

Atlantic Richfield conducted preliminary human health and ecological risk evaluations for the EFCR in 2002 (Gradient Corporation [Gradient], 2002). These evaluations utilized available environmental data collected primarily between 1998 and 2000 to characterize conditions in and proximate to the EFCR. Data developed for these evaluations included surface water chemistry, sediment chemistry, aquatic and sediment toxicity, fish tissue chemistry, and benthic macroinvertebrate community data collected by various parties including but not limited to

Atlantic Richfield (contractor ENSR International), U.S. Fish and Wildlife Service (USFWS), U.S. Forest Service (USFS), Nevada Division of Environmental Protection; Bureau of Water Quality Planning (NDEP), California Department of Fish and Game (CDFG), Dr. D. Herbst and the U.S. Geological Survey (USGS) (Gradient, 2002).

Screening level evaluations were conducted using a combination of conventional risk assessment benchmarks (e.g., water quality criteria/standards) and more site-specific analyses (i.e., sediment quality triad) when appropriate. For the purposes of this evaluation, relevant data from six stations on the EFCR and one station on Bryant Creek were evaluated. The lower Bryant Creek station was included in order to assist in interpreting the developed empirical data (Gradient, 2002). The conclusions from the Gradient report will be discussed in the RI/FS report.

1.6 PREVIOUS MITIGATION AND RESPONSE ACTIONS

The U.S. EPA identified five flows or discharge areas on-property that contribute most of AD loading to surface water at the Leviathan Mine. These are the Adit, Pit Underdrain (PUD), Channel Underdrain (CUD), the Delta Seep, and the Aspen Seep. Several mitigation and response actions (RAs) have been performed or are on-going at the above locations, which are described in the PWP and various RI/FS planning documents (Atlantic Richfield, 2009b).

2.0 DATA EVALUATION

Data collected prior to RI sampling activities (referred to herein as historical data) were considered in the development of FRI work plans. Historical data will be considered in the TDSRs as context for sampling data collected during remedial investigations (RI/FS data); however, much of the historical data is more than 10 years old and has not been subject to the same level of QA/QC documenting data collection and analysis as the RI/FS data. For these reasons and because the RI data was intended to comprehensively evaluate conditions in each media, the historical data will not be considered quantitatively in the BHHRA. If there is significant variability between the historical and RI/FS data discussed in the TDSRs that may be relevant to the BHHRA (e.g., not simply a verification of improving conditions with time), that information will be discussed in the TDSR for the media, and in the uncertainty analysis of the BHHRA.

2.1 DATA QUALITY OBJECTIVES

The data needs for the BHHRA have been considered in the development of DQOs in the PWP and in the FRI Work Plans (Atlantic Richfield, 2010c, 2013c and 201a) and related amendments and addenda. DQOs from these FRI Work Plan documents are presented collectively in the QAPP (Atlantic Richfield, 2017b). The DQOs in the FRI work plans explicitly reference

evaluation of potential human health risks and support the risk assessment process. Based on the On-Property and Off-Property FRI Work Plans and subsequent addenda and amendments, soil (including samples from mine waste, floodplain soils, the ore piles, and potentially Leviathan Mine Road), stream sediment, surface water, and biota samples have been and will be collected to characterize conditions at Leviathan Mine. As described in Section 1.1.3, TDSRs for each media will describe the data sets, characterize site conditions, define data evaluation units, and quantify exposure point concentrations. TDSRs are in various stages of development and will be completed for all media prior to development of the BHHRA.

2.2 DATA COLLECTION ACTIVITIES

To satisfy the DQOs, Atlantic Richfield has implemented various data collection activities to provide data for various environmental media to be used in the BHHRA. A summary of these data collection activities by environmental medium is provided in the following subsections. Additional details on the data collection activities can be reviewed in the various work plans, related work plan addenda or amendments, task sampling and analysis plans (TSAPs), and TDSRs. The most pertinent work plan or related addenda or amendments are referenced in the following sections. Reference data collection is described in the Final Reference Area Focused Remedial Investigation Work Plan (Atlantic Richfield, 2017a).

2.2.1 Mine Waste

Potential exposures to mine waste are being investigated within the On-Property Study Areas by implementing a phased approach to characterize mine waste, as described in the Task Sampling and Analysis Plan (TSAP) for Phase 2 Mine Waste Characterization dated October 24, 2014 (Atlantic Richfield, 2014h). The TSAP was prepared to supplement Amendment No. 6, Revision No. 1, of the On-Property FRI Work Plan dated June 4, 2014 (Atlantic Richfield, 2014a). The first phase (Phase 1) of mine waste characterization consisted of a screening survey using a field-portable x-ray fluorescence (FPXRF) analyzer to characterize the spatial distribution of metals across the extent of the previously mapped mine waste. The second phase (Phase 2) of mine waste characterization consisted of mine waste mapping, soil sampling from the upper 2 feet of mine waste, and analysis of the soil samples for RI/FS metals, acid-base accounting (ABA), agronomic characteristics, and grain-size distribution. A final TSAP was prepared for mine waste in November 2014 (Atlantic Richfield, 2014i).

To provide reference data for comparison to mine waste data, near-surface samples of naturally occurring geologic materials collected in the On-Property Study Areas were collected and analyzed for the same laboratory analytes in accordance with the Final Reference Area Focused Remedial Investigation Work Plan (Atlantic Richfield, 2017a).

Deeper soil in the mine waste has been sampled during the installation of groundwater monitoring wells (Section 2.2.2), but samples are generally collected at depths greater than 2 feet below ground surface (bgs), and are not considered relevant for human health risk assessment at this site.

2.2.2 Groundwater

Groundwater investigations within the On-Property Study Areas are being conducted through installation and sampling of groundwater monitoring wells as generally outlined in the On-Property FRI Work Plan (Atlantic Richfield, 2010c) and the 2016 Drilling Work Plan (Atlantic Richfield, 2016j). Monitoring wells are screened both in mine waste and in naturally occurring geologic materials to develop an understanding of hydrostratigraphy, groundwater flow directions and gradients, and groundwater geochemical characteristics. To date 14 pre-existing on-property wells and piezometers have been rehabilitated. More than 30 wells are being sampled to provide groundwater data to evaluate groundwater chemistry at Leviathan Mine. Groundwater samples have been and will be collected and analyzed for RI/FS metals, major ions, and other general chemical parameters as part of these groundwater investigations. Although exposure to groundwater would require installation of a water-supply well at the mine site, which is unlikely under future site conditions, the groundwater exposure pathway will be considered potentially complete in the BHHRA as required by the U.S. EPA because groundwater is designated for beneficial use as a water supply in the Water Quality Control Plan for the Lahontan Region (Basin Plan, LRWQCB, 2015). Specifically, groundwater within the Carson River Hydrologic Units (including Leviathan Mine) is designated for beneficial uses including use for municipal and domestic water supply

Surface water chemistry data also will be used to assess potential exposures related to groundwater that may be discharging to surface water features or seeps.

2.2.3 Surface Water

Potential exposures to surface water have been and will be investigated within the On-Property and Off-Property Study Areas through a surface water monitoring program.[4] This program includes surface water monitoring at 14 locations in Aspen and Leviathan Creeks within the On-Property Study Areas and 7 locations in Leviathan and Bryant Creeks within the DSA portion of the Off-Property Study Area (Figure 1). Additional investigations along the lower reaches of Bryant Creek within the DSA and along Doud Creek (a tributary to Bryant Creek) is ongoing to

[4] East Fork Carson River Supplemental Study Area is still undergoing an evaluation as to whether it is affected by the Leviathan Mine site. A determination will be made following a screening evaluation of surface water and sediment when the data is available.

supplement surface water investigations and evaluate potential contributions of RI/FS metals to lower Bryant Creek.

Surface water is monitored for concentrations of RI/FS metals, major ions, along with other general chemistry parameters and stream flow rates at the time of sampling. In addition, the LRWQCB began monitoring surface water quality and flow rates in the mid-1990s. The LRWQCB continues to monitor flow rates; however, they discontinued monitoring surface water quality in 2010. These historical data and surface water data from reference watersheds (i.e., Cottonwood and Mountaineer creeks) will be used to provide context to the RI/FS surface water monitoring program but will not be used quantitatively in the BHHRA. Additional details regarding the RI/FS surface water monitoring program are described in the following work plan documents:

- Request for Approval of 2012 Surface Water Monitoring Program, On-Property and Off-Property Focused Remedial Investigations, letter from Atlantic Richfield dated April 10, 2012 (Atlantic Richfield, 2012b).
- Approval of 2012 Surface Water Monitoring Program for Leviathan Mine, letter from U.S. EPA dated April 10, 2012 (U.S. EPA, 2012a).
- Amendments to 2012 Surface Water Monitoring Program, On-Property and Off-Property Focused Remedial Investigations, letter from Atlantic Richfield dated April 24, 2012 (Atlantic Richfield, 2012c).
- Approval of Amendments to 2012 Surface Water Monitoring Program for Leviathan Mine, letter from U.S. EPA dated April 25, 2012 (U.S. EPA, 2012b).
- Request for Approval of Change in Surface Water Monitoring Program, On-Property and Off-Property Focused Remedial Investigations, letter from Atlantic Richfield dated April 15, 2013 (Atlantic Richfield, 2013a).
- Partial Approval and Comment, Request for Approval of Change in Surface Water Monitoring Program, On-Property and Off-Property Focused Remedial Investigations, letter from U.S. EPA dated April 22, 2013 (U.S. EPA, 2013a).
- Modifications to 2014 Surface Water Monitoring Program dated June 25, 2014 (Atlantic Richfield, 2014b).
- Modifications to 2015 Surface Water Monitoring Program dated June 19, 2015 (Atlantic Richfield, 2015g).
- Modifications to 2016 Surface Water Monitoring Program dated May 6. (Atlantic Richfield, 2016d).

- Off-Property Focused Remedial Investigation Work Plan Addendum No. 3 – Task Sampling and Analysis Plan for Supplemental Investigation of Bryant Creek dated May 15, 2016 (Atlantic Richfield, 2016e).

- Final Reference Study Area Focused Remedial Investigation Work Plan, Revision No. 2 (Atlantic Richfield, 2017a).

2.2.4 Stream Sediment

Potential exposures to stream sediment have been investigated within On-Property, Off-Property, and Reference Study Areas. Stream sediment sampling targets the upper 2-3 centimeters of sediment in various channel types mapped in Aspen, Leviathan, and Bryant Creeks. In addition, stream sediment sampling has been conducted for Reference Study Areas in Cottonwood and Mountaineer creeks to provide data for comparison to On-Property and Off-Property reaches that were potentially impacted by the Leviathan Mine.

Details of the stream sediment sampling program are described in the following work plan documents:

- On-Property Focused Remedial Investigation Work Plan Amendment No. 7, Sediment Quality Triad Sampling in Aspen and Leviathan Creeks, letter from Atlantic Richfield dated June 14, 2013 (Atlantic Richfield, 2013b).

- Reference Area Focused Remedial Investigation Addendum No. 2, Sediment Quality Triad Sampling in Mountaineer Creek, Leviathan Mine Site, Alpine County, California, dated June 14 (Atlantic Richfield, 2013c)

- Revised Off-Property Focused Remedial Investigation Work Plan Addendum No. 2, dated June 28, 2013 (Atlantic Richfield, 2013d).

- On-Property Focused Remedial Investigation Work Plan Amendment No. 8, Sediment and Floodplain Soil Sampling, letter from Atlantic Richfield dated October 2, 2014 (Atlantic Richfield, 2014f).

- On-Property Focused Remedial Investigation Work Plan Amendment No. 10, Revision No. 3 - Stream Sediment and Floodplain Soil Characterization in Beaver Dam/Pond Complex dated September 30 (Atlantic Richfield, 2015h).

- Final Reference Study Area Focused Remedial Investigation Work Plan (Atlantic Richfield, 2017a).

2.2.5 Terrestrial Soil

Potential exposures to terrestrial soils that were potentially impacted by mine activities are being investigated within the River Ranch SSA and the Suspected Ore Piles along Leviathan Mine Road SSA.

2.2.5.1 River Ranch SSA

Investigation of the River Ranch SSA consists of the following activities:

- Conduct irrigation system and soil mapping to identify the locations of irrigation features and major soil depositional features to allow soil sampling to focus on areas that received irrigation from Bryant and Cottonwood creeks.

- Develop reference concentrations for RI/FS metals using laboratory analysis of soil samples. Reference concentrations derived from analysis of soils receiving irrigation water from Cottonwood Creek and will be used for comparison to results in areas irrigated from Bryant Creek.

- Perform soil sampling for RI/FS metals along transects near irrigation diversion structures to understand the spatial variability of RI/FS metals in areas that are thought to have received the largest amount of water diverted from Bryant Creek.

- Perform spatially-distributed soil sampling for RI/FS metals to provide broader data coverage over larger mapped areas irrigated by waters diverted from Bryant Creek.

- Conduct soil sampling for RI/FS metals at catchment locations upslope from the irrigation canal and related irrigated areas to provide information on potential influences of soil parent materials located upslope of irrigated areas and surface water runoff from these upslope areas onto irrigated areas.

- Conduct soil sampling for RI/FS metals within and along Bryant Creek and Cottonwood Creek irrigation canals to assess the variability of RI/FS metals in canals used to divert water from the creeks.

- Conduct surface water sampling of seeps in and around the area irrigated by Bryant Creek to provide information on potential influences of seep discharges to soils in irrigated areas.

Details regarding the scope of soil sampling in the River Ranch SSA are described in the following work plan documents:

- Off-Property and Reference Area FRI Work Plans, Response to Comments and Final Revised/Accelerated River Ranch, Soil Investigation Approach, letter from Atlantic Richfield dated August 26, 2014 (Atlantic Richfield, 2014d).

- Task-Specific Sampling and Analysis Plan for Irrigation System and Soil Mapping, Final Revised/Accelerated River Ranch Soil Investigation Approach, Off-Property and Reference Area FRI Work Plans, letter from Atlantic Richfield dated October 16, 2014 (Atlantic Richfield, 2014g).

- Task Sampling and Analysis Plan for FPXRF Surveys and Sampling for Laboratory Analysis, Final Revised/Accelerated River Ranch Soil Investigation Approach, Off-Property and Reference Area FRI Work Plans, Revision No. 1 dated June 24, 2016 (Atlantic Richfield, 2016h).

2.2.5.2 Suspected Ore Piles SSA

As described in Revised Off-Property Focused Remedial Investigation Work Plan Addendum No. 2 (Atlantic Richfield, 2013c), terrestrial soils have been investigated beneath and adjacent to Suspected Ore Piles along Leviathan Mine Road. The initial investigation consisted of collecting soil samples from five locations within each suspected ore pile. Samples were collected from the depth interval of 0 to 1.0 foot below ground surface for a total of five soil samples at each suspected ore pile. Soil samples were submitted for laboratory analysis of RI/FS metals, total organic carbon (TOC), and grain size.

Concentrations of RI/FS metals in these soil samples exceeded U.S. EPA Regional Screening Levels (RSLs) or U.S. EPA ecological soil screening levels (Eco-SSLs) for one or more metals, so that additional samples of the suspected ore piles were collected. The additional sampling included samples from greater depths (1.5 to 2.0 feet, 2.0 to 4.0 feet, and 4.0 to 6.0 feet below ground surface) as proposed in Off-Property FRI Work Plan Addendum No. 2 (Atlantic Richfield, 2013c). In addition, reference locations were sampled within an area of similar soil types and habitat conditions as described in the Final Reference Study Area FRI Work Plan (Atlantic Richfield, 2017a).

2.2.5.3 Leviathan Mine Road SSA

The preliminary investigations along the Leviathan Mine Road consisted of reconnaissance activities and a desk top mass balance evaluation to assess whether mine-related materials may have been used for road construction (Atlantic Richfield, 2013c). Preliminary investigations to identify the use or presence of mine-related materials for road construction were inconclusive (Brooks, 2004). As a result, disturbed areas where mine-related materials were potentially used as road materials were identified for sampling as outlined in:

- Task Sampling and Analysis Plan for Leviathan Mine Road, Revised Off-Property Focused Remedial Investigation Work Plan, Addendum No. 2, dated August 12, 2016 (Atlantic Richfield, 2016k).

2.2.6 Floodplain Soil

Potential exposures to floodplain soils that were potentially impacted by mine activities are being investigated within riparian floodplain areas along Aspen and Leviathan creeks within the On-Property Study Area and along Leviathan and Bryant creeks in the DSA portion of the Off-Property Study Area. Mapping of floodplain soils located adjacent to and near the active stream channels indicate frequent obvious relative differences in depositional sequence and composition. As a result, floodplain soils have been categorized into three general age classes based on relative differences in depositional sequence and composition.

Floodplain soil sampling was performed for soils in each of the three general age categories along transects adjacent to active stream channels. Soils were sampled to a depth of 6 feet or to a depth where refusal is encountered due to presence of bedrock or other native geologic materials. Soil samples were analyzed for RI/FS metals, TOC, and grain size distribution. In addition, floodplain soil sampling is being conducted for Reference Study Areas along Cottonwood and Mountaineer creeks to provide data for comparison to on-property and off-property reaches that were potentially impacted by the Leviathan Mine.

Details of the floodplain soil sampling are described in the following work plan documents:

- Revised Off-Property Focused Remedial Investigation Work Plan Addendum No. 2 dated June 28, 2013 (AMEC, 2013c).
- Revised Off-Property FRI Work Plan Addendum No. 2, Amendment No. 1, Confirmation Sampling of Age-Category 3 Floodplain Soil, June 28, 2014 (Atlantic Richfield, 2014c).
- On-Property Focused Remedial Investigation Work Plan Amendment No. 8, Detailed Stream Sediment and Floodplain Soil Investigations (Draft Final), March 13, 2015 (Atlantic Richfield, 2015c).
- On-Property Focused Remedial Investigation Work Plan Amendment No. 10, Revision No. 3 - Stream Sediment and Floodplain Soil Characterization in Beaver Dam/Pond Complex in On-Property Reach of Leviathan Creek, letter from Atlantic Richfield dated September 30, 2015 (Atlantic Richfield, 2015d).
- Revised Off-Property Area Focused Remedial Investigation Work Plan, Addendum 2 – Task Sampling and Analysis Plan for Floodplain Sampling in Downstream Study Area, Leviathan Mine Site, Alpine County, California, March 25.
- Final Reference Study Area Focused Remedial Investigation Work Plan, dated January 19, 2017 (Atlantic Richfield, 2017a).

2.2.7 Plants

Potential uptake and accumulation of metals in terrestrial and aquatic plants was investigated in On-Property, Off-Property, and Reference Study Areas. A general approach for plant sampling was previously described in work plans for these study areas. A initial FRI work plan for plants had only addressed on-property sampling (Atlantic Richfield, 2015e) and was superseded by a combined refined work plan for plant and habitat-related sampling for the On-Property, Off-Property and Reference Study Areas and submitted to U.S. EPA for review and approval on April 8, 2016 (Atlantic Richfield, 2016b).

2.2.8 Fish

Potential uptake and accumulation of metals in fish tissues was investigated in On-Property, Off-Property, and Reference Study Areas. A general approach for fish surveys and sampling was previously described in various work plans for these study areas in coordination with the Natural Resources Damages Trustees for the Leviathan Mine Site. Fish surveys and sampling were conducted in Aspen, Bryant, Leviathan, and Mountaineer creeks in 2013. In consideration of these data and the need for more comprehensive information on fish surveys and tissue concentrations, work plans for additional fish surveys and tissue sampling were developed. The approach for these additional fish surveys and sample is outlined in:

- On-Property, Off-Property Area, and Reference Area Focused Remedial Investigation Work Plans – Task Sampling and Analysis Plan for Fish Investigation (Draft Final) dated June 13, 2016 (Atlantic Richfield, 2016f).

2.3 DATA MANAGEMENT

Data management consists of two steps: reviewing data quality and assessing data adequacy.

2.3.1 Data Quality

Analytical data from the RI/FS will be evaluated in terms of usability for the BHHRA. The data quality evaluation will be performed in the TDSRs and will be summarized in the BHHRA. The evaluation for the BHHRA will be documented using the criteria provided by the U.S. EPA in the *Guidance for Data Usability in Risk Assessment (Part A), Final* (U.S. EPA, 1992). The U.S. EPA criteria include the following:

- **Reports** – confirmation that report(s) relied upon are complete and appropriate for use in the BHHRA.
- **Documentation** – confirmation that each analytical result is associated with a specific sample location and that the appropriate sampling procedure is documented.
- **Data Sources** – confirmation that the analytical methods used are appropriate to identify the analytes for the medium of interest.
- **Analytical Methods and Detection Limits** – confirmation that analytical methods appropriately identify the chemical form or species and that the sample detection limit is at or below a concentration appropriate for the risk assessment application.
- **Data Review** – confirmation that the quality of analytical results is assessed by a professional knowledgeable in field collection procedures and analytical chemistry and that data quality are adequate to estimate exposure concentrations. The data review process is specified in the *Quality Assurance Project Plan* and will be documented in the TDSR for each media (QAPP; Atlantic Richfield, 2017b).

- **Data Quality Assessment** – documentation that sampling and analysis data quality indicators (including completeness, comparability, representativeness, precision, and accuracy) are evaluated using criteria appropriate for human health risk assessment. This step will also be conducted consistent with the QAPP (Atlantic Richfield, 2017b) and will be documented in the TDSR for each media.

The results of these activities will be summarized in the BHHRA to clearly identify the data set of sufficient quality used in the BHHRA.

Results from FRI sample collection will be provided in an electronic format by the laboratories and uploaded into the project database. Previous data sets collected for the site (prior to the RI/FS) will be used to provide context for the evaluation but will not be used directly in the risk assessment because many of the data sets are more than 10 years old and do not reflect current conditions at the site (e.g., historic surface water data), and the data has not been part of the data quality review process identified in the RI/FS QAPP for this project. These historical data will be summarized in the TDSRs, and to the extent they indicate conditions different from those evaluated in the BHHRA and are not reflective of simple changes in conditions over time, they will be discussed in the uncertainty section of the BHHRA.

2.3.2 Data Adequacy

Once data sets of sufficient quality for a BHHRA have been identified, the adequacy of the data for conducting the BHHRA will be evaluated. For example, it is possible that some data may be eliminated based on quality issues, with a final result being that insufficient data is available for conducting the BHHRA for a particular RI/FS metal, medium, or data evaluation unit (e.g., a specific reach within Bryant Creek). These data gaps are being identified during iterative data review and resolved by the project team. Some options for addressing the data gaps are to collect additional data or use other appropriate data to evaluate the media (e.g., combining data across data evaluation units). These issues will be addressed in the TDSRs.

2.4 HAZARD IDENTIFICATION

Sample data collected for the Leviathan Mine site will be considered in the evaluation of potential health affects to current and future receptors. The FRI Work Plans outline the specific data to be collected as part of the RI/FS process. Data evaluation will include the examination of topography, surface water flow, sampling locations, COPC concentrations, and potential for exposure. The sampling results will be summarized and discussed by medium and by study area, as follows:

- terrestrial soil (e.g., mine waste, floodplain, ore piles, River Ranch soil and/or Leviathan Mine Road);

- surface water;
- groundwater;
- sediment; and
- biota (e.g., plants and aquatic organisms, which may be further subdivided as appropriate).

2.5 INITIAL ANALYTE LIST

U.S. EPA's SOW identified 19 parameters[5] to be considered as potential contaminants of concern (COCs) (U.S. EPA, 2008a). In April 2010, the U.S. EPA requested that Atlantic Richfield review the list of potential COCs listed in the SOW to identify the appropriate analyte list to be used in the RI. In response, Atlantic Richfield (2010b) developed a proposed RI/FS metal list through a multi-step process that considered the following:

- the history of mining activity at the Leviathan Mine,
- federal and state lists of target compounds for mining sites,
- statistical comparisons of sediment concentrations below the Leviathan mine to those in sediments collected from comparable non-impacted streams,
- toxicity criteria published by state and federal environmental agencies, and
- the list of 19 potential COCs contained in the UAO SOW.

Based on the evaluation procedures, a total of 20 metals were identified as RI/FS metals for further RI/FS sampling at Leviathan Mine. Additional constituents not included in the U.S. EPA's SOW that were added as RI/FS metals are antimony, barium, chromium VI, and silver. Constituents from the U.S. EPA's listing in the SOW that were excluded are pH, ferric and ferrous sulfate, total sulfate, and sulfuric acid. Although not identified here as RI/FS metals, additional parameters (e.g., sulfate and other general mineral parameters) have been measured in some of the RI/FS samples to assist in interpreting the geological, geochemical, or biological significance of the characterization results. As directed by U.S. EPA, the RI/FS analyte list will be used as the list of COPCs for evaluation in the human health risk assessment.

The RI/FS metal list of 20 COPCs is as follows:

[5] pH was also included as an analyte in EPA's SOW but is not considered a chemical of potential concern.

- ☐ aluminum
- ☐ antimony
- ☐ arsenic
- ☐ barium
- ☐ beryllium
- ☐ cadmium
- ☐ chromium
- ☐ chromium VI
- ☐ cobalt
- ☐ copper
- ☐ iron
- ☐ lead
- ☐ manganese
- ☐ mercury
- ☐ nickel
- ☐ selenium
- ☐ silver
- ☐ thallium
- ☐ vanadium
- ☐ zinc

2.6 Comparison to Reference Data

RI/FS metals concentrations in potentially affected study areas (site data) will be compared to relevant reference-area concentrations in comparable media as described in the Reference Area Work Plan (Atlantic Richfield, 2017a). This comparison will be documented in media-specific TDSRs as described in Section 1.1.4.

The process of developing reference data sets for comparison to site data and for use in risk assessments will vary somewhat by media, but will follow this general process using ProUCL software (Version 5.1.002; updated June 20, 2016) (U.S. EPA, 2016c):

1. Reference data for each medium for each metal will be evaluated using quantile (Q-Q) plots to assess the distribution of the data, potential for outliers, and potential for multiple data populations. Only reference data sets with more than 4 detected values and a frequency of detection greater than 10 percent will be considered adequate for statistical analysis (U.S. EPA, 2016c). If these criteria are not met, a qualitative evaluation of the reference data will be conducted.

2. Reference data for each medium for each metal will be evaluated for potential outliers. Outliers will be removed from the data set to develop reference (background) concentrations.

3. If multiple populations are apparent in the quantile plots (inferred from observation of inflection points in the quantile plots), the underlying source of the different populations will be evaluated (e.g., high/low flow, channel type). If data are normally distributed, the classic parametric analysis of variance (ANOVA) will be conducted to characterize groups of samples that appear to constitute independent populations. If

the data do not follow a normal distribution, a non-parametric one-way ANOVA test will be conducted. This may occur for one or more metals in the reference data set.

4. If ANOVA is performed, reference area samples will be grouped based on results of ANOVA evaluation to create multiple reference data sets for RI/FS metals. Professional judgment may be used to highlight one of the groups within a medium as more appropriate reference data set than another. For example, there may be one reference data set for all surface water for some metals and two separate reference data sets for other metals where variation with surface water flow (i.e., seasonal) is important. If differences are based solely on location, the locations will be evaluated to assess which location is more appropriate as a reference for Leviathan Mine site or if all the reference data spans the range of relevant reference concentrations. If the number of reference area samples is less than 10 for a specific group, the sample distribution will be evaluated to assess whether additional samples may be necessary.

5. ProUCL will be used to calculate a background threshold value (BTV) for reference concentrations for each group of reference samples using the underlying distribution of the specific data. The BTV will be the 95 percent upper simultaneous limit (USL) as calculated by ProUCL because we are planning to make multiple comparisons of site data to the BTV and may frequently have more than 10 to 15 samples in the background data set (U.S. EPA, 2016c). Alternatives to the USL will be considered if these assumptions do not apply. If the data set consists of more than one distribution, the 95 percent USL for each appropriate distribution will be calculated and the largest 95 percent USL among the distributions will be used as the BTV.

For the purpose of comparing data collected at the Leviathan Mine Site (site data) to reference data, the following general process will be followed:

1. Site data will be plotted using quantile plots for each spatial area to be evaluated (e.g., stream reach). Only site data sets with more than 4 detected values and a frequency of detection greater than 10 percent will be considered adequate for statistical analysis (U.S. EPA, 2016c). If these criteria are not met, a qualitative evaluation of the reference and site data will be conducted.

2. If multiple distributions appear possible for site data, conduct ANOVA for those RI/FS metals within each stream reach considering the grouping created for reference data (e.g., all surface water data, two groups representing high and low flow conditions).

3. The maximum and 95th percentile concentrations for each group of site data will be compared to the corresponding BTV for the reference data set. If the maximum and/or the 95th percentile concentrations are less than the corresponding BTV for reference data, the site data will be considered consistent with reference data (U.S. EPA, 2016c). If the estimated 95th percentile concentration is greater than the maximum concentration and is higher than the reference concentration, the samples driving the higher 95th percentile concentration for the site data will be evaluated as potential outliers and spatial variation within the data set will be considered.

4. If the maximum or 95th percentile concentrations for site data exceed the BTV for the reference data set, site data and reference-area data will be compared using the Wilcoxon Mann Whitney test (detections in greater than 60 percent of both sample sets with consistent detection limits) or the Gehan test (less than 60 percent detection frequency in one or both data sets and/or multiple detection limits) (U.S. EPA, 2016c). These tests are nonparametric statistical tests used to identify differences between population distributions. By comparing the relative ranks of the two data sets, the tests determine which data set is higher and whether the difference is significant. Advantages to using these tests are that (1) the two data sets are not required to be from known distributions or from the same distribution; (2) the tests can compare populations with unequal sample sizes; (3) the tests allow for non-detect measurements to be present in the data sets by treating them as ties; and (4) the tests limit the influence of outliers because the analysis utilizes data ranks instead of the actual measured concentrations (U.S. EPA, 2016c).

The results of the process described above will be used to identify RI/FS metals in site samples that are consistent with or different from reference data. The results of this comparison will be presented in the TDSRs and the Site Characterization report and conclusions summarized in the BHHRA. However, as required by U.S. EPA, all 20 RI/FS metals will be retained as COPCs at the site for the BHHRA. Reference sampling results will be evaluated in parallel with site results so cumulative risks and hazard indexes can be compared between potentially affected areas of Leviathan Mine and reference areas.

3.0 EXPOSURE ASSESSMENT

Exposure assessment involves the identification of the potential human exposure pathways at the site for present and potential future-use scenarios. The identification of potential human receptors is based on the characteristics of the site, the surrounding land uses, and the reasonably anticipated future land uses. Present conditions are as they exist today and future conditions are based on reasonably likely land uses in the future. OSWER Directive 9355.7-4 on land use in the CERCLA remedy selection process states that remedial action objectives developed during the RI/FS should reflect “reasonably anticipated future land use or uses.” The directive identifies key factors to be considered in determining a reasonably anticipated future land use, including current land use, zoning maps, population growth patterns, and historical development patterns. In addition, land ownership, access rights, and legal restrictions on consumptive use of fish and wildlife, including license requirements, seasons, and bag limits, will be considered in evaluating exposure.

3.1 SITE CHARACTERISTICS

The Leviathan Mine property is currently fenced, with locked gates at the entrances of the access roads from the north and south (Leviathan Mine Road). Access to on-property areas is likely to remain restricted to site workers in the future. During the winter months, potential

access is further limited because of snowpack, such that a standard four-wheel-drive vehicle typically cannot reach the mine property on the dirt access roads covered with snow. Access to the area, including the former mine operations, during the winter months typically requires the use of snowcats, snowmobiles, or other alternative transportation.

Off-property areas are primarily administered by the U.S. Forest Service. Physical or proprietary controls do not currently prohibit access to these areas, although access typically is limited during the winter months by heavy snow accumulations, and residential occupation is generally prohibited on Forest Service lands. The nearest private properties are parcels near the southern mine entrance.

Because of state and federal ownership and the involvement of the LRWQCB in future remedial activity, future land use is not anticipated to change materially at Leviathan Mine or in the area surrounding the Leviathan Mine.

3.2 CONCEPTUAL SITE MODEL FOR BASELINE HUMAN HEALTH RISK ASSESSMENT

Exposure pathways link the sources, locations, types of environmental releases, and environmental fate and transport with receptor locations and activity patterns. Exposure pathways identified initially in the CSM will be updated if information gathered during the RI suggest that modifications are necessary. Generally, an exposure pathway is considered complete if it consists of the following four elements:

- a source and mechanism of release (Section 3.2.1);
- a transport mechanism (Section 3.2.2);
- a receptor (Section 3.2.3); and
- an exposure point (i.e., point of potential contact with a contaminated medium) and an exposure route (e.g., ingestion) at the exposure point for a specific receptor (Section 3.2.4).

Current and reasonably anticipated potential future-use scenarios will be evaluated. Figure 2 presents the updated preliminary CSM for the site, and Table 1 summarizes exposure pathways in a tabular format based on U.S. EPA guidance (U.S. EPA, 2001). Table 1 is organized according to the receptors identified in Section 3.2.3. Figure 2 was revised to clarify and incorporate new information into the CSM since the BHHRA Work Plan was submitted to EPA for review.

As data and information about the site is collected and evaluated, the CSM may be modified. The final CSM will be presented in the final BHHRA report. A comprehensive descriptive of the programmatic CSM is provided in the RI/FS QAPP (Atlantic Richfield, 2017b).

3.2.1 Chemical Sources

The primary sources of COPCs at the site are overburden/waste rock and naturally occurring mineralized rock that generate AD when exposed to precipitation and/or groundwater. Overburden refers to largely non-mineralized soil/rock that was removed to obtain access to the ore rock. Waste rock refers to partially mineralized rock that was discarded at the Leviathan Mine and not shipped off site for processing. The mine property consists of remnant underground mine structures such as the Adit and an open pit mine that exposed naturally occurring rock to oxygen and water. Reclamation activities and construction of ponds and other surface water management structures have altered the flow of surface water and groundwater through naturally occurring mineralized soil/rock and accumulated overburden and waste rock.

The high sulfide content of the waste rock and exposed rock results in aqueous acidic discharges (pH between 2 and 5) as water percolates through the rock to groundwater and discharges to surface water. Groundwater and surface water with a low pH will result in the increased solubility of metals. Without treatment, the metals tend to move with the surface water and can be deposited in sediments as pH increases. Known mine-related discharge areas include the CUD, the Aspen Seep, the Delta Seep, the PUD, and the Adit.

Waste rock and overburden exist at various locations on the mine property. Some of this material reportedly was used for dust control and stabilization on Leviathan Mine Road, although this has not been confirmed. An estimated 22 million tons of waste rock/overburden was removed from the pit and placed elsewhere on the mine property (Brown and Caldwell, 1983). Since 1983, some of this material has been regraded, used for constructing foundations for the evaporation ponds, or placed back into the pit. More recently, Atlantic Richfield estimated the volume of waste rock and overburden in the mine waste pile based on spatial modeling to be approximately 13,550,000 cubic yards (Atlantic Richfield, 2016c).

3.2.2 Fate and Transport

There are a number of mechanisms by which COPCs identified at the Leviathan Mine can migrate to other areas or to other media. These mechanisms are described in the Programmatic CSM provided with the RI/FS QAPP (Atlantic Richfield, 2017b). The relevance of these mechanisms to the site is discussed below.

- **Leaching (Infiltration)** – Infiltration of precipitation, melted snowpack, and water stored or conveyed in man-made structures through the mine property, including mine tunnels, to groundwater may be a potential release mechanism for COPCs to shallow groundwater. Precipitation and snowmelt in contact with the mine property may become AD.

- **Groundwater Transport** – In the conceptual hydrogeologic model for the site, it is assumed that the majority of shallow groundwater from the Leviathan Mine ultimately discharges to Leviathan and Aspen Creeks. The discharge of groundwater to surface water will be evaluated further in the water balance for the site.

- **Surface Water Runoff** – Surface water runoff resulting from precipitation events may create AD when it contacts soil or rock, waste rock, or overburden and then migrates to Aspen and Leviathan creeks. Several interim remedies are in place, as described in the PWP, to mitigate the volume of untreated AD that reaches the local creeks. The low pH of AD can result in dissolution of metals into water from rock and sediment. Increases in pH can result in deposition of metals transported by surface water to sediment.

- **Erosion** – Soil, overburden, and waste rock at Leviathan Mine may be physically mobilized in runoff as entrained sediment during higher-volume precipitation events and may be deposited in creeks. Metals present in these materials may dissolve in surface water, depending on the pH of the runoff.

- **Deposition of Sediment** – Sediment may be deposited along the banks of creeks during high flow events and become accessible as floodplain soil.

- **Biotic Uptake** – COPCs identified at the site may be found in plants, aquatic organisms (including fish and benthic invertebrates), and wildlife that contact soil, surface water, and sediment affected by COPCs.

- **Fugitive Dust Generation** – Fugitive dusts may be generated from the waste rock/overburden at the Leviathan Mine, floodplain soil in the DSA, and along limited portions of Leviathan Mine Road. Historical floodplain deposits may also generate fugitive dust.

- **Volatilization** – Mercury in its elemental state is considered semi-volatile and may be volatilized from soil or surface water to ambient air. However, mercury at the site is anticipated to be primarily in a mineralized, inorganic form, which is significantly less volatile. Measurements of mercury concentrations in air at ground surface in mineralized areas indicate that mercury concentrations in air "did not pose a threat to human health" (Gustin et al., 2003). These measurements were conservative, as they did not adequately consider mixing with ambient air for typical human exposure. Additionally, the Leviathan Mine is not considered to be the source of mercury in streambed sediments (Bevans et al., 1998). As such, potential exposure to mercury via volatilization is not considered significant. If identified as a COPC, mercury will be evaluated via inhalation of fugitive dusts (see above).

3.2.3 Potential Receptors

The identification of potential human receptors is based on the characteristics of the site, the surrounding land uses, and the reasonably anticipated future land uses (Section 3.1). The following receptors will be evaluated in the BHHRA (including On-Property Study Areas, Off-Property Study Areas, and/or SSAs). Appendix A provides a more detailed description of the receptors and assumptions regarding exposure.

- **Current/Future On-Site Trespasser** – Although access to the Leviathan Mine property is restricted by fences with locked gates at the roadways, an adult trespasser could conceivably access the mine on foot as it is a large area that is not always monitored or occupied. The Current/Future Trespasser is assumed to be present for up to one week in a single year before being identified and removed by site personnel. The likelihood and duration of this exposure scenario is limited by the restricted roadway access, winter weather conditions, the remote location, periodic activities related to remediation, and public access to alternative areas outside the mine operations area. There is no difference anticipated for potential exposure for this receptor from current to future conditions.

- **Current Off-Property ATV Rider** – Areas beyond the access-control fencing appear to have been used by ATVs. Potential exposure of an adult ATV rider will be evaluated in these off-property areas. The Current Off-Property ATV Rider is assumed to be an adult who is present at the site for 52 days per year, one visit per week for the year. We anticipate that this receptor would be at least 7 years old and as such will be evaluated as an adult from 16 to 42 years old (26-year exposure period).

- **Current Off-Property Recreational Visitor** – Areas beyond the access-control fencing could be accessed by a Recreational Visitor for hiking, camping, hunting, and fishing. Potential exposures related to off-road vehicle use will be addressed by the ATV rider receptor describe above. Previous assessments of a Recreational Visitor at the site by the California Department of Health Services performed on behalf of the Agency for Toxic Substance Disease Registry within the U.S. Department of Health and Human Services (ATSDR; 2003) and Gradient (2002) for the East Fork of the Carson River indicate that these activities are most likely during the summer months, when access to the area is not limited by snow and potential exposure is higher because warmer temperatures reduce the amount of clothing worn. The Current Recreational Visitor is assumed to be present in the area for up to two weeks per year. We also anticipate that this scenario would address potential occupational exposure for U.S. Forest Service personnel or for users of an off-site recreational cabin that may occasionally visit the off-property portions of the site. This receptor scenario includes both a child exposure (1 to 6 years) and adult exposure (7 to 26 years), assuming the same person returns annually to the same camp site for a 2-week vacation.

- **Current/Future Off-Property Forager** – A Washoe Tribe Member or others could forage in the unrestricted off-property areas of the site periodically. Current/Future Foragers are conservatively assumed to access off-property portions of the site

periodically for a total of 60 days per year. Both adults and children are assumed to be Current/Future Foragers. Consumption rates for a forager are lower than those assumed for a Subsistence Washoe Tribe Member to represent the less intensive use of the area for sustenance.

- **Future Off-Site Rancher (River Ranch SSA)** – During past agricultural growing seasons, water from Bryant Creek was diverted for irrigation purposes to the River Ranch property, which was historically used for a cattle operation (Robison Engineering, 2008). The surface water diversion (River Ranch irrigation channel) is located immediately downstream of the Doud Springs inlet into Bryant Creek. The diversion is approximately 7.8 miles downstream from the Mine property and is located on the west side of Bryant Creek. This diversion channel, which appears to be unlined and runs for approximately 2 to 3 miles before reaching the River Ranch (south irrigation area), was used for agricultural irrigation on the River Ranch. Livestock pastured on the River Ranch could have fed on grass grown with the diversion water. Another diversion from Bryant Creek is located about 0.25 miles above the mouth of Bryant Creek as it enters the East Fork of the Carson River. This diversion was used to irrigate River Ranch pasture land to the north of Bryant Creek (north irrigation area), along the East Fork of the Carson River (ATSDR, 2003). During the site walk in June 2007, it was evident that water was not being diverted from Bryant Creek for pasture irrigation, and cattle grazing was not occurring. Subsequent field observations as recent as 2014 by Amec Foster Wheeler staff suggest water diversion and grazing are not currently occurring. It is uncertain whether ranching activities will resume. Water diverted from Bryant Creek was used for flood irrigation of pastures, but to our knowledge not as a water supply for the ranch or used for growing plants for human consumption. A landslide, breach and road crossings have made the canal diverting water from Bryant Creek unusable for directing water to River Ranch. Potential uptake of RI/FS metals in soil by plants will be estimated based on uptake from soil using soil sample results at the River Ranch property. Even if water from Bryant Creek was used to irrigate plants, the residual concentrations in the soil are the primary source of COPCs for uptake by the plants.

  The Future Off-Site Rancher is conservatively assumed to reside on the ranch property for 350 days per year and assumed to consume beef raised on the ranch (although it has not been documented that this occurred). This scenario is listed as a "future" potential exposure scenario because ranching operations are not currently occurring and the buildings on the property are in disrepair and not currently livable. Although full-time residential use of the ranch property is assumed for the rancher, it is likely that ranch personnel would only be present seasonally when active cattle management is necessary. A spring has been observed at the site and water conveyance pipes from the irrigation channel have not been observed. These observations suggest that water for consumption by cattle and people living at the ranch did not come from the irrigation channels, so water consumption and domestic water use are not considered complete exposure pathways for this scenario. To conservatively define this potential exposure scenario, we have assumed that the ranch personnel could have children that would be exposed via the same exposure pathways as the Future Off-Site Rancher.

- **Current/Future Off-site Resident (ore piles and Leviathan Mine Road SSAs)** – Residences are located near Leviathan Mine Road where it intersects with Route 395. Two suspected ore piles have been observed in this area, and overburden and waste rock may have been used historically for limited road base construction (Figure 1). The question of whether waste rock was used this distance from the active portion of the mine is being evaluated as described in the Off-Property FRI Work Plan and related addenda. Potential exposure may occur if windblown dust from the ore piles or Leviathan Mine Road accumulates at the residences. Residents are assumed to be present for 350 days of the year (U.S. EPA, 2014). Both adults and children are assumed to be Current Off-Site Residents. There is no difference anticipated for potential exposure for this receptor from current to future conditions.

- **Future On-Property/Off-Property Subsistence Washoe Tribe Member** –The Washoe Tribe has developed a hypothetical reasonable maximum exposure (RME) scenario for future use of the Pine Nut Allotments downstream of the site (Figure 1; AESE, 2005a, 2005b). These exposures do not occur currently (i.e., no one currently lives on the Pine Nut Allotments near Bryant Creek), but hypothetically this scenario could occur in the future. The hypothetical RME scenario assumes that a tribe member lives a subsistence lifestyle with family somewhere within the Bryant Creek drainage downstream of the Leviathan Mine site (Walker Research, 2003). Therefore, for purposes of the BHHRA, the most probable location of the hypothetical tribe member residence is assumed to be in the farthest upstream available allotment (AESE, 2005a) (Figure 1). Land ownership and use restrictions prevent a tribe member from constructing a home and living a subsistence lifestyle on the state-owned portion of the Leviathan Mine site or on U.S. Forest Service land. It is likely that the state of California and the U.S. Forest Service will retain ownership of the Leviathan Mine property and surrounding areas, and that a residence could not be built in the future on the mine property or on U.S. Forest Service land. However, as required by EPA, the BHHRA will evaluate exposure risk for Subsistence Washoe Tribe Members assumed to be living anywhere on affected areas of the Leviathan Mine site, either on- or off-property. The proposed subsistence lifestyle scenario includes a home garden, raising livestock (beef will be used as a surrogate for all livestock), using wood for fuel, no paved areas, and a surface water source of drinking water from the nearest creek in the related study area. Potential exposure would be driven by location-specific concentrations for exposure media (e.g., soil, drinking water, plants). A Future Subsistence Washoe Tribe Member is conservatively assumed to be present at the specific location for 365 days per year. Both adults and children are assumed to be present.

- **Future On-Property Forager** –The differences between the Current/Future Off-Property and Future Off-Property Forager scenarios are spatial and temporal. Current/Future Off-Property Foragers are assumed to access only the DSA because access to the Leviathan Mine property is currently restricted by fencing. Although access to the entire mine property is likely to remain restricted, the future exposure scenario assumes non-subsistence, foraging use of the ACSA, PSA, and LCSA (excluding areas where remedial activities are occurring and/or where institutional controls are in place). Similar to the Current/Future Off-Property Forager, exposure is assumed to occur over 60 days per year. Restrictions against on-property access are reasonably likely to continue, and enforceable proprietary controls will likely be

implemented, but these will be discussed in the FS and are not considered for the BHHRA.

- **Future On-Property Recreational Visitor** – Similar in duration to the Current Recreational Visitor, this receptor may access on-property mine operation areas that are currently fenced (excluding areas where remedial activities are occurring and/or where institutional controls are in place) for up to two weeks, assuming access is no longer restricted by fencing. These activities are limited to the summer months when access to the area is not limited by snow and potential exposure is higher because warmer temperatures reduce the amount of clothing worn. We anticipate that this scenario would address potential occupational exposure for U.S. Forest Service or LRWQCB personnel or occasional visits by persons from a nearby recreational cabin. This scenario includes both a child exposure (1 to 6 years) and adult exposure (7 to 26 years), assuming the same person returns annually to the same camp site for a 2-week vacation. As with the Future On-Property Forager scenario, restrictions against on-property access are reasonably likely to continue, and enforceable proprietary controls will likely be implemented, but these will be discussed in the FS and are not considered for the BHHRA.

- **Future On-Property ATV Rider** – The Future On-Property ATV Rider is assumed to be an adult who is present at the site for 52 days per year, one visit per week for the year. We anticipate that this receptor would be at least 7 years old and as such, will be evaluated as an adult from 16 to 42 years old (26-year exposure period). As with the Future On-Property Forager scenario, restrictions against on-property access are reasonably likely to continue, and enforceable institutional controls will likely be implemented, but these will be discussed in the FS and are not considered for the BHHRA.

3.2.4 Exposure Points and Routes

Based on the COPCs, affected media, and migration pathways discussed above, points of potential human contact with site-related COPCs include primary environmental media (soil, surface water, and sediment) and secondary media (related to one or more primary media, including air, plants, aquatic organisms, wildlife, and cattle).

- **Soil** – Soil exposure addresses exposure to mine waste, floodplain soil, River Ranch soil, ore piles, and/or Leviathan Mine Road. Potential exposure routes associated with COPCs in soil include direct and indirect exposure routes. Direct exposure routes include incidental ingestion, dermal contact, and inhalation of airborne particulates. Indirect exposure routes include ingestion of plants, cattle, and wildlife where biota has been affected by COPCs in soil.

- **Groundwater** – In the Basin Plan (LRWQB, 2015), groundwater within the Carson River Hydrologic Units (including Leviathan Mine) is designated for beneficial use as a domestic water supply. So for the purpose of the BHHRA, groundwater is considered a potential exposure medium, although this would require a groundwater well to be installed on-property. Potential groundwater exposure will be assumed for the Future Subsistence Washoe Tribe Member. Either groundwater or surface water

will be used as a domestic water supply for a specific scenario, but not both simultaneously. Direct exposure routes include ingestion and dermal contact. Surface water exposure will be used to assess potential exposure related to groundwater discharging to surface water.

- **Surface Water** – Surface water exposure points may consist of separate stream segments (data evaluation units) or study areas that are evaluated independently according to differences in concentrations, sample distributions, and confluences with other streams. Variations in water depth and stream segment morphology may affect the extent of surface water exposure, particularly via dermal exposure and incidental ingestion associated with swimming and wading. Potential exposure routes applicable to COPCs in surface water include direct and indirect exposure routes. Direct exposure routes include ingestion and dermal contact. Indirect exposure routes include ingestion of plants, aquatic organisms, and wildlife where these media have been exposed to COPCs in surface water.

- **Sediment** – Similar to surface water, sediment exposure points may consist of separate stream segments or study areas that are evaluated independently according to differences in concentrations, sample distributions, and confluences with other streams. Potential exposure routes applicable to COPCs in sediment include direct and indirect exposure routes. Direct exposure routes include incidental ingestion and dermal contact. Indirect exposure routes include ingestion of aquatic plants, aquatic organisms, and wildlife where these media have been exposed to COPCs in sediment.

3.2.5 Exposure Pathways

Given the characteristics of the COPCs of interest and release processes discussed above, this section describes the potential exposure pathways for current and future land use at the site by each identified receptor.

- **Current/Future On-Property Trespasser** – A Current/Future On-Property Trespasser could potentially be exposed directly to mine waste or floodplain soil via incidental ingestion, dermal contact, and inhalation of airborne particulates; however, floodplain soil exposure pathways are considered only potentially complete pending data evaluation. The Current Trespasser could also consume plants and wildlife exposed to soil.[6] Where surface water is present, this receptor potentially could be exposed directly to COPCs in surface water and sediment via dermal contact (during swimming[7] or wading) and incidental ingestion. Also, this receptor could ingest aquatic organisms, plants, and wildlife potentially affected by COPCs in surface water, soil and/or sediment.

- **Current/Future Recreational Visitor** – The Current Off-Property Recreational Visitor and Future On-Property Recreational Visitor have the same exposure

[6] The specific plants that may be consumed have been identified based on a biological survey of the study areas and information provided by the Washoe Tribe. The specific plants to be sampled were identified in the plant and habitat-related soil investigations (Atlantic Richfield, 2015b).

[7] Swimming will only be considered applicable if an area of pooled water more than three feet deep is identified.

pathways. A Recreational Visitor could potentially be exposed directly to COPCs in surface water and sediment via dermal contact (during swimming or wading) and incidental ingestion. This receptor could ingest aquatic organisms, plants, and wildlife potentially affected by COPCs in surface water and sediment. This receptor potentially could be exposed directly to COPCs in mine waste (future only) and floodplain soil via ingestion, dermal contact, and inhalation of airborne particulates, as well as via ingestion of plants and wildlife exposed to soil; however, floodplain soil-related pathways are considered only potentially complete until additional data is collected.

- **Future Off-site Rancher (River Ranch SSA)** – A Future Off-Site Rancher could potentially be exposed to COPCs in soil directly or that may bio accumulate from soil in the cattle. COPCs may have accumulated in the soil over time resulting in the potential for direct contact exposure and inhalation of airborne particulates. Exposure to sediment and surface water in the irrigation ditches via dermal exposure and incidental ingestion will be evaluated based on sediment samples in the ditch and COPC concentrations in Bryant Creek surface water. Due to the proximity of River Ranch to Bryant Creek, EPA has requested that we assume this receptor could be exposed to sediment and surface water in the creek, and may consume aquatic organisms and wildlife. This receptor may also be exposed via consumption of plants grown in soil at the River Ranch; however ingestion of Bryant Creek water for drinking will not be evaluated. Consumption of wildlife and consumption of cattle will be assessed independently, but not cumulatively.

- **Current Off-Site Resident** (ore piles and Leviathan Mine Road SSAs) – Although it is unclear whether waste rock and overburden from the site were used for construction of relevant portions of Leviathan Mine Road adjacent to the residential area, this pathway assumes that a Current Off-Site Resident could be exposed to windblown dust and dust from road traffic that originates on Leviathan Mine Road near the residential area. Additionally, this receptor addresses potential exposure to windblown dust from the two ore piles along Leviathan Mine Road. If the windblown dust has deposited over time, the Current Off-Site Resident could be exposed via direct contact with soil and ingestion of plants. This receptor is included specifically to address exposures at an off-site residence; other exposure pathways, such as ingestion of wildlife, are addressed by other receptors.

- **Current/Future Off-Property and Future On-Property Forager** – The Current/Future Off-Property Forager and Future On-Property Forager have the same exposure pathways. The Forager scenarios include direct exposure to COPCs in surface water and sediment via dermal contact (during swimming or wading) and ingestion. The Forager could potentially also be exposed directly to mine waste soil (future only) and floodplain soil via ingestion, dermal contact, and inhalation of airborne particulates. However, the floodplain soil exposure pathways are considered only potentially complete pending data collection. The Forager also could ingest aquatic organisms, plants, and wildlife potentially affected by COPCs in surface water, sediment, and/or soil.

- **Future On- and Off-Property Subsistence Washoe Tribe Member** – A Future On- and Off-Property Subsistence Washoe Tribe Member could potentially be exposed

directly to COPCs in surface water and sediment via dermal contact (during bathing, swimming, or wading) and ingestion in the off-property area. The Future Subsistence Washoe Tribe Member also could potentially be exposed directly to mine waste or floodplain soil via ingestion, dermal contact, and inhalation of airborne particulates; however, the floodplain soil exposure pathways are considered only potentially complete pending data collection. The Future Subsistence Washoe Tribe Member also could ingest aquatic organisms, plants, livestock, and wildlife potentially affected by COPCs in surface water, sediment, and/or soil.

- **Future On-Property and Current Off-Property ATV Rider** - A Future On-Property and Current Off-Property ATV Rider could potentially be exposed directly to COPCs in mine waste, floodplain soil, or Leviathan Mine Road/ore pile soil via ingestion, dermal contact and inhalation of airborne particulates; however, the floodplain soil exposure pathways are considered potentially completed pending review of sample results.

3.2.6 Exposure Scenarios by Study Area and Data Evaluation Unit

As discussed previously, the site has been divided into three main study areas (On-Property, Off-Property [DSA], and RSA) and four SSAs (River Ranch, ore piles, Leviathan Mine Road, and East Fork Carson River) to conduct the RI/FS. Additionally, the On-Property Study Area was divided into the LCSA, ACSA, and PSA. Exposure media within study areas may be subdivided into data evaluation units to evaluate potential human health risk. For example, Leviathan and Bryant creeks in the DSA may be subdivided into four stream reaches as described in the Off-Property FRI Work Plan for the BHHRA. Specific data evaluation units will be identified in the TDSRs for each media.

All receptors are not applicable to all study areas or data evaluation units; for example, the Current/Future Trespasser applies only to On-Property Areas. The specific receptors are not likely to remain in one data evaluation unit or study area for the duration of their exposure (e.g., Current/Future Trespassers can wander between data evaluation units or study areas). However, as a simple first step, risks will be evaluated within a data evaluation unit or study area assuming a receptor spent 100% of their time in a single area. Assumptions about fraction of exposure within a data evaluation unit or study area may also be considered after the initial evaluation and presented in TDSRs.

3.2.6.1 Study Areas

- **Pit Study Area** – The PSA is completely within the disturbed portion of the mine property and likely will be actively managed in connection with future remedial activities. The Pit Study Area is primarily composed of the mine pit (90 to 180 feet deep and 1890 feet across by 1190 feet wide with a generally steep slope to the bottom of the pit). This large, deep pit is not conducive to recreational activities or foraging. The Pit Study Area surrounding the pit itself has been disturbed by mining and remedial activities and is likely to remain in a similar condition for the

foreseeable future, such that it is not conducive to recreational or foraging activities in the same way that the riparian corridor near Aspen & Leviathan Creeks may be. Potential exposure will be evaluated for Current/Future On-Property Trespassers. However, as required by U.S. EPA, Future Recreational Visitors, Future ATV Riders, Future Subsistence Washoe Tribe Members and Future On-Property Foragers will also be considered to have access to the Pit Study Area. Figure 3 presents receptors and exposure pathways relevant to this study area.

- **Leviathan Creek Study Area** – The LCSA includes soil, sediment, and surface water as primary exposure media. Potential exposure for the following receptors will be evaluated for this area: Current/Future On-Property Trespassers, Future On-Property Recreational Visitors, Future ATV Riders, Future On-Property Foragers, and Future On-Property Subsistence Washoe Tribe Member. Figure 4 presents receptors and exposure pathways relevant to this study area.

- **Aspen Creek Study Area** – The ACSA also includes soil, sediment, and surface water as primary exposure media. Potential exposure for the following receptors will be evaluated for this area: Current/Future On-Property Trespassers, Future On-Property Recreational Visitors, Future On-Property ATV Riders, Future On-Property Foragers, and Future Subsistence Washoe Tribe Members. Figure 5 presents receptors and exposure pathways relevant to this study area.

- **Downstream Study Area** – By definition, the DSA is entirely beyond the on-property portion of the site (downstream of the confluence of Leviathan and Aspen Creeks). Potential exposure for the following receptors will be evaluated for this area: Current/Future Off-Property Recreational Visitor, Current/Future ATV Rider, Current/Future Off-Property Forager, and Future Off-Property Subsistence Washoe Tribe Member. Figure 6 presents receptors and exposure pathways relevant to this study area.

Preliminary comparisons of sampling data collected in the SSAs to screening levels indicates that the River Ranch property and the ore piles warrant further evaluation in the BHHRA. Further screening of the Leviathan Mine Road and the EFCR SSAs will be performed when additional sampling data collected in 2016 (including reference concentrations) are available. The exposure pathways relevant to specific receptors in SSAs (Future Off-Site Rancher, Current Off-Site Resident, and Current/Future ATV Rider) are presented on Figure 7.

3.2.6.2 Data Evaluation Units

Data evaluation units have been and will be selected so that the information gathered to represent them would support the decisions to be made. Human and ecological exposures and potential remedies were and will be considered in selection of the data evaluation units. Data evaluation units include definition of the area reasonably anticipated to be associated with each receptor and exposure scenario and for the BHHRA will be considered exposure areas. Technology limitations may similarly constrain definition of data evaluation units. Each data

evaluation unit will be carefully selected after weighing these various constraints. Data evaluation units will be presented in media-specific TDSRs and summarized in the BHHRA.

3.3 EXPOSURE QUANTIFICATION

The following paragraphs describe how exposure will be quantified for the exposure scenarios for the site. The assumptions and approaches to be used are consistent with RAGS guidance (U.S. EPA, 1989), including use of exposure scenarios that assume the "highest exposure that is reasonably expected to occur at the site."

3.3.1 Exposure Point Concentrations

The concentrations of COPCs at specific exposure points will vary over space and time. However, a single estimate of an EPC is required for risk assessment calculations as currently required by U.S. EPA guidance (U.S. EPA, 1989, 1992). This single value must be representative of the average concentration to which a person would be exposed over the duration of the exposure.

EPCs generally are estimated using either measured concentrations in environmental media or developed using fate and transport models. The EPCs for wildlife will be consistent with the approach used in the ecological assessment to the extent appropriate. Site-specific measurements of tissue concentrations for fish will be preferred to estimations based on literature uptake factors. Site-specific uptake factors from soil are being developed to address plant concentrations as described in the work plans for plant and habitat-related soil sampling for the On-Property, Off-Property, and Reference Study Areas (Atlantic Richfield, 2016b). EPCs for cattle will be developed from soil concentrations using California's Office of Environmental Health Hazard Assessment guidance (OEHHA, 2015). EPCs will be developed and presented in media-specific TDSRs.

Independent EPCs will be developed for each medium within each data evaluation unit or study area as appropriate. In some cases, it may make sense to combine data from several data evaluation units, and in other cases, data within a single data evaluation unit may require separate evaluation (e.g., identification of a hot spot). For example, if some of the data for a data evaluation unit is rejected based on quality assurance/quality control (QA/QC) issues, but an adjacent data evaluation unit has similar concentrations, the data sets may be combined to provide sufficient data for statistical evaluation.

In addition, EPCs will be developed for COPCs in the reference-area data set for each medium evaluated in the BHHRA. The purpose of developing reference-area EPCs is to evaluate potential chemical exposure based on existing conditions in similar areas that are unrelated to

the site. The EPCs for the reference-area data set will be carried through the risk calculations separately but in the same manner as the EPCs for site media to develop estimates of potential health risks specific to the reference areas. The potential health risks specific to the reference areas can then be compared with health risks from environmental media at the site.

Consistent with U.S. EPA guidance (U.S. EPA, 2002b), EPCs will be based on the 95 percent upper confidence limit (95% UCL) of the mean to estimate a reasonable maximum exposure scenario for each data evaluation unit. U.S. EPA's ProUCL software (Version 5.0.002; U.S. EPA, 2016c) will be used to develop 95% UCLs based on the distribution of the data for each chemical. This software considers non-detect values in the development of the 95% UCL. In the event that the calculated 95% UCLs exceed the maximum detected value, the maximum detected value will be used as the EPC. Duplicate samples collected for quality control purposes will not be considered in the development of EPCs.

The specific calculation of EPCs will be presented in the media-specific TDSRs to be submitted to the U.S. EPA after the data is collected and evaluated and before the BHHRA is conducted.

3.3.2 Exposure Equations

The "Annual Average Daily Dose" (AADD) and "Lifetime Average Daily Dose" (LADD) are the parameters used to quantify exposure doses in a risk assessment for non-inhalation exposure pathways. The AADD is used as a standard measure for characterizing long-term noncarcinogenic effects. The LADD is used to estimate potential carcinogenic risks for exposures that may occur over varying durations, from a single event to an average 70-year human lifetime. For inhalation exposure pathways, the correlated parameters are the "Annual Average Concentration" (AAC) and the "Lifetime Average Concentration" (LAC).

The equations for calculating AADD and LADD for ingestion exposures are those presented by the U.S. EPA in its 1989 RAGS guidance (U.S. EPA, 1989). The AADD and LADD equations for dermal exposures are taken from the 2004 RAGS dermal guidance (U.S. EPA, 2004). The AAC and LAC equations for inhalation exposures are taken from the 2009 RAGS inhalation guidance (U.S. EPA, 2009a).

Table 2 summarizes the exposure equations that will be used for the BHHRA. In the BHHRA, information from Tables 2, 3.1, and 3.2 (see Section 3.3.3) will be used to develop the Exposure Assessment Table provided in U.S. EPA's RAGS, Part D guidance (U.S. EPA, 2001, Table 4).

3.3.3 Exposure Parameters

Exposure parameters are quantitative estimates of the frequency, duration, and magnitude of exposure to various media based on information contained in U.S. EPA guidance, as well as on site-specific information and professional judgment. The exposure parameters were selected from the U.S. EPA (1989, 2000, 2002c, 2004, 2008b, 2011c, 2014); Cal/EPA's DTSC (2014, 2015) guidance; ATSDR (2003, 2016); Virginia Department of Environmental Quality (VDEQ, 2016), and the RME scenario (AESE, 2005a,b), as appropriate, or they are based on site-specific factors when applicable.

Tables 3.1 and 3.2 present the exposure assumptions that represent a reasonable maximum exposure for adult and child receptors for each relevant receptor, respectively. Appendix A presents a narrative discussion of the exposure scenarios and parameters. As discussed with EPA, a central tendency estimate (CTE) will not be included in the BHHRA.

In addition to exposure assumptions related to media contact rates and durations, we have included a parameter to describe the fraction of the media available from the study area (Fa). Fraction of the media available from the study area or the data evaluation unit (compared with other possible sources of exposure) will be applied to specific exposure pathways where the exposure rate may be limited by availability of the exposure media. The default assumption is that fraction of exposure is 100 percent. Fraction of the media available will be developed on a media- and study area– or data evaluation unit–specific basis. For example, reference-area creeks may be used to estimate the availability of fish for potential consumption, which will be compared to the consumption rate used to estimate exposure in the study areas. If the mass of fish available from a sustainable fish population were less than the daily or annualized consumption rate, then Fa would reflect this limitation on the fish available from the study area. The Washoe Tribe RME scenario already accounts for a reduction in fish consumption based on the availability in the creeks, but this reduction will be re-evaluated using site-specific data. Similarly, if the sustainable native plant biomass within a given study area is found to be insufficient to support the dietary assumptions in the RME, Fa adjustments may need to be made. The specific exposure pathways where Fa may be applied include ingestion of the following: aquatic organisms, plants, wildlife, and beef. The values for Fa will be different for each exposure pathway and will be estimated based on available information and in some cases, site-specific data may be collected. Proposed adjustment to the Fa for any media and exposure pathway will be documented in a TDSR or other transmittal for consideration by EPA before the BHHRA is performed.

3.3.4 Absorption and Bioavailability

The chemical form of metals in environmental media and the type of environmental medium may affect the dermal absorption and oral bioavailability of those metals in the gastrointestinal tract (GI tract). The dermal absorption and oral bioavailability of chemicals vary by chemical and media type and range from 0 to 100 percent. Dermal absorption addresses the difference between the dose applied to the skin and the dose absorbed through the skin layers. Relative bioavailability for oral exposures accounts for the relative absorption of the chemical in the GI tract from potential exposure in the environmental medium (e.g., soil, water, biota) compared to the medium in the study from which the oral toxicity criteria was derived. For example, the relative bioavailability of lead is based on 30 percent bioavailability from incidental soil ingestion compared to 50 percent bioavailability in water (the key study was based on lead ingestion via drinking water). So, if a study used to define toxicity was based on exposure to lead in water, but the actual exposure occurs via lead in soil, then the relative bioavailability of lead would be 30 percent in soil divided by 50 percent bioavailability in water, which is equal to 60 percent relative bioavailability for soil compared to water.

Table 4 presents a summary of relative oral bioavailability and dermal absorption fractions recommended by the U.S. EPA to be incorporated into the calculations for the oral and dermal exposure pathways, respectively. Essentially, inhalation exposure does not incorporate an absorption adjustment because it is assumed that 100 percent of the deposited dose is available for uptake into the systemic circulation (U.S. EPA, 2009a). Three separate categories of exposure have been included for the oral exposure pathways: soil/sediment, water, and diet. For cadmium and manganese, the toxicity criteria presented in Table 4 incorporate the relative bioavailability of these compounds in various media. For this work plan, the relative bioavailability of both water and diet will be generally assumed to be 1 for the other COPCs (RBAow and RBAod, respectively, in Table 4). For certain dietary metals (e.g., arsenic), these assumptions may be adjusted based on measurement of organic and inorganic metals fractions in plants and fish and site-specific bioaccessibility measurements for arsenic and lead. For soil, until additional data is collected to develop more site-specific values, the relative bioavailability is assumed to be 1, except for lead and arsenic, for which it is assumed to be 0.6 (U.S. EPA, 2007a, U.S. EPA, 2016b).

A TSAP is being developed to evaluate the bioaccessibility of key RI/FS metals for consideration by U.S. EPA for use in the risk assessment. Soil samples will be collected and analyzed for a subset of key RI/FS metals using EPA Method 9200. Additional details regarding the sampling and bioaccessability testing of mine waste, sediment, floodplain soil, ore pile and Leviathan Mine Road material, and River Ranch soil and corresponding reference soil will be described in the TSAP to be submitted under separate cover. Bioavailability of lead and arsenic

will be estimated from the bioaccessibility measures using regression equations developed for these metals (U.S. EPA, 2007b and Diamond et al., 2016). Bioaccessibility of the other metals will be used as an indicator in the uncertainty analysis of the risk assessment to understand how bioavailability of the other metals may affect risk assessment results. If bioaccessibility testing indicates a significant potential change in the area requiring remediation, a bioavailability study may be proposed as part of the FS to further characterize areas requiring remediation. The results of the bioaccessibility/bioavailability testing will be reported and incorporated into the risk assessment.

4.0 TOXICITY ASSESSMENT

The toxicity assessment presents the general toxicological properties of the selected COPCs using the most current toxicological human health effects data. Toxicological values and information regarding the potential for carcinogens and noncarcinogens to cause adverse health effects in humans will be obtained from a hierarchy of U.S. EPA sources, beginning with the Integrated Risk Information System (IRIS) online database (U.S. EPA, 2017a). IRIS provides chemical-specific toxicity data that represent the U.S. EPA's consensus. The quantitative toxicity values and supporting explanations in IRIS have been reviewed and agreed upon by the U.S. EPA using available studies on a chemical. The complete hierarchy of sources reviewed is as follows:

- Tier 1: U.S. EPA's IRIS database (U.S. EPA, 2017a);
- Tier 2: U.S. EPA's Provisional Peer Reviewed Toxicity Values (PPRTVs) (U.S. EPA, 2017b);
- Tier 3: Other toxicity values – Tier 3 includes additional U.S. EPA and non-U.S. EPA sources of toxicity information. Non-U.S. EPA sources include the ATSDR (ATSDR, 2016) and Cal/EPA (OEHHA, 2017). U.S. EPA sources include the most current Health Effects Assessment Summary Tables (HEAST; U.S. EPA, 2011d).

For dermal exposure, the exposure assessment results in an estimate of absorbed dose. However, oral toxicity criteria, which are typically used to assess risk from dermal exposure, are typically based on administered dose. The difference between administered and absorbed dose in the development of oral toxicity criteria can result in an underestimation of potential health risks from dermal exposure (U.S. EPA, 2004). Oral toxicity criteria based on an administered dose may therefore need to be adjusted to account for the difference between the administered dose in the critical study (which formed the basis of the toxicity criterion) and the absorption efficiency of the chemical in question so the oral toxicity criteria can be adjusted and appropriately applied to dermal exposures. Tables 5.1 and 6.1 present the oral to dermal adjustment factor (ABS_{GI}) and the adjusted toxicity criteria for dermal exposures.

4.1 NONCARCINOGENIC HEALTH EFFECTS

For the evaluation of noncarcinogens in the risk assessment, chronic and subchronic reference doses (RfDs) for the ingestion route and reference concentrations (RfCs) for the inhalation route are used. A chronic RfD (in milligrams per kilogram per day, or mg/kg-day) is an estimate of a daily exposure level for the human population, including sensitive subpopulations that are likely to be without appreciable risk of deleterious effects during a lifetime. The RfC is expressed in units of micrograms of chemical per cubic meter of air ($\mu g/m^3$) and is an estimate of the maximum air concentration that can be present over a specified time without an appreciable risk of deleterious effects. Chronic reference doses and reference concentrations are generally used to evaluate the potential noncarcinogenic effects associated with exposure periods between six years and a lifetime. For shorter-term exposures, subchronic toxicity criteria will be applied if available. Some of the exposure periods for the receptors (e.g., the Current Trespasser and Current and Future Recreational Visitor) are significantly less than one year, which meets the definition of subchronic (or intermediate) exposure (ATSDR, 2016). Tables 5.1 and 5.2 present the non-cancer toxicity data for oral, dermal, and inhalation exposures, respectively.

4.2 CARCINOGENIC HEALTH EFFECTS

In risk assessment, a slope factor is used to estimate an upper-bound probability of an individual developing cancer as a result of a lifetime of exposure to a particular level of a potential carcinogen. Specifically, a slope factor is a plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime and is usually the 95% UCL of the slope of the dose-response curve expressed in $(mg/kg\text{-}day)^{-1}$ for non-inhalation pathways or $(\mu g/m^3)^{-1}$ for inhalation pathways. Tables 6.1 and 6.2 present the cancer toxicity data for oral/dermal and inhalation exposures, respectively.

Among the carcinogens listed as RI/FS metals, only hexavalent chromium is categorized as a mutagen by U.S. EPA (U.S. EPA, 2016b). Classification of a chemical as a mutagen requires that the estimation of potential health risks be based on four specific age categories to account for the higher risks from exposure to mutagenic chemicals at younger ages. Currently, the proposed exposure assumptions for the site are based on U.S. EPA's standard practice to use two age categories (child and adult). If hexavalent chromium is identified as a COPC in any media, exposure assumptions for the relevant age categories will be developed.

4.3 EVALUATION OF LEAD

Unlike other chemicals, the potential adverse health effects from exposure to lead are evaluated based on estimates of blood lead concentrations (micrograms per deciliter, or µg/dL) rather than on dose (mg/kg-day). Studies evaluating potential adverse human health effects associated with lead have been correlated with blood lead levels (e.g., a blood lead level of "x" is associated

with a particular likelihood of an adverse health effect). Specifically, the blood lead level of concern is a 1 µg/dL increase in blood lead concentration related to site-specific conditions and site-specific exposures.

As presented in Tables 6.1 and 6.2, OEHHA has published unit risk factors for evaluating potential carcinogenic effects of exposure to lead; however, the noncarcinogenic effects evaluated using predicted blood lead levels are the more critical health endpoint. Because the U.S. EPA has not identified lead as a carcinogen, only the potential noncarcinogenic effects based on blood lead concentrations will be evaluated quantitatively.

4.3.1 Fetal and Adult Exposures

U.S. EPA's Adult Lead Methodology (ALM; U.S. EPA, 2003) will be used to evaluate adult exposure and subsequent fetal exposure in pregnant women. The model uses site-specific lead concentrations in soil and estimates the distributional pattern of blood lead levels in potentially exposed receptors. In the ALM model, exposure to lead is evaluated in two steps. The first step is designed to estimate the blood lead concentration in adults based on a given exposure to lead in soil using a biokinetic slope factor (BKSF), which relates increases in typical adult blood lead concentrations to average daily lead exposure. The second step of the model is designed to estimate the corresponding blood lead concentration in a fetus, assuming the adult is a pregnant female. The average blood lead level in an adult is multiplied by the proportion of fetal blood lead concentration at birth based on maternal blood lead concentration, and an estimated value of the individual geometric standard deviation among adults ($GSD_{i,adult}$). The ALM model will be run for the two exposure scenarios where only adults are exposed (current trespasser and current/future recreational visitor) using the most recent version of U.S. EPA's ALM model spreadsheet (U.S. EPA, 2009c) and appropriate exposure assumptions based on those in Table 3.1.

Site-specific exposure to lead in this model is accounted for based on exposure to lead in specific media in units of micrograms per day. Exposure assumptions for primary and secondary pathways (e.g., ingestion of biota) in Table 3.1 will be used as the basis for estimating total daily exposure to lead, but may be adjusted for consistency with the inputs and form of the model. For example, adding site-specific fish consumption to the model will be conservative because typical fish ingestion is included in measured blood lead levels used to represent population background exposure. Measured blood lead levels already address exposure to lead from food consumption, and thus the model may "double count" the contribution from background sources of lead and site-specific sources of lead. This topic will be addressed in the uncertainty analysis for the site.

4.3.2 Child Exposures

Although the ALM evaluates potential fetal blood lead levels, it does not specifically evaluate children's blood lead levels. The U.S. EPA's Integrated Exposure-Uptake Biokinetic (IEUBK) Model (U.S. EPA, 1994) will be used to model blood lead levels in children for all five receptors that are children at the time of exposure (Current/Future Foragers, Future Subsistence Washoe Tribe Member, Future Off-Site Rancher, Current/Future Recreational Visitor, and Current Off-Site Resident). Similar to the ALM model, exposure assumptions for primary and secondary pathways (e.g., ingestion of biota) in Table 3.2 will be used as the basis for estimating total daily exposure to lead. As a point of comparison, the Department of Toxic Substance Control's Lead Risk Assessment Spreadsheet (LeadSpread) will be used to evaluate these same exposures by children.

5.0 RISK CHARACTERIZATION

In this section of the risk assessment, toxicity and exposure assessments will be integrated into quantitative and qualitative expressions of noncarcinogenic hazards and carcinogenic risks. The estimates of hazard and risk for individual COPCs and exposure pathways will be presented numerically in spreadsheets contained in an appendix.

Risks will be characterized by data evaluation unit or study area as appropriate. Exposure to multiple media within the same data evaluation unit or study area by the same receptor will be summed to estimate cumulative exposure. To provide context for potentially site-related exposures, risks also will be characterized using the EPCs developed for reference data for the same COPCs (Section 3.3.1). Potential health risks specific to the reference areas will be calculated for each media to provide context for health risks associated with exposure to environmental media at the site.

5.1 NONCARCINOGENIC HEALTH EFFECTS

The potential for noncarcinogenic effects will be evaluated by comparing exposure over a specified time period with a reference dose derived for a similar exposure period. This ratio of exposure to toxicity is referred to as a hazard quotient, which is calculated as follows for non-inhalation exposures:

$$\text{Hazard Quotient}_i = \frac{AADD_i}{RfD_i}$$

where:

$AADD_i$ = annual average daily dose for chemical "i" (mg/kg-day)

RfD_i = reference dose (oral or dermal) for chemical "i" (mg/kg-day)

For inhalation exposures, the hazard quotient is calculated as follows:

$$\text{Hazard Quotient}_i = \frac{AAC_i}{RfC_i}$$

where:

AAC_i = annual average concentration for chemical "i" (µg/m^3)

RfC_i = reference concentration for chemical "i" (µg/m^3)

In cases where individual COPCs potentially act on the same organs or result in the same health endpoint (e.g., respiratory irritants), potential additive effects may be addressed by calculating a hazard index as follows:

$$\text{Hazard Index} = \sum_{i=1}^{n} \text{Hazard Quotient}_i$$

where: i = specific health endpoint

A hazard index or hazard quotient (for effects which are not additive) of less than or equal to 1 indicates acceptable levels of exposure for COPCs having an additive effect. In this BHHRA, a screening-level hazard index will be calculated by summing the hazard quotients for all COPCs, regardless of toxic endpoint, as recommended by agency guidance (U.S. EPA, 1989). This approach is generally believed to overestimate the potential for noncarcinogenic health effects due to simultaneous exposure to multiple chemicals because it does not account for different toxic endpoints (U.S. EPA, 1989; NRC, 1988; Risk Commission, 1997; Seed et al., 1995). However, it can be used as a screening tool to rapidly identify those exposure scenarios for which exposure to multiple COPCs does not pose a noncarcinogenic health risk. If the hazard index is greater than 1 from the summing of hazard quotients, segregation of the hazard index by critical effect and mechanism of action will be performed as appropriate.

5.2 CARCINOGENIC HEALTH EFFECTS

Carcinogenic risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. The slope factor converts estimated daily intakes averaged over a lifetime of exposure to incremental risk of an individual developing cancer (U.S. EPA, 1989). This carcinogenic risk estimate is generally an

upper-bound value since the slope factor is often a 95% UCL of probability of response based on experimental animal data. Cancer risk for non-inhalation exposure is calculated as follows:

$$\text{Lifetime Excess Cancer Risk}_i = LADD_i \cdot SF_i$$

where:

$LADD_i$ = lifetime average daily dose for chemical "i" (mg/kg-day)

SF_i = slope factor (oral or dermal) for chemical "i" $(\text{mg/kg-day})^{-1}$

For inhalation exposures, the hazard quotient is calculated as follows:

$$\text{Lifetime Excess Cancer Risk}_i = LAC_i \cdot IUR_i$$

where:

LAC_i = lifetime average concentration for chemical "i" ($\mu g/m^3$)

IUR_i = inhalation unit risk for chemical "i" $(\mu g/m^3)^{-1}$

The estimated excess cancer risks for each chemical and exposure route are summed regardless of toxic endpoint to estimate the total excess cancer risk for the exposed individual:

$$\text{Lifetime Excess Cancer Risk} = \sum_{i=1}^{n} \text{Lifetime Excess Cancer Risk}_i$$

5.3 SUMMARY OF RISK CHARACTERIZATION

In general, the U.S. EPA recommends a target value or risk range (i.e., hazard index of 1 or risk range of 10^{-4} to 10^{-6}) as thresholds for evaluating potential human health impacts. Estimated risks and hazard indices will be combined for a given receptor across media, COPCs, exposure pathways, and age groups, as appropriate. If calculated risk ranges exceed U.S. EPA-recommended thresholds for particular exposure scenarios, follow-up site-specific analyses may be performed to reduce the conservatism and uncertainty of certain exposure assumptions before reaching final risk-based conclusions. The results presented in the calculations will be compared to these target levels and discussed. These comparisons aid in meeting the objectives of the BHHRA, including the following:

- Determine whether additional response action is necessary at the site.
- Provide a basis for determining residual chemical levels that are adequately protective of human health.

- Provide a basis for comparing potential health impacts of various remedial alternatives.

- Support selection of the no-action remedial alternative for all or certain portions of the site, where appropriate.

5.4 UNCERTAINTIES AND LIMITATIONS IN RISK ASSESSMENT

In any risk assessment, estimates of potential carcinogenic risk and noncarcinogenic health effects have numerous associated uncertainties. The primary areas of uncertainty in the data evaluation, exposure assessment, toxicity assessment, and risk characterization will be qualitatively discussed, including whether the uncertainty may result in overestimates or underestimates of potential risk. For example, there is uncertainty in the toxicity criteria for the various COPCs, but those toxicity criteria are developed using conservative assumptions to ensure they are protective, and they are likely to overestimate actual risk. A table summarizing each source of uncertainty and the direction and approximate magnitude of the uncertainty will be provided. The need for any quantitative uncertainty analysis will be determined upon completion of the first draft of the BHHRA.

6.0 NEXT STEPS

The schedule for completion of the BHHRA is dependent on the collection of data characterizing conditions at the site. The preliminary step of the BHHRA will be the development of media-specific TDSRs to summarize the data collected to characterize the nature and extent of chemicals in the environment and to develop data evaluation units (i.e., exposure areas) and exposure point concentrations for each media for use in the BHHRA. The media-specific TDSRs will be compiled and summarized into a Site Characterization Report to be completed by December 31, 2017. The BHHRA will be completed approximately 6 months after completion of the Site Characterization Report on or about June 30, 2018. We anticipate receiving comments from U.S. EPA to the Site Characterization report and TDSRs with regard to the data evaluation units and exposure point concentrations within two months after submittal (i.e., on or about February 28, 2018).

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TABLES

TABLE 1
SELECTION OF EXPOSURE PATHWAYS
(RAGS Part D, Table 1)
Leviathan Mine Site
Alpine County, California

Scenario Time Frame	Medium	Exposure Point [1]	Receptor Population	Receptor Age	Exposure Route	On-Property/Off-Property/ Supplemental [2]	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Surface Water [3]	Surface Water	Trespasser	Adult	Ingestion/Dermal Contact	On-Property	Quant	Potentially complete exposure pathway
		Aquatic Organisms		Adult	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Wildlife		Adult	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Plants		Adult	Ingestion	On-Property	Quant	Potentially complete exposure pathway
	Sediment [3]	Sediment	Trespasser	Adult	Ingestion/Dermal Contact	On-Property	Quant	Potentially complete exposure pathway
		Aquatic Organisms		Adult	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Wildlife		Adult	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Plants		Adult	Ingestion	On-Property	Quant	Potentially complete exposure pathway
	Groundwater	Groundwater	Trespasser	Adult	Ingestion/Dermal Contact	On-Property	None	Incomplete exposure pathway
	Mine Waste Soil	Mine Waste Soil	Trespasser	Adult	Ingestion/Dermal Contact	On-Property	Quant	Potentially complete exposure pathway
		Plants		Adult	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Wildlife		Adult	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Ambient Air (Particulates)		Adult	Inhalation	On-Property	Quant	Potentially complete exposure pathway
	Floodplain Soil	Floodplain Soil	Trespasser	Adult	Ingestion/Dermal Contact	On-Property	Quant	Potentially complete exposure pathway, pending additional data
		Ambient Air (Particulates)		Adult	Inhalation	On-Property	Quant	Potentially complete exposure pathway, pending additional data
		Plants		Adult	Ingestion	On-Property	Quant	Potentially complete exposure pathway, pending additional data
		Wildlife		Adult	Ingestion	On-Property	Quant	Potentially complete exposure pathway, pending additional data
Current	Surface Water [3,4]	Surface Water	Recreational Visitor	Adult/Child	Ingestion/Dermal Contact	Off-Property	Quant	Potentially complete exposure pathway
		Aquatic Organisms		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway
		Wildlife		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway
		Plants		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway
	Sediment [3]	Sediment	Recreational Visitor	Adult/Child	Ingestion/Dermal Contact	Off-Property	Quant	Potentially complete exposure pathway
		Aquatic Organisms		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway
		Wildlife		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway
		Plants		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway
	Groundwater	Groundwater	Recreational Visitor	Adult/Child	Ingestion/Dermal Contact	Off-Property	None	Incomplete exposure pathway
	Floodplain Soil	Floodplain Soil	Recreational Visitor	Adult/Child	Ingestion/Dermal Contact	Off-Property	Quant	Potentially complete exposure pathway, pending additional data
		Ambient Air (Particulates)		Adult/Child	Inhalation	Off-Property	Quant	Potentially complete exposure pathway, pending additional data
		Plants		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway, pending additional data
		Wildlife		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway, pending additional data
	Ore Piles and Soil on Leviathan Mine Road	Off-Property Soil	Recreational Visitor	Adult/Child	Ingestion/Dermal Contact	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
		Plants		Adult/Child	Ingestion	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
		Wildlife		Adult/Child	Ingestion	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
		Ambient Air (Particulates)		Adult/Child	Inhalation	Supplemental	Quant	Potentially complete exposure pathway, pending additional data

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Scenario Time Frame	Medium	Exposure Point [1]	Receptor Population	Receptor Age	Exposure Route	On-Property/Off-Property/ Supplemental [2]	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future	Surface Water [3]	Surface Water	Recreational Visitor	Adult/Child	Ingestion/Dermal Contact	On-Property	Quant	Potentially complete exposure pathway
		Aquatic Organisms		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Wildlife		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Plants		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway
	Sediment [3]	Sediment	Recreational Visitor	Adult/Child	Ingestion/Dermal Contact	On-Property	Quant	Potentially complete exposure pathway
		Aquatic Organisms		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Wildlife		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Plants		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway
	Groundwater	Groundwater	Recreational Visitor	Adult/Child	Ingestion/Dermal Contact	On-Property	None	Incomplete exposure pathway
	Mine Waste Soil	Mine Waste Soil	Recreational Visitor	Adult/Child	Ingestion/Dermal Contact	On-Property	Quant	Potentially complete exposure pathway
		Plants		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Wildlife		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Ambient Air (Particulates)		Adult/Child	Inhalation	On-Property	Quant	Potentially complete exposure pathway
	Floodplain Soil	Floodplain Soil	Recreational Visitor	Adult/Child	Ingestion/Dermal Contact	On-Property	Quant	Potentially complete exposure pathway, pending additional data
		Ambient Air (Particulates)		Adult/Child	Inhalation	On-Property	Quant	Potentially complete exposure pathway, pending additional data
		Plants		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway, pending additional data
		Wildlife		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway, pending additional data
	Ore Pile and Soil on Leviathan Mine Road	Off-Property Soil	Recreational Visitor	Adult/Child	Ingestion/Dermal Contact	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
		Plants		Adult/Child	Ingestion	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
		Wildlife		Adult/Child	Ingestion	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
		Ambient Air (Particulates)		Adult/Child	Inhalation	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
Future	Ranch Soil	Ranch Plants	Rancher	Adult/Child	Ingestion	Supplemental	Quant	Potentially complete exposure pathway
		Cattle		Adult/Child	Ingestion	Supplemental	Quant	Potentially complete exposure pathway
		Ranch Soil		Adult/Child	Ingestion/Dermal Contact	Supplemental	Quant	Potentially complete exposure pathway
		Ambient Air (Particulates)		Adult/Child	Inhalation	Supplemental	Quant	Potentially complete exposure pathway
	Surface Water [3,4]	Surface Water	Rancher	Adult/Child	Ingestion/Dermal Contact	Supplemental	Quant	Potentially complete exposure pathway
		Aquatic Organisms		Adult/Child	Ingestion	Supplemental	Quant	Potentially complete exposure pathway
		Wildlife		Adult/Child	Ingestion	Supplemental	Quant	Potentially complete exposure pathway
		Plants		Adult/Child	Ingestion	Supplemental	Quant	Potentially complete exposure pathway
	Sediment [3]	Sediment	Rancher	Adult/Child	Ingestion/Dermal Contact	On-Property	Quant	Potentially complete exposure pathway
		Aquatic Organisms		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Wildlife		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Plants		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway

TABLE 1
SELECTION OF EXPOSURE PATHWAYS
(RAGS Part D, Table 1)
Leviathan Mine Site
Alpine County, California

Scenario Time Frame	Medium	Exposure Point [1]	Receptor Population	Receptor Age	Exposure Route	On-Property/Off-Property/ Supplemental [2]	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/ Future	Ore Piles and Soil on Leviathan Mine Road	Off-Property Soil	Resident	Adult/Child	Ingestion/Dermal Contact	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
		Plants		Adult/Child	Ingestion	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
		Wildlife		Adult/Child	Ingestion	Supplemental	None	Incomplete exposure pathway
		Ambient Air (Particulates)		Adult/Child	Inhalation	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
Current	Surface Water [3,4]	Surface Water	Forager	Adult/Child	Ingestion/Dermal Contact	Off-Property	Quant	Potentially complete exposure pathway
		Aquatic Organisms		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway
		Wildlife		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway
		Plants		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway
	Sediment [3]	Sediment		Adult/Child	Ingestion/Dermal Contact	Off-Property	Quant	Potentially complete exposure pathway
		Aquatic Organisms		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway
		Wildlife		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway
		Plants		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway
	Groundwater	Groundwater	Forager	Adult/Child	Ingestion/Dermal Contact	Off-Property	None	Incomplete exposure pathway
	Floodplain Soil	Soil Near Creek	Forager	Adult/Child	Ingestion/Dermal Contact	Off-Property	Quant	Potentially complete exposure pathway, pending additional data
		Ambient Air (Particulates)		Adult/Child	Inhalation	Off-Property	Quant	Potentially complete exposure pathway, pending additional data
		Plants		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway, pending additional data
		Wildlife		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway, pending additional data
	Ore Piles and Soil on Leviathan Mine Road	Off-Property Soil	Forager	Adult/Child	Ingestion/Dermal Contact	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
		Plants		Adult/Child	Ingestion	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
		Wildlife		Adult/Child	Ingestion	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
		Ambient Air (Particulates)		Adult/Child	Inhalation	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
Future	Surface Water [3]	Surface Water	Forager	Adult/Child	Ingestion/Dermal Contact	On-Property	Quant	Potentially complete exposure pathway
		Aquatic Organisms		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Wildlife		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Plants		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway
	Sediment [3]	Sediment	Forager	Adult/Child	Ingestion/Dermal Contact	On-Property	Quant	Potentially complete exposure pathway
		Aquatic Organisms		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Wildlife		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Plants		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway
	Groundwater	Groundwater	Forager	Adult/Child	Ingestion/Dermal Contact	On-Property	None	Incomplete exposure pathway
	Floodplain Soil	Soil Near Creek	Forager	Adult/Child	Ingestion/Dermal Contact	On-Property	Quant	Potentially complete exposure pathway, pending additional data
		Ambient Air (Particulates)		Adult/Child	Inhalation	On-Property	Quant	Potentially complete exposure pathway, pending additional data
		Plants		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway, pending additional data
		Wildlife		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway, pending additional data

TABLE 1
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Leviathan Mine Site
Alpine County, California

Scenario Time Frame	Medium	Exposure Point [1]	Receptor Population	Receptor Age	Exposure Route	On-Property/Off-Property/ Supplemental [2]	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future	Mine Waste Soil	On-Property Soil	Forager	Adult/Child	Ingestion/Dermal Contact	On-Property	Quant	Potentially complete exposure pathway
		Plants		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Wildlife		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Ambient Air (Particulates)		Adult/Child	Inhalation	On-Property	Quant	Potentially complete exposure pathway
	Soil on Leviathan Mine Road	Off-Property Soil	Forager	Adult/Child	Ingestion/Dermal Contact	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
		Plants		Adult/Child	Ingestion	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
		Wildlife		Adult/Child	Ingestion	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
		Ambient Air (Particulates)		Adult/Child	Inhalation	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
Future	Surface Water [3,4]	Surface Water	Subsistence Washoe Tribe Member	Adult/Child	Ingestion/Dermal Contact	Off-Property	Quant	Potentially complete exposure pathway
		Aquatic Organisms		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway
		Wildlife		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway
		Cattle		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway
		Plants		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway
	Sediment [3]	Sediment	Subsistence Washoe Tribe Member	Adult/Child	Ingestion/Dermal Contact	Off-Property	Quant	Potentially complete exposure pathway
		Aquatic Organisms		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway
		Wildlife		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway
		Plants		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway
	Mine Waste Soil	On-Property Soil	Subsistence Washoe Tribe Member	Adult/Child	Ingestion/Dermal Contact	On-Property	Quant	Potentially complete exposure pathway
		Plants		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Wildlife		Adult/Child	Ingestion	On-Property	Quant	Potentially complete exposure pathway
		Ambient Air (Particulates)		Adult/Child	Inhalation	On-Property	Quant	Potentially complete exposure pathway
	Groundwater	Groundwater	Subsistence Washoe Tribe Member	Adult/Child	Ingestion/Dermal Contact	Off-Property	None	Incomplete exposure pathway
	Floodplain Soil	Soil Near Creek	Subsistence Washoe Tribe Member	Adult/Child	Ingestion/Dermal Contact	Off-Property	Quant	Potentially complete exposure pathway, pending additional data
		Ambient Air (Particulates)		Adult/Child	Inhalation	Off-Property	Quant	Potentially complete exposure pathway, pending additional data
		Plants		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway, pending additional data
		Cattle		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway, pending additional data
		Wildlife		Adult/Child	Ingestion	Off-Property	Quant	Potentially complete exposure pathway, pending additional data
	Ore Piles and Soil on Leviathan Mine Road	Off-Property Soil	Subsistence Washoe Tribe Member	Adult/Child	Ingestion/Dermal Contact	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
		Plants		Adult/Child	Ingestion	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
		Wildlife		Adult/Child	Ingestion	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
		Ambient Air (Particulates)		Adult/Child	Inhalation	Supplemental	Quant	Potentially complete exposure pathway, pending additional data

TABLE 1
SELECTION OF EXPOSURE PATHWAYS
(RAGS Part D, Table 1)
Leviathan Mine Site
Alpine County, California

Scenario Time Frame	Medium	Exposure Point [1]	Receptor Population	Receptor Age	Exposure Route	On-Property/Off-Property/ Supplemental [2]	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current	Floodplain Soil	Soil Near Creek	ATV Rider	Adult	Ingestion/Dermal Contact	Off-Property	Quant	Potentially complete exposure pathway, pending additional data
		Ambient Air (Particulates)		Adult	Inhalation	Off-Property	Quant	Potentially complete exposure pathway, pending additional data
		Plants		Adult	Ingestion	Off-Property	None	Incomplete exposure pathway
		Wildlife		Adult	Ingestion	Off-Property	None	Incomplete exposure pathway
	Ore Piles and Soil on Leviathan Mine Road	Off-Property Soil	ATV Rider	Adult	Ingestion/Dermal Contact	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
		Plants		Adult	Ingestion	Supplemental	None	Incomplete exposure pathway
		Wildlife		Adult	Ingestion	Supplemental	None	Incomplete exposure pathway
		Ambient Air (Particulates)		Adult	Inhalation	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
Future	Floodplain Soil	Soil Near Creek	ATV Rider	Adult	Ingestion/Dermal Contact	On-Property	Quant	Potentially complete exposure pathway, pending additional data
		Ambient Air (Particulates)		Adult	Inhalation	On-Property	Quant	Potentially complete exposure pathway, pending additional data
		Plants		Adult	Ingestion	On-Property	None	Incomplete exposure pathway
		Wildlife		Adult	Ingestion	On-Property	None	Incomplete exposure pathway
	Ore Piles and Soil on Leviathan Mine Road	Off-Property Soil	ATV Rider	Adult	Ingestion/Dermal Contact	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
		Plants		Adult	Ingestion	Supplemental	None	Incomplete exposure pathway
		Wildlife		Adult	Ingestion	Supplemental	None	Incomplete exposure pathway
		Ambient Air (Particulates)		Adult	Inhalation	Supplemental	Quant	Potentially complete exposure pathway, pending additional data
	Mine Waste Soil	On-Property Soil	ATV Rider	Adult	Ingestion/Dermal Contact	On-Property	Quant	Potentially complete exposure pathway, pending additional data
		Plants		Adult	Ingestion	On-Property	None	Incomplete exposure pathway
		Wildlife		Adult	Ingestion	On-Property	None	Incomplete exposure pathway
		Ambient Air (Particulates)		Adult	Inhalation	On-Property	Quant	Potentially complete exposure pathway, pending additional data

Notes
1. These describe specific exposure media. The general location is provided in the on-property/off-property/supplemental column. Specific locations will be developed for each receptor for each media.
2. This column refers to the location of the exposure. For the purpose of the RI/FS, the Leviathan Mine site is made up of two general areas: on-property areas, which collectively comprise the Pit Study Area, Leviathan Creek Study Area, and the Aspen Creek Study Area; and the off-property area, which is made up of the Downstream Study Area. Additionally, there are four supplemental study areas (Ore Piles, Leviathan Mine Road, River Ranch, and East Fork Carson RIver) that may also have exposures related to historical activities at Leviathan Mine.
3. The exposure pathways related to surface water and sediment only apply to receptors in decision units where Leviathan, Aspen, or Bryant Creek can be accessed.
4. May include the East Fork Carson River if potential impact from Leviathan Mine is observed.

Abbreviation
Quant = Quantitative

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TABLE 2
EXPOSURE EQUATIONS
Leviathan Mine Site
Alpine County, California

INGESTION OF SURFACE WATER		Explanation	
AADD =	$\frac{(Csw \times IRw \times RBAow \times EF \times ED)}{(BW \times ATnc)}$	Csw - Concentration in surface water (mg/L) IRw - Water ingestion rate (L/day) RBAow - Relative bioavailability from surface water	BW - Body weight (kg) ATnc - Averaging time for noncarcinogens (days) ATca - Averaging time for carcinogens (days)
LADD =	$\frac{(Csw \times IRw \times RBAow \times EF \times ED)}{(BW \times ATca)}$	EF - Exposure frequency for ingestion (days/year) ED - Exposure duration (years)	

DERMAL CONTACT WITH SURFACE WATER – WADING		Explanation	
AADD =	$\frac{(DAevent_w \times SAw \times EV \times EFw \times ED)}{(BW \times ATnc)}$	$DAevent_w$ - Dermal absorption during wading (mg/cm^2/event) SAw - Surface area exposed to surface water (wading) (cm^2) EFw - Exposure frequency for wading (days/year)	Kp - Permeability constant (cm/hr) Csw - Concentration in surface water (mg/L) $tevent_w$ - Wading event duration (hrs/day)
LADD =	$\frac{(DAevent_w \times SAw \times EV \times EFw \times ED)}{(BW \times ATca)}$	ED - Exposure duration (years) BW - Body weight (kg) ATnc - Averaging time for noncarcinogens (days)	$CFl\text{-}cm^3$ - Conversion factor from L to cm^3 (0.001) EV - Event frequency (events/day)
DAevent =	$Kp \times Csw \times tevent_w \times CFl\text{-}cm^3$	ATca - Averaging time for carcinogens (days)	

DERMAL CONTACT WITH SURFACE WATER – SWIMMING		Explanation	
AADD =	$\frac{(DAevent_{sw} \times SAsw \times EV \times EFsw \times ED)}{(BW \times ATnc)}$	$DAevent_{sw}$ - Dermal absorption during swimming (U.S. EPA, 2004) (mg/cm^2/event) SAsw - Surface area exposed to surface water (swimming) (cm^2) EFsw = Exposure frequency for swimming (days/year)	ATca - Averaging time for carcinogens (days) Kp - Permeability constant (cm/hr) Csw - Concentration in surface water (mg/L)
LADD =	$\frac{(DAevent_{sw} \times SAsw \times EV \times EFsw \times ED)}{(BW \times ATca)}$	ED - Exposure duration (years) BW - Body weight (kg) ATnc - Averaging time for noncarcinogens (days)	$tevent_{sw}$ - Swimming event duration (hrs/day) $CFl\text{-}cm^3$ - Conversion factor from L to cm^3 (0.001) EV - Event frequency (events/day)
DAevent =	$Kp \times Csw \times tevent_{sw} \times CFl\text{-}cm^3$		

INGESTION OF AQUATIC ORGANISMS		Explanation	
AADD =	$\frac{(Cao \times IRao \times RBAod \times Fa \times EF \times ED \times CFg\text{-}kg)}{(BW \times ATnc)}$	Cao - Concentration in aquatic organisms (mg/kg) IRao - Ingestion rate of aquatic organisms (g/day) RBAod - Relative bioavailability from diet (unitless)	CFg-kg - Conversion factor from g to kg (0.001) BW - Body weight (kg) ATnc - Averaging time for noncarcinogens (days)
LADD =	$\frac{(Cao \times IRao \times RBAod \times Fa \times EF \times ED \times CFg\text{-}kg)}{(BW \times ATca)}$	Fa - Fraction from study area (%) EF - Exposure frequency (days/year) ED - Exposure duration (years)	ATca - Averaging time for carcinogens (days)

INGESTION OF WILDLIFE		Explanation	
AADD =	$\frac{(Cwl \times IRwl \times RBAod \times Fa \times EF \times ED \times CFg\text{-}kg)}{(BW \times ATnc)}$	Cwl - Concentration in wildlife (mg/kg) IRwl - Ingestion rate of wildlife (g/day) RBAod - Relative bioavailability from diet	CFg-kg - Conversion factor from g to kg (0.001) BW - Body weight (kg) ATnc - Averaging time for noncarcinogens (days)
LADD =	$\frac{(Cwl \times IRwl \times RBAod \times Fa \times EF \times ED \times CFg\text{-}kg)}{(BW \times ATca)}$	Fa - Fraction from study area (%) EF - Exposure frequency (days/year) ED - Exposure duration (years)	ATca - Averaging time for carcinogens (days)

INGESTION OF PLANTS		Explanation	
AADD =	$\frac{(Cp \times IRp \times RBAod \times Fa \times EF \times ED \times CFg\text{-}kg)}{(BW \times ATnc)}$	Cp - Concentration in plants (mg/kg) IRp - Ingestion rate of plants (g/day) RBAod - Relative bioavailability from diet (unitless)	CFg-kg - Conversion factor from g to kg (0.001) BW - Body weight (kg) ATnc - Averaging time for noncarcinogens (days)
LADD =	$\frac{(Cp \times IRp \times RBAod \times Fa \times EF \times ED \times CFg\text{-}kg)}{(BW \times ATca)}$	Fa - Fraction from study area (%) EF - Exposure frequency (days/year) ED - Exposure duration (years)	ATca - Averaging time for carcinogens (days)

INGESTION OF BEEF		Explanation	
AADD =	$\frac{(Cb \times IRb \times RBAod \times Fa \times EF \times ED \times CFg\text{-}kg)}{(BW \times ATnc)}$	Cb - Concentration in beef (mg/kg) IRb - Ingestion rate of beef (g/day) RBAod - Relative bioavailability from diet (unitless)	CFg-kg - Conversion factor from g to kg (0.001) BW - Body weight (kg) ATnc - Averaging time for noncarcinogens (days)
LADD =	$\frac{(Cb \times IRb \times RBAod \times Fa \times EF \times ED \times CFg\text{-}kg)}{(BW \times ATca)}$	Fa - Fraction from study area (%) EF - Exposure frequency (days/year) ED - Exposure duration (years)	ATca - Averaging time for carcinogens (days)

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TABLE 2
EXPOSURE EQUATIONS
Leviathan Mine Site
Alpine County, California

INGESTION OF SOIL		Explanation	
AADD =	$\frac{(Cs \times IRs \times RBAos \times EF \times ED \times CFmg\text{-}kg)}{(BW \times ATnc)}$	Cs - Concentration in soil (mg/kg) IRs - Ingestion rate of soil (mg/day) RBAos - Relative bioavailability from soil/sediment (unitless) EF - Exposure frequency (days/year) ED - Exposure duration (years) CFmg-kg - Conversion factor from mg to kg (0.000001)	BW - Body weight (kg) ATnc - Averaging time for noncarcinogens (days) ATca - Averaging time for carcinogens (days)
LADD =	$\frac{(Cs \times IRs \times RBAos \times EF \times ED \times CFmg\text{-}kg)}{(BW \times ATca)}$		

DERMAL CONTACT WITH SOIL		Explanation	
AADD =	$\frac{(Cs \times SAs \times SAFs \times ABSds \times EVs \times EF \times ED \times CFmg\text{-}kg)}{(BW \times ATnc)}$	Cs - Concentration in soil (mg/kg) SAs - Surface Area for soil contact (cm^2/event) SAFs - Skin adherence factor for soil (mg/cm^2) ABSds - Dermal absorption fraction from soil/sediment (unitless) EF - Exposure frequency (days/year) EVs - Event frequency (events/day)	ED - Exposure duration (years) CFmg-kg - Conversion factor from mg to kg (0.000001) BW - Body weight (kg) ATnc - Averaging time for noncarcinogens (days) ATca - Averaging time for carcinogens (days)
LADD =	$\frac{(Cs \times SAs \times SAFs \times ABSds \times EVs \times EF \times ED \times CFmg\text{-}kg)}{(BW \times ATca)}$		

INHALATION OF RESUSPENDED SOIL PARTICULATES		Explanation	
AAC =	$\frac{(Cs \times ET \times EF \times ED \times CFmg\text{-}ug)}{(PEF \times ATnc \times CFdays\text{-}hrs)}$	Cs - Concentration in soil (mg/kg) ET - Event time (hours/day) EF - Exposure frequency (days/year) ED - Exposure duration (years) PEF - Particulate emission factor (m^3/kg)	ATnc - Averaging time for noncarcinogens (days) ATca - Averaging time for carcinogens (hours) CFmg-µg - Conversion factor from mg to µg (1000) CFdays-hrs - Conversion factor from days to hrs (24)
LAC =	$\frac{(Cs \times ET \times EF \times ED \times CFmg\text{-}ug)}{(PEF \times ATca \times CFdays\text{-}hrs)}$		

INGESTION OF SEDIMENT-WADING		Explanation	
AADD =	$\frac{(Csd \times IRsd \times RBAos \times EFw \times ED \times CFmg\text{-}kg)}{(BW \times ATnc)}$	Csd - Concentration in sediment (mg/kg) IRsd - Ingestion rate of sediment (mg/day) RBAosd - Relative bioavilability from soil/sediment (unitless) EFw - Exposure frequency for wading (days/year) ED - Exposure duration (years) CFmg-kg - Conversion factor from mg to kg (0.000001)	BW - Body weight (kg) ATnc - Averaging time for noncarcinogens (days) ATca - Averaging time for carcinogens (days)
LADD =	$\frac{(Csd \times IRsd \times RBAos \times EFw \times ED \times CFmg\text{-}kg)}{(BW \times ATca)}$		

DERMAL CONTACT WITH SEDIMENT-WADING		Explanation	
AADD =	$\frac{(Csd \times SAsd \times SAFsd \times ABSds \times EVw \times EFw \times ED \times CFmg\text{-}kg)}{(BW \times ATnc)}$	Csd - Concentration in sediment (mg/kg) SAsd - Surface Area for sediment contact (cm^2/event) SAFsd - Skin adherence factor for sediment contact (mg/cm^2) ABSds - Dermal absorption fraction from soil/sediment (unitless) EFw - Exposure frequency for wading (days/year) EVw - Event frequency (events/day)	ED - Exposure duration (years) CFmg-kg - Conversion factor from mg to kg (0.000001) BW - Body weight (kg) ATnc - Averaging time for noncarcinogens (days) ATca - Averaging time for carcinogens (days)
LADD =	$\frac{(Csd \times SAsd \times SAFsd \times ABSds \times EVw \times EFw \times ED \times CFmg\text{-}kg)}{(BW \times ATca)}$		

Abbreviations

AAC = Annual average concentration (in micrograms per cubic meter)
AADD = Annual average daily dose (in milligrams per kilogram-day)
cm^2 = square centimeters
cm^3 = cubic centimeters
g = gram
hr = hour
kg = kilogram
L = liter
LAC = Lifetime average concentration (in micrograms per cubic meter)
LADD = Lifetime average daily dose (in milligrams per kilogram-day)
m^3 = cubic meters
mg = milligram
µg = microgram

TABLE 3.1
EXPOSURE PARAMETERS FOR ADULT RECEPTOR - REASONABLE MAXIMUM EXPOSURE
Leviathan Mine Site
Alpine County, California

Exposure Parameter	Abbreviation	Units		Current/Future Trespasser	Current and Future Recreational Visitor	Current and Future ATV Rider	Future Off-Site Rancher	Current and Future Off-Site[1] Resident	Current and Future Forager	Future Subsistence Washoe Tribe Member
GENERAL EXPOSURE PARAMETERS [2]										
Exposure Frequency	EF	days/year	Value:	7	14	52	350	350	60	365
			Rationale:	Professional judgment; Appendix B	Professional judgement, two-week vacation period (U.S. EPA, 2014)	Professional judgement; once per week during year	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	ATSDR, 2003; estimated time spent in vicinity of mine per year.	Year-round
Exposure Duration	ED	years	Value:	1	20	26	20	20	64	64
			Rationale:	Professional judgment; trespassing on site occurs once in a lifetime.	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	Lifetime after childhood; 70 year lifetime	Lifetime after childhood; 70 year lifetime
Body Weight	BW	kg	Value:	80	80	80	80	80	80	80
			Rationale:	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014
Averaging Time	AT	days	Value:	25550 (ATca; carcinogens) 365 (ATnc; noncarcinogens)	25550 (ATca; carcinogens) 7300 (ATnc; noncarcinogens)	25550 (ATca; carcinogens) 9490 (ATnc; noncarcinogens)	25550 (ATca; carcinogens) 7300 (ATnc; noncarcinogens)	25550 (ATca; carcinogens) 7300 (ATnc; noncarcinogens)	25550 (ATca; carcinogens) 23360 (ATnc; noncarcinogens)	25550 (ATca; carcinogens) 23360 (ATnc; noncarcinogens)
			Rationale:	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014
PATHWAY-SPECIFIC PARAMETERS										
Ingestion of Water [3]										
Ingestion Rate	IRw	liters/day	Value:	2.5	2.5		0.053		2.5	3
			Rationale:	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014		U.S. EPA, 2011c; Table 3-5; Upper percentile value for adults for incidental ingestion while wading.		DTSC, 2014; U.S. EPA, 2014	AESE, 2005b; 3 liters per day plus 1 liter for each use of the sweat lodge during ritual purification; at 24 uses per year, this is 3.065 liters per day, which we are rounding down to 3.
Dermal Contact with Surface Water - Wading										
Surface Area	SAw	cm^2	Value:	6,032	6,032		6,032		6,032	6,032
			Rationale:	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014		DTSC, 2014; U.S. EPA, 2014		DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014
Event Duration - Wading	$tevent_w$	hours/day	Value:	1	1		1		1	1
			Rationale:	ATSDR, 2003	ATSDR, 2003		ATSDR, 2003		ATSDR, 2003	ATSDR, 2003
Event Frequency	EVw	events/day	Value:	1	1		1		1	1
			Rationale:	ATSDR, 2003	ATSDR, 2003		ATSDR, 2003		U.S. EPA, 2004a	U.S. EPA, 2004a
Exposure Frequency - Wading	EFw	days	Value:	7	14		12		60	84
			Rationale:	Professional judgment	Professional judgement; once per day for two-week vacation period (U.S. EPA, 2014)		Professional judgement; wading once per week during 12 weeks in the summer		ATSDR, 2003; estimated time spent in vicinity of mine per year.	Professional judgment; exposure occurs daily over 12 weeks of summer.

TABLE 3.1
EXPOSURE PARAMETERS FOR ADULT RECEPTOR - REASONABLE MAXIMUM EXPOSURE
Leviathan Mine Site
Alpine County, California

Exposure Parameter	Abbreviation	Units		Current/Future Trespasser	Current and Future Recreational Visitor	Current and Future ATV Rider	Future Off-Site Rancher	Current and Future Off-Site[1] Resident	Current and Future Forager	Future Subsistence Washoe Tribe Member
Dermal Contact with Surface Water - Swimming/Bathing										
Surface Area	SAsw	cm^2	Value:	20,900	20,900		20,900		20,900	20,900
			Rationale:	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014		DTSC, 2014; U.S. EPA, 2014		DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014
Exposure Frequency - Swimming/Bathing	EFsw	days/year	Value:	2	4		12		24	104
			Rationale:	ATSDR, 2003; U.S. EPA, 2011c; 2 swims per week (average from ATSDR, 2003) for 1 week	ATSDR, 2003; U.S. EPA, 2011c; 2 swims per week (average from ATSDR, 2003) for 2 weeks		Professional judgement; 1 swim per week for 12 weeks in summer		ATSDR, 2003; U.S. EPA, 2011c; 2 swims per week (average from ATSDR, 2003) for 12 weeks in summer	Assumes that surface or ground water is used for bathing two times per week.
Event Duration - Swimming/Bathing	$tevent_{sw}$	hr/day	Value:	0.71	0.71		0.71		0.71	0.71
			Rationale:	U.S. EPA, 2014	U.S. EPA, 2014		U.S. EPA, 2014		U.S. EPA, 2014	U.S. EPA, 2014
Event Frequency	EVsw	events/day	Value:	1	1		1		1	1
			Rationale:	U.S. EPA, 2004a	U.S. EPA, 2004a		U.S. EPA, 2004a		U.S. EPA, 2004a	U.S. EPA, 2004a
Ingestion of Aquatic Organisms										
Fraction from Study Area	Fa	%	Value:	less than or equal to 100%	less than or equal to 100%		less than or equal to 100%		71	71
			Rationale:	100% pending further analysis and concurrence by U.S. EPA	100% pending further analysis and concurrence by U.S. EPA		100% pending further analysis and concurrence by U.S. EPA		AESE, 2005b	AESE, 2005b
Ingestion Rate	IRao	g/day	Value:	42	42		42		200 (200 * 0.71 = 142)	200 (200 * 0.71 = 142)
			Rationale:	U.S. EPA, 2011c; Table 10-5; 95th percentile; Freshwater recreational fishing in Washington State.	U.S. EPA, 2011c; Table 10-5; 95th percentile; Freshwater recreational fishing in Washington State.		U.S. EPA, 2011c; Table 10-5; 95th percentile; Freshwater recreational fishing in Washington State.		AESE, 2005b; Due to size of the site-specific streams, the fish ingestion rate was lowered in AESE's RME scenario from 200 g/day to 142 g/day using a fraction from study area value of 71%.	AESE, 2005b; Due to size of the site-specific streams, the fish ingestion rate was lowered in AESE's RME scenario from 200 g/day to 142 g/day using a fraction from study area value of 71%.
Ingestion of Wildlife										
Fraction from Study Area	Fa	%	Value:	less than or equal to 100%	less than or equal to 100%		less than or equal to 100%		less than or equal to 100%	less than or equal to 100%
			Rationale:	100% pending further analysis and concurrence by U.S. EPA	100% pending further analysis and concurrence by U.S. EPA		100% pending further analysis and concurrence by U.S. EPA		100% pending further analysis and concurrence by U.S. EPA	100% pending further analysis and concurrence by U.S. EPA
Ingestion Rate [4]	IRwl	g/day	Value:	86	86		--		200	278
			Rationale:	U.S. EPA, 2011c; 50 percent of Table 11-1 weighted total meat consumption for ages 6 to 26 years	U.S. EPA, 2011c; 50 percent of Table 11-1 weighted total meat consumption for ages 6 to 26 years		Beef consumption from cattle raised at the ranch provides the main source of protein which is supplemented by non-site related sources.		U.S. EPA, 2011c; Table 11-18; 100 percent of the total mean meat consumption for American Indian	AESE, 2005b, Note: Ingestion of wildlife species will be replaced with ingestion of livestock raised at the Pine Nut Allottments for subsistence tribe members.

TABLE 3.1
EXPOSURE PARAMETERS FOR ADULT RECEPTOR - REASONABLE MAXIMUM EXPOSURE
Leviathan Mine Site
Alpine County, California

Exposure Parameter	Abbreviation	Units		Current/Future Trespasser	Current and Future Recreational Visitor	Current and Future ATV Rider	Future Off-Site Rancher	Current and Future Off-Site[1] Resident	Current and Future Forager	Future Subsistence Washoe Tribe Member
Ingestion of Plants										
Fraction from Study Area	Fa	%	Value:	less than or equal to 100%	less than or equal to 100%		less than or equal to 100%	less than or equal to 100%	less than or equal to 100%	less than or equal to 100%
			Rationale:	100% pending further analysis and concurrence by U.S. EPA	100% pending further analysis and concurrence by U.S. EPA		100% pending further analysis and concurrence by U.S. EPA	100% pending further analysis and concurrence by U.S. EPA	100% pending further analysis and concurrence by U.S. EPA	100% pending further analysis and concurrence by U.S. EPA
Ingestion Rate [5]	IRp	g/day	Value:	132	132		132	237	464	Total plant consumption = 1936; 80 for pine nuts, 300 for roots/tubers, 300 for bulbs, 333 for berries/fruits/garden vegetables, 833 for greens, 50 for seeds/grain, 40 for honey/teas
			Rationale:	U.S. EPA, 2011c; 50 percent of Mean consumption rates of vegetables and fruit (Table 9-4) for the overall population multiplied by 80 kg body weight. Trespasser is assumed to bring food with him so only 50% is based on foraging.	U.S. EPA, 2011c; 50 percent of Mean consumption rates of vegetables and fruit (Table 9-4) for the overall population multiplied by 80 kg body weight. Recreator is assumed to bring food with him so only 50% is based on foraging.		U.S. EPA, 2011c; 50 percent of Mean consumption rates of vegetables and fruit (Table 9-4) for the overall population multiplied by 80 kg body weight. Rancher is assumed to consume only 50% of plant ingestion based on foraging.	U.S. EPA, 2011c; based on mean consumption rates of home-produced vegetables in the West (Table 13-14) and homeproduced fruit in the West (Table 13-9).	U.S. EPA, 2011c; 100 percent of the mean consumption rates of vegetables and fruit for American Indian (Table 9-14). Can be apportioned among various plant types if plant concentrations are sufficiently different.	AESE, 2005b, RME scenario
Ingestion of Beef										
Fraction from Study Area	Fa	%	Value:				less than or equal to 100%			less than or equal to 100%
			Rationale:				100% pending further analysis and concurrence by U.S. EPA			100% pending further analysis and concurrence by U.S. EPA
Ingestion Rate	IRb	g/day	Value:				62			278
			Rationale:				U.S. EPA, 2011c; Table 11-5; total mean beef consumption rate			AESE, 2005b. This rate assumes that domestically raised animals will provided 100% of exposure and that cattle will be used as the representative animal for that exposure.
Ingestion of Soil										
Ingestion Rate	IRs	mg/day	Value:	150	150	150	100	100	150	400
			Rationale:	Standard adult soil ingestion (U.S. EPA, 2014) increased by 50 percent to account for increase at a campground based on Table 5-5 (U.S. EPA, 2011c).	Standard adult soil ingestion (U.S. EPA, 2014) increased by 50 percent to account for increase at a campground based on Table 5-5 (U.S. EPA, 2011c).	Standard adult soil ingestion (U.S. EPA, 2014) increased by 50 percent to account for increase at a campground based on Table 5-5 (U.S. EPA, 2011c). Assumed that ATV rider may have similar increase for ingestion.	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	Standard adult soil ingestion (U.S. EPA, 2014) increased by 50 percent to account for increase at a campground based on Table 5-5 (U.S. EPA, 2011c).	AESE, 2005b. This rate is based on indoor and outdoor activities, a greater rate of gathering, processing, and other uses of natural resources, as well as on residual soil on grown and gathered plants. Episodic events (1 gram each) are considered, such as wetland gathering, cultural activities with higher soil contact, and so on. It does not specifically include geophagia or pica.
Dermal Contact with Soil										
Surface Area	SAs	cm^2/event	Value:	6,032	6,032	6,032	6,032	6,032	6,032	6,032
			Rationale:	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014
Soil/Skin Adherence Factor	SAFs	mg/cm^2	Value:	0.2	0.2	0.2	0.2	0.07	0.2	0.2
			Rationale:	DTSC, 2014; industrial worker	DTSC, 2014; industrial worker	DTSC, 2014; industrial worker	DTSC, 2014; industrial worker	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; industrial worker	DTSC, 2014; industrial worker
Event Frequency	EVs	events/day	Value:	1	1	1	1	1	1	1
			Rationale:	U.S. EPA, 2004a	U.S. EPA, 2004a	U.S. EPA, 2004a	U.S. EPA, 2004a	U.S. EPA, 2004a	U.S. EPA, 2004a	U.S. EPA, 2004a
Inhalation of Soil Particulates in Ambient Air										
Particulate Emission Factor[7]	PEF	m^3/kg	Value:	1.316×10^9	1.316×10^9	2.9×10^5	1.316×10^9	to be calculated [6]	1.316×10^9	1.316×10^9
			Rationale:	U.S. EPA, 2002c; Site-specific values may be developed.	U.S. EPA, 2002c; Site-specific values may be developed.	ATSDR, 2008	U.S. EPA, 2002c; Site-specific values may be developed.	--	U.S. EPA, 2002c; Site-specific values may be developed.	U.S. EPA, 2002c; Site-specific values may be developed.
Exposure Time	ET	hours/day	Value:	24	24	4	24	24	24	24
			Rationale:	Entire day	Entire day	ATV use for 4 hours a day	Entire day	Entire day	Entire day	Entire day

TABLE 3.1
EXPOSURE PARAMETERS FOR ADULT RECEPTOR - REASONABLE MAXIMUM EXPOSURE
Leviathan Mine Site
Alpine County, California

Exposure Parameter	Abbreviation	Units		Current/Future Trespasser	Current and Future Recreational Visitor	Current and Future ATV Rider	Future Off-Site Rancher	Current and Future Off-Site[1] Resident	Current and Future Forager	Future Subsistence Washoe Tribe Member
Ingestion of Sediment										
Ingestion Rate	IRsd	mg/day	Value:	15	15		10		15	40
			Rationale:	VDEQ, 2016; 10% of soil ingestion rate	VDEQ, 2016; 10% of soil ingestion rate		VDEQ, 2016; 10% of soil ingestion rate		VDEQ, 2016; 10% of soil ingestion rate	VDEQ, 2016; 10% of soil ingestion rate
Exposure Frequency - Wading	EFw	days	Value:	7	14		12		60	84
			Rationale:	Professional judgment; Appendix B	Professional judgement, two-week vacation period (U.S. EPA, 2014)		Professional judgement; wading once per week during 12 weeks in the summer		ATSDR, 2003; estimated time spent in vicinity of mine per year.	Professional judgment; exposure occurs daily over 12 weeks of summer.
Dermal Contact with Sediment										
Surface Area	SAsd	cm^2/event	Value:	5,120	5,120		5,120		5,120	5,120
			Rationale:	EFH, 2011c; Table 7-12; total of mean values for lower leg, feet, and hands of adult males	EFH, 2011c; Table 7-12; total of mean values for lower leg, feet, and hands of adult males		EFH, 2011c; Table 7-12; total of mean values for lower leg, feet, and hands of adult males		EFH, 2011c; Table 7-12; total of mean values for lower leg, feet, and hands of adult males	EFH, 2011c; Table 7-12; total of mean values for lower leg, feet, and hands of adult males
Sediment/Skin Adherence Factor	SAFsd	mg/cm^2	Value:	0.2	0.2		0.2		0.2	0.2
			Rationale:	DTSC, 2014; industrial worker	DTSC, 2014; industrial worker		DTSC, 2014; industrial worker		DTSC, 2014; industrial worker	DTSC, 2014; industrial worker
Event Frequency - Wading	EVw	events/day	Value:	1	1		1		1	1
			Rationale:	U.S. EPA, 2004a	U.S. EPA, 2004a		U.S. EPA, 2004a		U.S. EPA, 2004a	U.S. EPA, 2004a
Exposure Frequency - Wading	EFw	days	Value:	7	14		12		60	84
			Rationale:	Professional judgment; Appendix B	Professional judgement, two-week vacation period (U.S. EPA, 2014)		Professional judgement; wading once per week during 12 weeks in the summer		ATSDR, 2003; estimated time spent in vicinity of mine per year.	Professional judgment; exposure occurs daily over 12 weeks of summer.

Notes
1. The off-site receptors do not access the on-property study areas, but may be exposed based on transport of chemicals to these specific supplemental study areas.
2. General exposure parameters apply to all pathways except where noted.
3. Water supply is assumed to be either groundwater or surface water as appropriate to the scenario. Both groundwater and surface water on-site will be considered for the subsistence Washoe scenario. Only surface water will be considered for the trespasser, recreational visitor, foraging Washoe tribe member, and River Ranch scenarios.
4. Ingestion rates may be subdivided or combined by type of wildlife once site-specific data is available.
5. Ingestion rates may be subdivided or combined by type of plant once site-specific data is available.

Shading indicates an incomplete exposure pathway for a particular receptor.

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Abbreviations
-- = not applicable
cm^2 = square centimeters
g = grams
hr = hour
kg = kilograms
m^3 = cubic meters
mg = milligrams

TABLE 3.2
EXPOSURE PARAMETERS FOR CHILD RECEPTOR - REASONABLE MAXIMUM EXPOSURE
Leviathan Mine Site
Alpine County, California

Exposure Parameter	Abbreviation	Units		Current and Future Recreational Visitor	Future Off-Site Rancher	Current and Future Off-Site[1] Resident	Current and Future Forager	Future Subsistence Washoe Tribe Member
GENERAL EXPOSURE PARAMETERS [2]								
Exposure Frequency	EF	days/year	Value:	14	350	350	60	365
			Rationale:	Professional judgement, two-week vacation period (U.S. EPA, 2014)	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	ATSDR, 2003; estimated time spent in vicinity of mine per year.	Year-round
Exposure Duration	ED	years	Value:	6	6	6	6	6
			Rationale:	U.S. EPA, 1989; U.S. EPA, 2014	U.S. EPA, 1989; U.S. EPA, 2014	U.S. EPA, 1989; U.S. EPA, 2014	U.S. EPA, 1989; U.S. EPA, 2014	U.S. EPA, 1989; U.S. EPA, 2014
Body Weight	BW	kg	Value:	15	15	15	15	15
			Rationale:	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014
Averaging Time	AT	days	Value:	25550 (ATca; carcinogens) 2190 (ATnc; noncarcinogens)	25550 (ATca; carcinogens) 2190 (ATnc; noncarcinogens)	25550 (ATca; carcinogens) 2190 (ATnc; noncarcinogens)	25550 (ATca; carcinogens) 2190 (ATnc; noncarcinogens)	25550 (ATca; carcinogens) 2190 (ATnc; noncarcinogens)
			Rationale:	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014
PATHWAY-SPECIFIC PARAMETERS								
Ingestion of Water [3]								
Ingestion Rate	IRw	L/day	Value:	0.78	0.09		0.78	0.78
			Rationale:	DTSC, 2014; U.S. EPA, 2014	U.S. EPA, 2011c; Table 3-5; Upper percentile value for children for incidental ingestion while wading		DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014
Dermal Contact with Surface Water – Wading								
Surface Area	SAw	cm^2	Value:	2,690	2,690		2,690	2,690
			Rationale:	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014		DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014
Event Duration – Wading	$tevent_w$	hr/day	Value:	1	1		1	1
			Rationale:	ATSDR, 2003	ATSDR, 2003		ATSDR, 2003	ATSDR, 2003
Event Frequency	EVw	events/day	Value:	1	1		1	1
			Rationale:	U.S. EPA, 2004a	U.S. EPA, 2004a		U.S. EPA, 2004a	U.S. EPA, 2004a
Exposure Frequency – Wading	EFw	days/year	Value:	14	12		60	84
			Rationale:	Professional judgement, two-week vacation period (U.S. EPA, 2014)	Professional judgement: wading once per week during 12 weeks in the summer.		ATSDR, 2003; estimated time spent in vicinity of mine per year.	Professional judgment; exposure occurs daily over 12 weeks of summer.

TABLE 3.2
EXPOSURE PARAMETERS FOR CHILD RECEPTOR - REASONABLE MAXIMUM EXPOSURE
Leviathan Mine Site
Alpine County, California

Exposure Parameter	Abbreviation	Units		Current and Future Recreational Visitor	Future Off-Site Rancher	Current and Future Off-Site[1] Resident	Current and Future Forager	Future Subsistence Washoe Tribe Member
Dermal Contact with Surface Water – Swimming/Bathing								
Surface Area	SAsw	cm^2	Value:	6,378	6,378		6,378	6,378
			Rationale:	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014		DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014
Exposure Frequency – Swimming/Bathing	EFsw	days/year	Value:	4	12		24	104
			Rationale:	Professional judgement; two swims per week for a two-week vacation period	Professional judgement; 1 swim per week for 12 weeks in summer		ATSDR, 2003; U.S. EPA, 2011c; 2 swims per week (average from ATSDR, 2003) for 12 weeks in	Assumes that surface or groundwater is used for bathing two times per week.
Event Frequency	EVsw	events/day	Value:	1	1		1	1
			Rationale:	U.S. EPA, 2004a	U.S. EPA, 2004a		U.S. EPA, 2004a	U.S. EPA, 2004a
Event Duration – Swimming/Bathing	$tevent_{sw}$	hr/day	Value:	0.71	0.71		1	1.0
			Rationale:	U.S. EPA, 2014	U.S. EPA, 2014		ATSDR, 2003; U.S. EPA 2011c	ATSDR, 2003; U.S. EPA 2011c
Ingestion of Aquatic Organisms								
Fraction from Study Area	Fa	%	Value:	less than or equal to 100%	less than or equal to 100%		71	71
			Rationale:	100% pending further analysis and concurrence by U.S. EPA	100% pending further analysis and concurrence by U.S. EPA		AESE, 2005b	AESE, 2005b
Ingestion Rate	IRao	g/day	Value:	29	29		100 (100 * 0.71 = 71)	100 (100 * 0.71 = 71)
			Rationale:	U.S. EPA, 2011c; Table 10-5; 95th percentile; children of freshwater recreational anglers in Washington State.	U.S. EPA, 2011c; Table 10-5; 95th percentile; children of freshwater recreational anglers in Washington State.		AESE, 2005b; 50 percent of Adult Washoe Tribe Member ingestion of aquatic organisms rate	AESE, 2005b; 50 percent of Adult Washoe Tribe Member ingestion of aquatic organisms rate
Ingestion of Wildlife								
Fraction from Study Area	Fa	%	Value:	less than or equal to 100%	less than or equal to 100%		less than or equal to 100%	less than or equal to 100%
			Rationale:	100% pending further analysis and concurrence by U.S. EPA	100% pending further analysis and concurrence by U.S. EPA		100% pending further analysis and concurrence by U.S. EPA	100% pending further analysis and concurrence by U.S. EPA
Ingestion Rate [4]	IRwl	g/day	Value:	53	--		53	53
			Rationale:	U.S. EPA, 2011c; mean meat intake; weighted average for child from birth 6 years (Table 11-4).	Beef consumption from cattle raised at the ranch provides the main source of protein which is supplemented by non-site related		U.S. EPA, 2011c; mean meat intake; weighted average for child from birth 6 years (Table 11-4).	U.S. EPA, 2011c; mean meat intake; weighted average for child from birth 6 years (Table 11-4).
Ingestion of Beef								
Ingestion Rate	IRb	g/day	Value:		22			139
			Rationale:		U.S. EPA, 2011c, Table 11-6, weighted average beef consumption from birth to five years old.			AESE, 2005b. This rate assumes that domestically raised animals will provided 100% of exposure and that cattle will be used as the representative animal for that exposure. Exposure is 50 percent of adult exposure.

TABLE 3.2
EXPOSURE PARAMETERS FOR CHILD RECEPTOR - REASONABLE MAXIMUM EXPOSURE
Leviathan Mine Site
Alpine County, California

Exposure Parameter	Abbreviation	Units		Current and Future Recreational Visitor	Future Off-Site Rancher	Current and Future Off-Site[1] Resident	Current and Future Forager	Future Subsistence Washoe Tribe Member
Ingestion of Plants								
Fraction from Study Area	Fa	%	Value:	less than or equal to 100%	less than or equal to 100%		less than or equal to 100%	less than or equal to 100%
			Rationale:	100% pending further analysis and concurrence by U.S. EPA	100% pending further analysis and concurrence by U.S. EPA		100% pending further analysis and concurrence by U.S. EPA	100% pending further analysis and concurrence by U.S. EPA
Ingestion Rate [5]	IRp	g/day	Value:	96	96	144	192	20 for pine nuts, 75 for roots/tubers, 75 for bulbs, 83 for berries/fruits/garden vegetables, 208 for greens, 12 for seeds/grain, 10 for honey/teas, Total plant consumption = 968
			Rationale:	U.S. EPA, 2011c; 50 percent of age-weighted mean consumption rates of vegetables and fruit (Table 9-4) multiplied by 15 kg body weight. Recreator is assumed to bring food with him so only 50% is based on foraging.	U.S. EPA, 2011c; 50 percent of age-weighted mean consumption rates of vegetables and fruit (Table 9-4) multiplied by 15 kg body weight. Rancher is assumed to obtain food from other sources so only 50% is based on foraging.	U.S. EPA, 2008b; Mean value of home-produced intake of vegetables and home-produced intake of fruits; weighted average for child 1 to 6 years (Table ES-1).	U.S. EPA, 2011c; the mean consumption rates of vegetables and fruit for a child weighted from birth to 6 years old (Table 9-1; UI.S. EPA). Can be apportioned among various plant types if plant concentrations are sufficiently different.	AESE, 2005b, RME scenario. Exposure is 50 percent of adult exposure.
Ingestion of Soil								
Ingestion Rate	IRs	mg/day	Value:	200	200	200	400	400
			Rationale:	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	AESE, 2005	AESE, 2005
Dermal Contact with Soil								
Surface Area	SAs×SAFs	cm^2	Value:	2,900	2,900	2,900	2,900	2,900
			Rationale:	DTSC, 2014	DTSC, 2014	DTSC, 2014	DTSC, 2014	DTSC, 2014
Skin Adherence Factor	SAF	mg/cm^2	Value:	0.2	0.2	0.2	0.2	0.2
			Rationale:	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014	DTSC, 2014; U.S. EPA, 2014
Event Frequency	EVs	events/day	Value:	1	1	1	1	1
			Rationale:	U.S. EPA, 2004a	U.S. EPA, 2004a	U.S. EPA, 2004a	U.S. EPA, 2004a	U.S. EPA, 2004a

TABLE 3.2
EXPOSURE PARAMETERS FOR CHILD RECEPTOR - REASONABLE MAXIMUM EXPOSURE
Leviathan Mine Site
Alpine County, California

Exposure Parameter	Abbreviation	Units		Current and Future Recreational Visitor	Future Off-Site Rancher	Current and Future Off-Site[1] Resident	Current and Future Forager	Future Subsistence Washoe Tribe Member
Inhalation of Soil Particulates in Ambient Air								
Particulate Emission Factor[7]	PEF	m^3/kg	Value:	1.316×10^9	1.316×10^9	to be calculated[6]	1.316×10^9	1.316×10^9
			Rationale:	U.S. EPA, 2002c	U.S. EPA, 2002c	--	U.S. EPA, 2002c	U.S. EPA, 2002c
Exposure Time	ET	hours/day	Value:	24	24	24	24	24
			Rationale:	Entire day	Entire day	Entire day	Entire day	Entire day
Ingestion of Sediment								
Ingestion Rate	IRsd	mg/day	Value:	20	20		40	40
			Rationale:	VDEQ, 2016; 10% of soil ingestion rate	VDEQ, 2016; 10% of soil ingestion rate		AESE, 2005b; 10 percent of soil ingestion for child	AESE, 2005b; 10 percent of soil ingestion for child
Exposure Frequency – Wading	EFw	years	Value:	14	12		60	84
			Rationale:	Professional judgement, daily wading over a two-week vacation period (U.S. EPA, 2014)	Professional judgement: wading once per week during 12 weeks in the summer.		ATSDR, 2003; estimated time spent in vicinity of mine per year.	Professional judgment; exposure occurs daily over 12 weeks of summer.
Dermal Contact with Sediment								
Surface Area	SAsd	cm^2/event	Value:	2,900	2,900		2,900	2,900
			Rationale:	DTSC, 2014	DTSC, 2014		DTSC, 2014	DTSC, 2014
Sediment/Skin Adherence Factor	SAFsd	mg/cm^2	Value:	0.2	0.2		0.3	0.3
			Rationale:	U.S. EPA, 2004a	U.S. EPA, 2004a		U.S. EPA, 2004a; value for reed gatherer used.	U.S. EPA, 2004a; value for reed gatherer used.
Event Frequency	EVw	events/day	Value:	1	1		1	1
			Rationale:	U.S. EPA, 2004a	U.S. EPA, 2004a		U.S. EPA, 2004a	U.S. EPA, 2004a
Exposure Frequency – Wading	EFw	days/year	Value:	14	12		60	84
			Rationale:	Professional judgement, daily wading over a two-week vacation period (U.S. EPA, 2014)	Professional judgement: wading once per week during 12 weeks in the summer.		ATSDR, 2003; estimated time spent in vicinity of mine per year.	Professional judgment; exposure occurs daily over 12 weeks of summer.

Notes
1. The off-site receptors do not access the on-property study areas, but may be exposed based on transport of chemicals to these specific supplemental study areas.
2. General exposure parameters apply to all pathways except where noted.
3. Water supply is assumed to be either groundwater or surface water as appropriate to the scenario. Both groundwater and surface water on-site will be considered for the subsistence Washoe scenario. Only surface water will be considered for the recreational visitor, foraging Washoe, and River Ranch scenarios.
4. Ingestion rates may be subdivided or combined by type of wildlife once site-specific data is available.
5. Ingestion rates may be subdivided or combined by type of plant once site-specific data is available.
6. Site-specific conditions when available will be incorporated into this value.

Shading indicates an incomplete exposure pathway for a particular receptor.

Abbreviations
-- = not applicable
cm^2 = square centimeters
g = grams
h = hour
kg = kilograms
L = liters
m^3 = cubic meters
mg = milligrams
µg = micrograms

References

AESE, Inc., 2005b, Draft Washoe Tribe Provisional Reasonable Maximum Exposure Factors (RME) for the Leviathan Mine Superfund Site Risk Assessments, June 27.
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U.S. Environmental Protection Agency (U.S. EPA), 2002c, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, December.
U.S. Environmental Protection Agency (U.S. EPA), 2004a, Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).
U.S. Environmental Protection Agency (U.S. EPA), 2011c, Exposure Factors Handbook, Volume 1, General Factors, October.
U.S. Environmental Protection Agency (U.S. EPA), 2014, Human Health Evaluation Manual, Supplemental Guidance: "Update of Standard Default Exposure Factors," Office of Emergency and Remedial Response, Washington, D.C.
Virginia Department of Environmental Quality (VDEQ), 2016, Voluntary Remediation Program - Risk Assessment Guidance.

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TABLE 4
RELATIVE BIOAVAILABILITY AND ABSORPTION FRACTIONS FOR CHEMICALS OF POTENTIAL CONCERN
Leviathan Mine Site
Alpine County, California

Chemical	Relative Bioavailability from Soil/Sediment[1] (RBAos)		Relative Bioavailability from Water [1] (RBAow)		Relative Bioavailability from Diet [1] (RBAod)		Dermal Absorption from Soil (ABSds)		Dermal Absorption from Water (Kp)	
	(unitless)	Ref	(unitless)	Ref	(unitless)	Ref	(unitless)	Ref	(cm/hr)	Ref
Aluminum	1	1	1	1	1	1	0.01	2	0.001	3
Antimony	1	1	1	1	1	1	0.01	2	0.001	3
Arsenic	0.6	4	1	1	1	1	0.03	2	0.001	3
Barium	1	1	1	1	1	1	0.01	2	0.001	3
Beryllium	1	1	1	1	1	1	0.01	2	0.001	3
Cadmium	1	1	1	1	1	1	0.001	2	0.001	3
Chromium III	1	1	1	1	1	1	0.01	2	0.001	3
Chromium VI	1	1	1	1	1	1	0	2	0.002	3
Cobalt	1	1	1	1	1	1	0.01	2	0.0004	3
Copper	1	1	1	1	1	1	0.01	2	0.001	3
Iron	1	1	1	1	1	1	0.01	2	0.001	3
Lead	0.6	5	1	1	1	1	0.01	2	0.0001	3
Manganese	1	1	1	1	1	1	0.01	2	0.001	3
Mercury	1	1	1	1	1	1	0.01	2	0.001	3
Nickel	1	1	1	1	1	1	0.01	2	0.0002	3
Selenium	1	1	1	1	1	1	0.01	2	0.001	3
Silver	1	1	1	1	1	1	0.01	2	0.0006	3
Thallium	1	1	1	1	1	1	0.01	2	0.001	3
Vanadium	1	1	1	1	1	1	0.01	2	0.001	3
Zinc	1	1	1	1	1	1	0.01	2	0.0006	3

Notes

1. For oral absorption, a default absorption fraction of 1 is used. Chemical-specific information for this site will be collected as appropriate prior to implementation of the risk assessment work plan.

References

(1) U.S. Environmental Protection Agency (EPA), 1989, Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part A).

(2) Department of Toxic Substances Control, 2015, Preliminary Endangerment Assessment, Guidance Manual, California Environmental Protection Agency. Revised October.

(3) U.S. Environmental Protection Agency (EPA), 2004, Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment).

(4) U.S. Environmental Protection Agency (EPA), 2012, Recommendations for Default Value for Relative Bioavailability of Arsenic in Soil, December 2012. OSWER 9200.1-113

(5) U.S. Environmental Protection Agency (EPA), 2007a, Estimation of Relative Bioavailability of Lead in Soil and Soil-Like Materials Using In Vivo and In Vitro Methods.

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TABLE 5.1
NON-CANCER TOXICITY DATA - ORAL/DERMAL
(RAGS Part D, Table 5)
Leviathan Mine Site
Alpine County, California

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value (RfDo)	Units	(1) Oral to Dermal Adjustment Factor (ABS_{GI})	(2) Adjusted Dermal RfD (RfD_{ABS})	Units	Primary Target Organ(s)	Combined Uncertainty/ Modifying Factors	Source(s) of RfD/ Target Organ	(3) Date of RfD/ Target Organ (MM/DD/YY)
Aluminum	Chronic	1	mg/kg-day	100%	1	mg/kg-day	Nervous System	100	PPRTV	02/13/17
Aluminum	Subchronic	1	mg/kg-day	100%	1	mg/kg-day	Nervous System	30	MRL	02/13/17
Antimony	Chronic	0.0004	mg/kg-day	15%	0.00006	mg/kg-day	Blood	1000	IRIS	02/13/17
Arsenic	Chronic	3.00E-04	mg/kg-day	100%	0.0003	mg/kg-day	Skin	3	IRIS	02/13/17
Barium	Chronic	0.2	mg/kg-day	7%	0.014	mg/kg-day	Kidney	300	IRIS	02/13/17
Barium	Subchronic	0.07	mg/kg-day	7%	0.0049	mg/kg-day	Cardiovascular	3	HEAST	12/01/11
Beryllium	Chronic	0.002	mg/kg-day	0.7%	0.000014	mg/kg-day	Small Intestine	300	IRIS	02/13/17
Beryllium	Subchronic	0.005	mg/kg-day	0.7%	0.000035	mg/kg-day	No observed adverse effect	100	HEAST	12/01/11
Cadmium (water)	Chronic	0.0005	mg/kg-day	5.0%	0.000025	mg/kg-day	Kidney	10	IRIS	02/13/17
Cadmium (soil or diet)	Chronic	0.001	mg/kg-day	2.5%	0.000025	mg/kg-day	Kidney	10	IRIS	02/13/17
Cadmium	Subchronic	0.0005	mg/kg-day	2.5%	0.000013	mg/kg-day	Muscular System	100	MRL	03/01/16
Chromium III	Chronic	1.5	mg/kg-day	1.3%	0.020	mg/kg-day	No observed adverse effect	1000	IRIS	02/13/17
Chromium III	Subchronic	1.5	mg/kg-day	1.3%	0.020	mg/kg-day	No observed adverse effect	1000	HEAST	12/01/11
Chromium VI	Chronic	0.003	mg/kg-day	2.5%	0.000075	mg/kg-day	No observed adverse effect	900	IRIS	02/13/17
Chromium VI	Subchronic	0.005	mg/kg-day	2.5%	0.00013	mg/kg-day	Blood	100	MRL	03/01/16
Cobalt	Chronic	0.0003	mg/kg-day	100%	0.0003	mg/kg-day	Thyroid	3000	PPRTV	02/13/17
Cobalt	Subchronic	0.003	mg/kg-day	100%	0.003	mg/kg-day	Blood	100	PPRTV	02/13/17
Copper	Chronic	0.04	mg/kg-day	100%	0.04	mg/kg-day	Gastrointestinal	--	HEAST	12/01/11
Copper	Subchronic	0.01	mg/kg-day	100%	0.01	mg/kg-day	Gastrointestinal	3	MRL	03/01/16
Iron	Chronic	0.7	mg/kg-day	100%	0.7	mg/kg-day	Gastrointestinal	1.5	PPRTV	02/13/17
Lead (4)	Chronic	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese (dietary)	Chronic	0.14	mg/kg-day	100%	0.14	mg/kg-day	Nervous System	1	IRIS	02/13/17
Manganese (soil or water)	Chronic	0.024	mg/kg-day	4%	0.0009	mg/kg-day	Nervous System	3	IRIS	02/13/17
Manganese (dietary)	Subchronic	0.14	mg/kg-day	100%	0.14	mg/kg-day	Nervous System	1	HEAST	12/01/11
Mercury	Chronic	0.00016	mg/kg-day	100%	0.00016	mg/kg-day	Nervous System	--	REL	02/13/17
Nickel	Chronic	0.02	mg/kg-day	4%	0.0008	mg/kg-day	Various	300	IRIS	02/13/17

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TABLE 5.1
NON-CANCER TOXICITY DATA - ORAL/DERMAL
(RAGS Part D, Table 5)
Leviathan Mine Site
Alpine County, California

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value (RfDo)	Units	(1) Oral to Dermal Adjustment Factor (ABS_{GI})	(2) Adjusted Dermal RfD (RfD_{ABS})	Units	Primary Target Organ(s)	Combined Uncertainty/ Modifying Factors	Source(s) of RfD/ Target Organ	(3) Date of RfD/ Target Organ (MM/DD/YY)
Selenium	Chronic	0.005	mg/kg-day	100%	0.005	mg/kg-day	Various	3	IRIS	02/13/17
Silver	Chronic	0.005	mg/kg-day	4%	0.0002	mg/kg-day	Skin	3	IRIS	02/13/17
Thallium	Chronic	0.00001	mg/kg-day	100%	0.00001	mg/kg-day	Hair, Body	3000	PPRTV	02/13/17
Vanadium (5)	Chronic	0.005	mg/kg-day	2.6%	0.00013	mg/kg-day	Hair	100	IRIS	02/13/17
Vanadium	Subchronic	0.0007	mg/kg-day	2.6%	0.0000182	mg/kg-day	Kidney	300	PPRTV	02/13/17
Zinc	Chronic	0.3	mg/kg-day	100%	0.3	mg/kg-day	Blood	3	IRIS	02/13/17
Zinc	Subchronic	0.3	mg/kg-day	100%	0.3	mg/kg-day	Blood	3	MRL	03/01/16

Notes

(1) Refer to RAGS, Part E (U.S. EPA, 2004)

(2) $RfD_{ABS} = RfD_O \times ABS_{GI}$

(3) For HEAST values, the date of HEAST publication is provided.
For IRIS values, the date IRIS was searched is provided.
For PPRTV values, the date the PPRTV database was searched is provided.
For REL values, the date the OEHHA database was searched is provided.
For MRL values, the date the latest MRL list was published is provided.

(4) Lead is not evaluated using an RfD approach.

(5) The oral RfD for vanadium was adjusted from the oral RfD of vanadium pentoxide based on the molecular weight of vanadium in vanadium pentoxide.

Abbreviations

-- = Not available
HEAST= Health Effects Assessment Summary Tables (U.S. EPA, 2011)
IRIS = Integrated Risk Information System (U.S. EPA, 2017a)
mg/kg-day = milligrams per kilogram per day
MRL = Minimal Risk Level (ATSDR, 2016)
NA = Not applicable
OEHHA = Office of Environmental Health Hazard Assessment
PPRTV = Preliminary Peer Reviewed Toxicity Values (U.S. EPA, 2017b)
REL = Reference Exposure Level (OEHHA, 2017)
RfD - Reference dose

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TABLE 5.2
NON-CANCER TOXICITY DATA - INHALATION
RAGS Part D, Table 5)
Leviathan Mine Site
Alpine County, California

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC	Units	Primary Target Organ(s)	Combined Uncertainty/ Modifying Factors	Sources of RfC/ Target Organ	(1) Reference Dates (MM/DD/YY)
Aluminum	Chronic	5	$\mu g/m^3$	Nervous System	300	PPRTV	02/13/17
Antimony	--	--	--	--	--	--	--
Arsenic	Chronic	0.015	$\mu g/m^3$	Various	30	REL	02/13/17
Barium	Chronic	0.5	$\mu g/m^3$	Fetus	1000	HEAST	12/01/11
Beryllium	Chronic	0.02	$\mu g/m^3$	Lung	10	IRIS	02/13/17
Cadmium	Chronic	0.01	$\mu g/m^3$	Kidney	10	MRL	03/01/16
Chromium VI	Chronic	0.1	$\mu g/m^3$	Lung	90	IRIS	02/13/17
Chromium VI	Subchronic	0.3	$\mu g/m^3$	Lung	30	MRL	03/01/16
Cobalt	Chronic	0.006	$\mu g/m^3$	Lung	300	PPRTV	02/13/17
Copper	--	--	--	--	--	--	--
Iron	--	--	--	--	--	--	--
Lead (2)	NA	NA	NA	NA	NA	NA	NA
Manganese	Chronic	0.05	$\mu g/m^3$	Nervous System	1000	IRIS	02/13/17
Mercury	Chronic	0.3	$\mu g/m^3$	Nervous System	30	IRIS	02/13/17
Nickel	Chronic	0.014	$\mu g/m^3$	Respiratory System	100	REL	02/13/17
Nickel	Subchronic	0.2	$\mu g/m^3$	Respiratory System	100	MRL	03/01/16
Selenium	Chronic	20	$\mu g/m^3$	Various	--	REL	02/13/17
Silver	--	--	--	--	--	--	--
Thallium	--	--	--	--	--	--	--
Vanadium	Chronic	0.1	$\mu g/m^3$	Respiratory System	30	MRL	03/01/16
Zinc	--	--	--	--	--	--	--

ED_001709_00002224-00083

TABLE 5.2
NON-CANCER TOXICITY DATA - INHALATION
RAGS Part D, Table 5)
Leviathan Mine Site
Alpine County, California

Notes

(1) For IRIS values, the date IRIS was searched is provided.
For MRL values, the date of the current MRL list is provided.
For PPRTV values, the date of database search is provided.
For REL values, the date the OEHHA toxicity criteria database was searched is provided.
For HEAST values, the date of HEAST publication is provided.

(2) Lead is not evaluated using an RfC approach.

Abbreviations

-- = Not available
HEAST= Health Effects Assessment Summary Tables (U.S. EPA, 2011)
IRIS = Integrated Risk Information System (U.S. EPA, 2017a)
MRL = Minimal Risk Level (ATSDR, 2016)
$\mu g/m^3$ = micrograms per cubic meter
NA = Not applicable
OEHHA = Office of Environmental Health Hazard Assessment
PPRTV = Preliminary Peer Reviewed Toxicity Values (U.S. EPA, 2017b)
RfC = Reference concentration
REL = Reference Exposure Level (OEHHA, 2017)

TABLE 6.1
CANCER TOXICITY DATA - ORAL/DERMAL
(RAGS Part D, Table 6)
Leviathan Mine Site
Alpine County, California

Chemical of Potential Concern	Oral Cancer Slope Factor (SF_O)	(1) Oral to Dermal Adjustment Factor (ABS_{GI})	(2) Adjusted Dermal Cancer Slope Factor (SF_{ABS})	Units	Weight of Evidence/ Cancer Guideline Description	(3) Source of SF_O / Weight of Evidence	(4) Date (MM/DD/YY)
Aluminum	--	100%	--	--	--	--	--
Antimony	--	15%	--	--	--	--	--
Arsenic	1.5	100%	1.5	$(mg/kg\text{-}day)^{-1}$	A	OEHHA/IRIS	02/13/17
Barium	--	7%	--	--	D	IRIS	02/13/17
Beryllium	--	0.7%	--	--	--	--	--
Cadmium (soil or diet)	--	2.5%	--	--	--	--	--
Cadmium (water)	--	5.0%	--	--	--	--	--
Chromium III	--	1.3%	--	--	D	IRIS	02/13/17
Chromium VI	0.5	2.5%	20	$(mg/kg\text{-}day)^{-1}$	D	OEHHA/IRIS	02/13/17
Cobalt	--	100%	--	--	--	--	--
Copper	--	100%	--	--	--	--	--
Iron	--	100%	--	--	--	--	--
Lead (5)	--	--	--	--	B2	IRIS	02/13/17
Manganese (soil or water)	--	4%	--	--	D	IRIS	02/13/17
Manganese (dietary)	--	100%	--	--	D	IRIS	02/13/17
Mercury	--	100%	--	--	D	IRIS	02/13/17
Nickel	--	4%	--	--	--	--	--
Selenium	--	100%	--	--	D	IRIS	02/13/17
Silver	--	4%	--	--	D	IRIS	02/13/17
Thallium	--	100%	--	--	D	IRIS	02/13/17
Vanadium	--	2.6%	--	--	--	--	--
Zinc	--	100%	--	--	D	IRIS	02/13/17

TABLE 6.1
CANCER TOXICITY DATA - ORAL/DERMAL
(RAGS Part D, Table 6)
Leviathan Mine Site
Alpine County, California

Notes

(1) Refer to RAGS, Part E (U.S. EPA, 2004)

(2) $SF_{ABS} = SF_O / ABS_{gi}$

(3) IRIS = Integrated Risk Information System (U.S. EPA, 2017a)
OEHHA = Office of Environmental Health Hazard Assessment (OEHHA, 2017)

(4) For IRIS values, the date IRIS was searched is provided.
For OEHHA values, the date the OEHHA toxicity criteria database was searched is provided.

(5) OEHHA has published an inhalation unit risk value for lead; however, lead will be evaluated using the U.S. EPA's IEUBK model and adult lead model (ALM).

Abbreviations

Weight of Evidence / EPA Group:

A = Human carcinogen

B1 = Probable human carcinogen - indicates that limited human data are available

B2 = Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans

C = Possible human carcinogen

D = Not classifiable as a human carcinogen

$(mg/kg\text{-}day)^{-1}$ = risk per milligrams per kilogram per day

-- = Not available

TABLE 6.2
CANCER TOXICITY DATA - INHALATION
(RAGS Part D, Table 6)
Leviathan Mine Site
Alpine County, California

Chemical of Potential Concern		Inhalation Unit Risk (IUR)	Units	Weight of Evidence/ Cancer Guideline Description	(1) Sources of IUR / Weight of Evidence	(2) Date (MM/DD/YY)
Aluminum		--	--	--	--	--
Antimony		--	--	--	--	--
Arsenic		0.0043	$(\mu g/m^3)^{-1}$	A	IRIS	02/13/17
Barium		--	--	D	IRIS	02/13/17
Beryllium		0.0024	$(\mu g/m^3)^{-1}$	B1	IRIS	02/13/17
Cadmium		0.0018	$(\mu g/m^3)^{-1}$	B1	IRIS	02/13/17
Chromium III		--	--	D	IRIS	02/13/17
Chromium VI		0.012	$(\mu g/m^3)^{-1}$	A	IRIS	02/13/17
Cobalt		0.009	$(\mu g/m^3)^{-1}$	LI	PPRTV	02/13/17
Copper		--	--	--	--	--
Iron		--	--	--	--	--
Lead	(3)	--	--	B2	IRIS	02/13/17
Manganese		--	--	D	IRIS	02/13/17
Mercury		--	--	D	IRIS	02/13/17
Nickel		0.00026	$(\mu g/m^3)^{-1}$	A	OEHHA/IRIS	02/13/17
Selenium		--	--	D	IRIS	02/13/17
Silver		--	--	D	IRIS	02/13/17
Thallium		--	--	--	--	--
Vanadium		--	--	--	--	--
Zinc		--	--	D	IRIS	02/13/17

TABLE 6.2
CANCER TOXICITY DATA - INHALATION
(RAGS Part D, Table 6)
Leviathan Mine Site
Alpine County, California

Notes

(1) IRIS = Integrated Risk Information System (U.S. EPA, 2017a)
OEHHA = Office of Environmental Health Hazard Assessment (OEHHA, 2017)
PPRTV = Provisional Peer Reviewed Toxicity Value (U.S. EPA, 2017b)

(2) For IRIS values, the date IRIS was searched is provided.
For OEHHA values, the date the OEHHA Toxicity Criteria Database was searched is provided.
For PPRTV values, the date the PPRTV database was searched is provided.

(3) OEHHA has published an inhalation unit risk value for lead; however, lead will be evaluated using the U.S. EPA's IEUBK model and adult lead model (ALM).

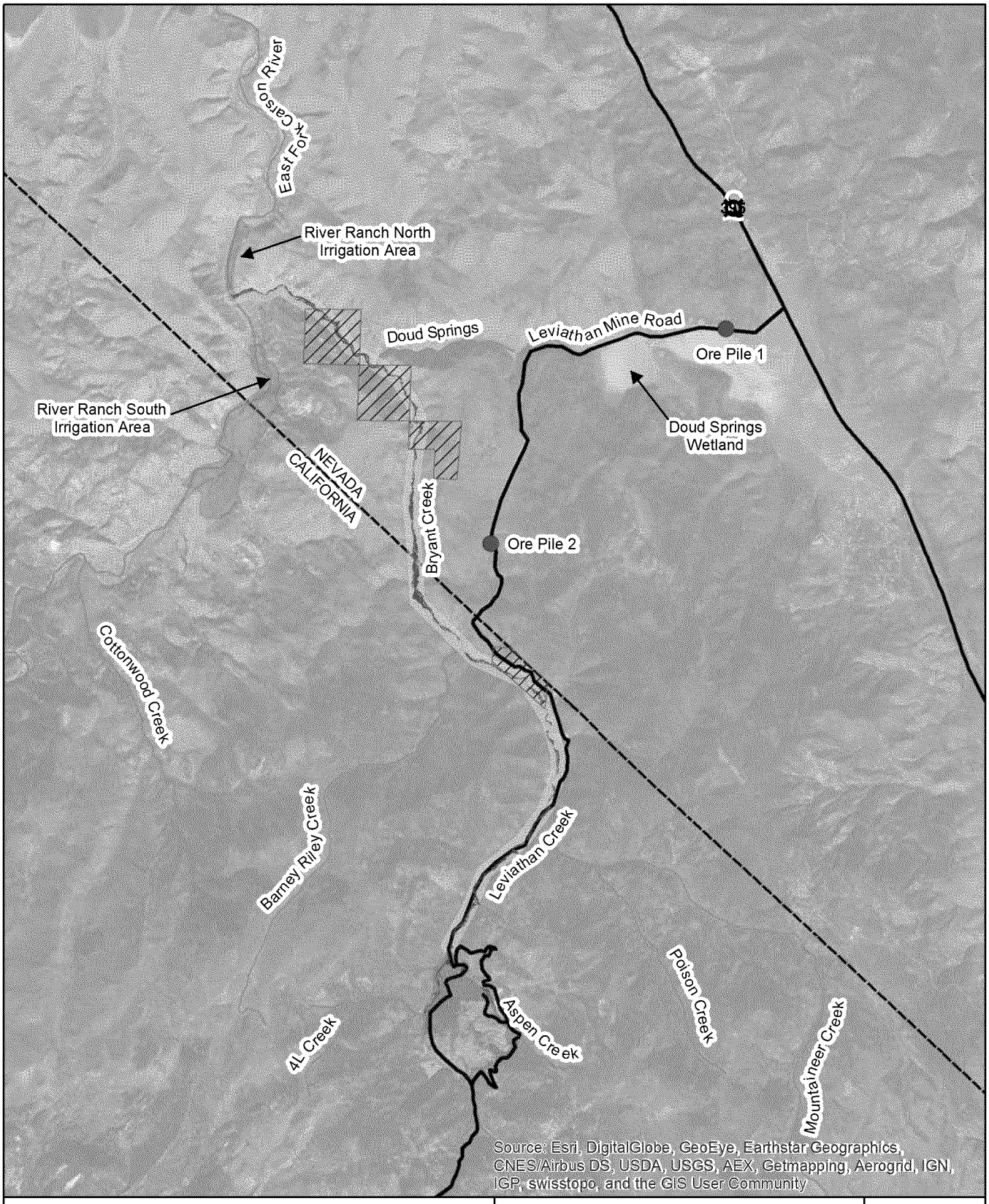
Abbreviations

-- = Not available

$(\mu g/m^3)^{-1}$ = risk per microgram per cubic meter

Weight of Evidence/EPA Group:
A = Human carcinogen
B1 = Probable human carcinogen – indicates that limited human data are available.
B2 = Probable human carcinogen – indicates sufficient evidence in animals and inadequate or no evidence in humans
C = Possible human carcinogen
D = Not classifiable as a human carcinogen
LI = Likely to be carcinogenic to humans by inhalation route

FIGURES



Explanation

- Downstream Study Area (Bounded by Extent of Floodplain Soil)
- On Property Study Area
- Floodplain Terraces
- Pine Nut Allotments
- Creek
- Leviathan Mine Road and Access Roads

0 4,000 Feet

LEVIATHAN MINE RI/FS
STUDY AREAS
Leviathan Mine Site
Alpine County, California

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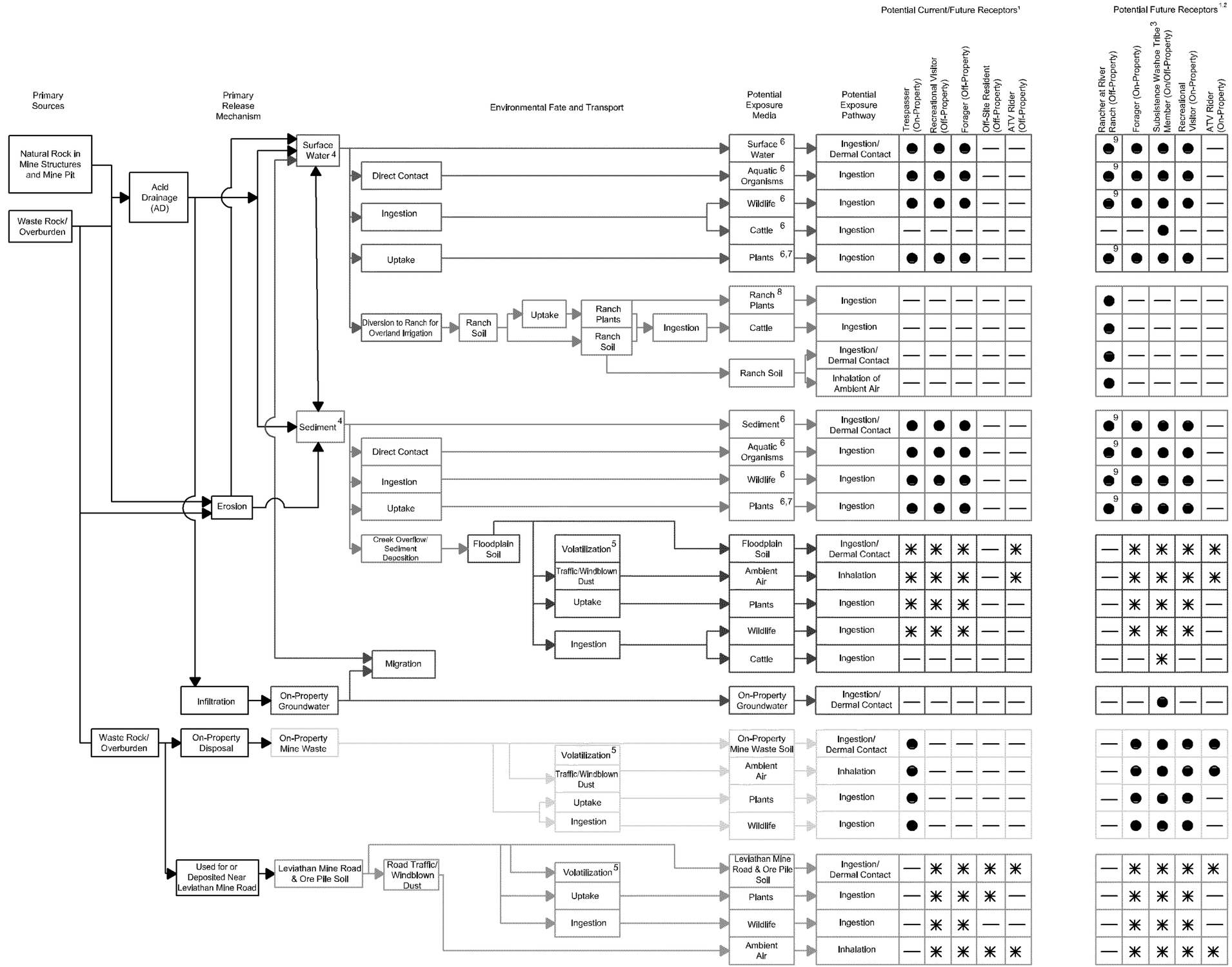
Date: 04/22/2015 | Project No. 0013091

Figure 1

P:\Project\13000s\13091 Leviathan\14000 Database_CAD\CAD\DrawingFiles\HHRA\SiteMap_SAr.mxd



Explanation

- ● Potentially complete exposure pathway
- ✳ Potentially complete exposure pathway, pending additional data
- — Incomplete exposure pathway

Pathways related to:

- Surface Water
- River Ranch Soil
- Sediment
- Flood Plain Soil
- Groundwater
- On-Property Mine Waste
- Leviathan Mine Road & Ore Pile Soil

Notes:

1. The Leviathan Mine RI/FS activities address three separate areas. The On-property Study Areas are within the boundaries of the former mine site and are comprised of the Leviathan Creek, Aspen Creek, and Pit study areas. The Off-property Study Area is the riparian corridor along Leviathan Creek, beyond the On-property Study Areas, and Bryant Creek, which begins after the confluence of Leviathan and Mountaineer Creeks and ends at the confluence with East Fork Carson River. The Supplemental Study Areas include River Ranch, Leviathan Mine Road, the ore piles on Leviathan Mine Road, and East Fork Carson River, and will be included in the baseline human health risk assessment if the media have been impacted by the Leviathan Mine.
2. If institutional controls restricting on-property access are sufficiently documented as final remedies, these future on-property receptors may not be relevant.
3. At U.S. EPA's request, the Subsistence Washoe Tribe Member scenario is assumed to be present throughout the Leviathan Mine Study Area.
4. Surface water and sediment exposure pathways are relevant to Leviathan, Aspen and Bryant Creeks. East Fork Carson River is a supplemental study area, which will be included in the baseline human health risk assessment if it is adversely impacted by the Leviathan Mine.
5. Only one RI/FS analyte is considered volatile, mercury. Potential exposure to mercury volatilized from soil at this site is not considered significant.
6. Only applies in areas where surface water is present (e.g., not applicable to the Pit Study Area).
7. Plant tissue concentrations will not be evaluated separately for soil/sediment and water uptake. They will be evaluated using dry weight analytical results for soil/sediment, which accounts for metals concentrations from both sources.
8. Water that could be diverted from Bryant Creek for soil irrigation at River Ranch will be addressed using the results of soil sampling performed on the River Ranch property. Even if water from Bryant Creek was used to irrigate plants, the residual concentrations in the soil are the primary measure of COPCs for uptake by the plants.
9. Potential exposure to surface water and sediment for the Rancher at River Ranch will be based on measurements in the portion of Bryant Creek nearest the irrigation diversions that lead to the River Ranch property and/or the locations where Bryant Creek runs closest to the River Ranch property.

HUMAN HEALTH CONCEPTUAL SITE MODEL
Leviathan Mine Site
Alpine County, California

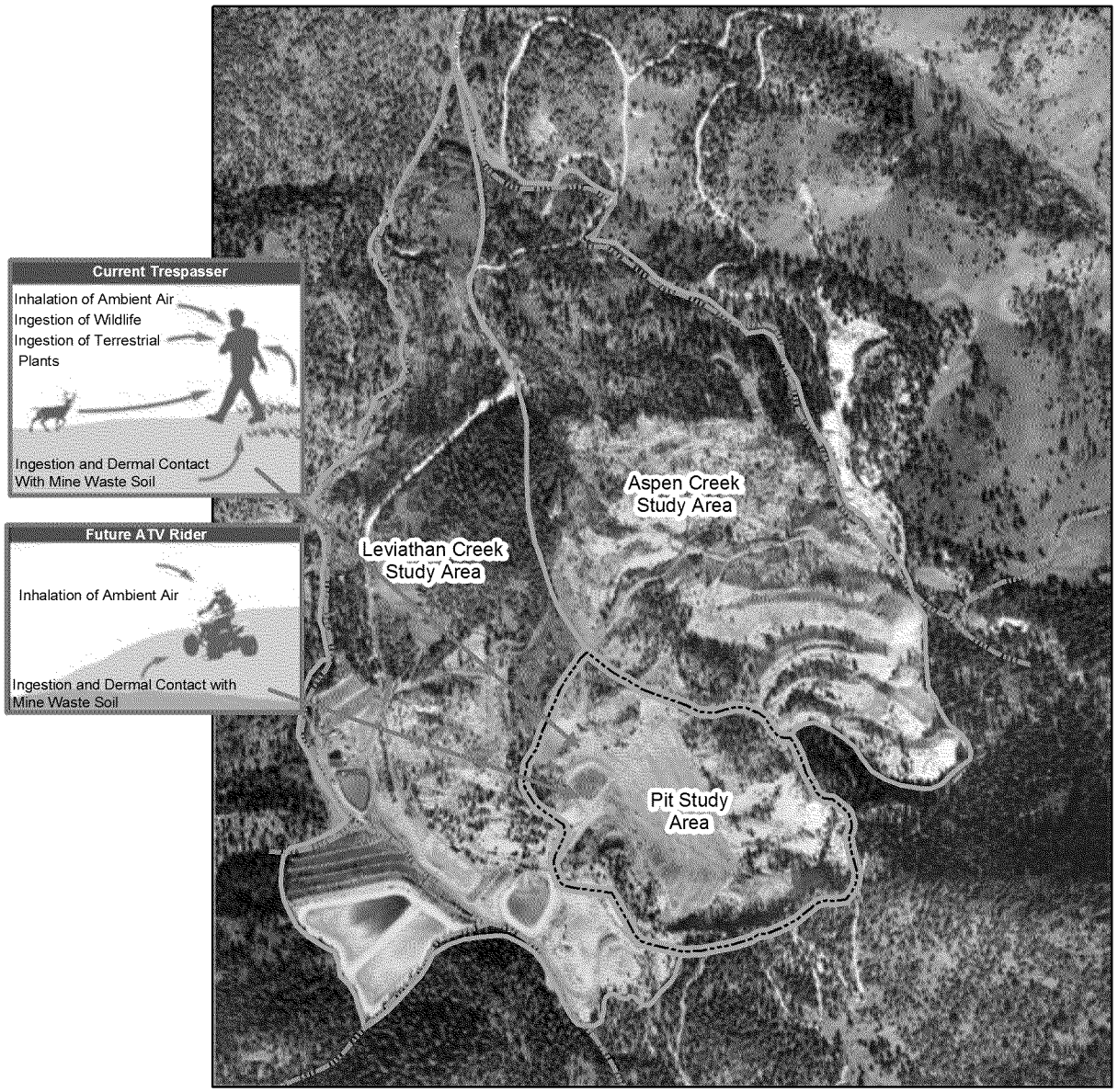
amec foster wheeler

Figure 2

By: dpv | Date: 02/24/17 | Project No. 0013091

Plot Date: 02/24/17 - 2:47pm, Plotted by: donna.valasek
Drawing Path: P:\Project\13000s\13091 Leviathan\14000 Database_CAD\CAD\DrawingFiles\HHRA\, Drawing Name: HumanHealthSiteModel.dwg

P:\Project\13000s\13091 Leviathan\14000 Database_CAD\CAD\DrawingFiles\HHRA\PitStudyArea.mxd



Explanation

Creek

On-Property Study Area

0 1,000 Feet

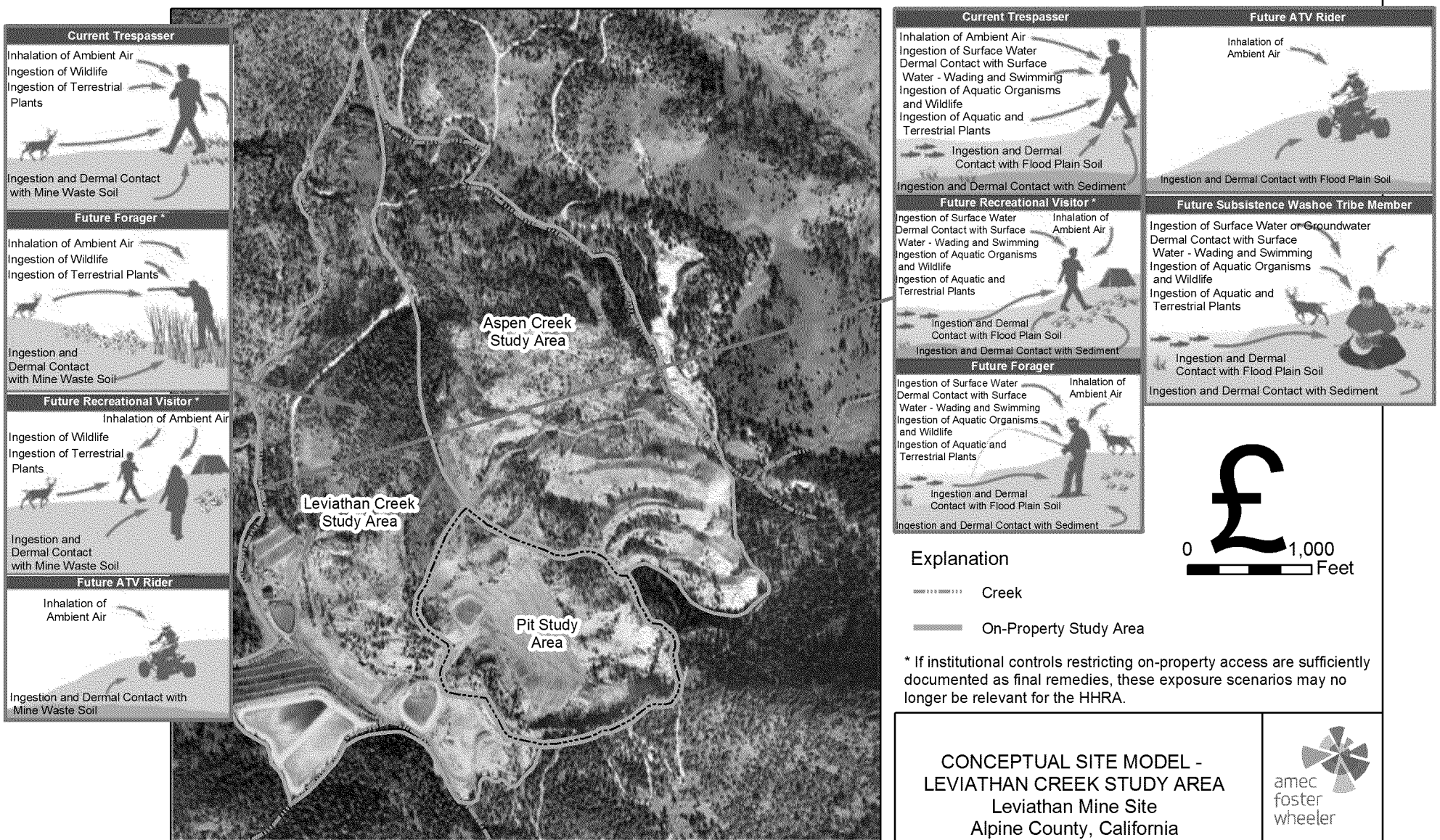
CONCEPTUAL SITE MODEL - PIT STUDY AREA
Leviathan Mine Site
Alpine County, California

amec foster wheeler

Date: 02/24/2017 | Project No. 0013091

Figure 3

P:\Project\13000s\13091 Leviathan\14000 Database_CAD\CAD\DrawingFiles\HHRA\LCSA.mxd



* If institutional controls restricting on-property access are sufficiently documented as final remedies, these exposure scenarios may no longer be relevant for the HHRA.

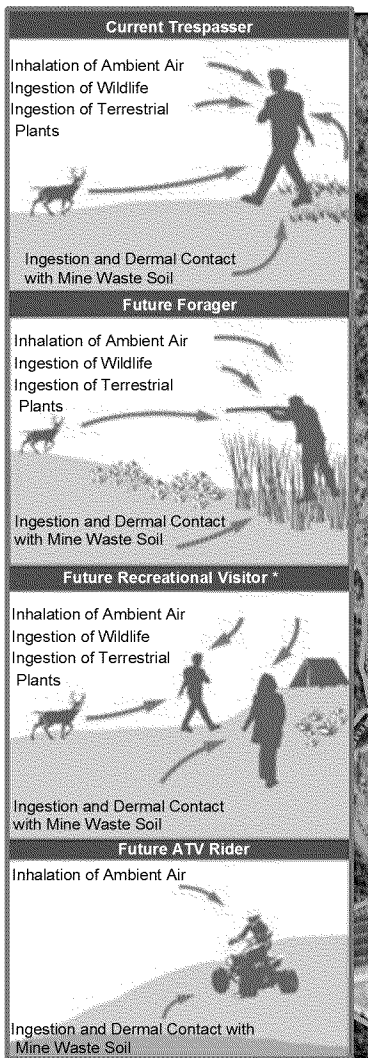
CONCEPTUAL SITE MODEL - LEVIATHAN CREEK STUDY AREA
Leviathan Mine Site
Alpine County, California

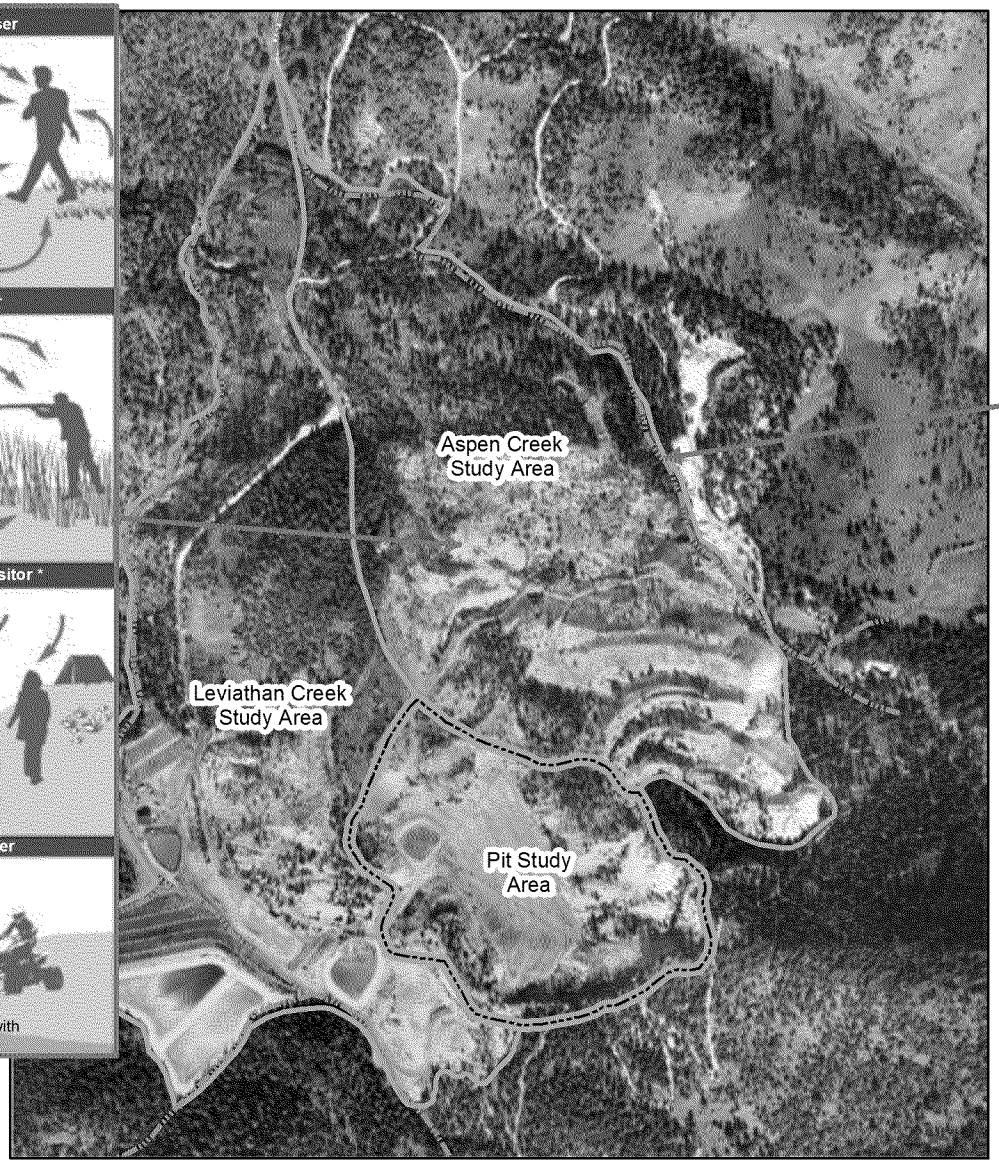
amec foster wheeler

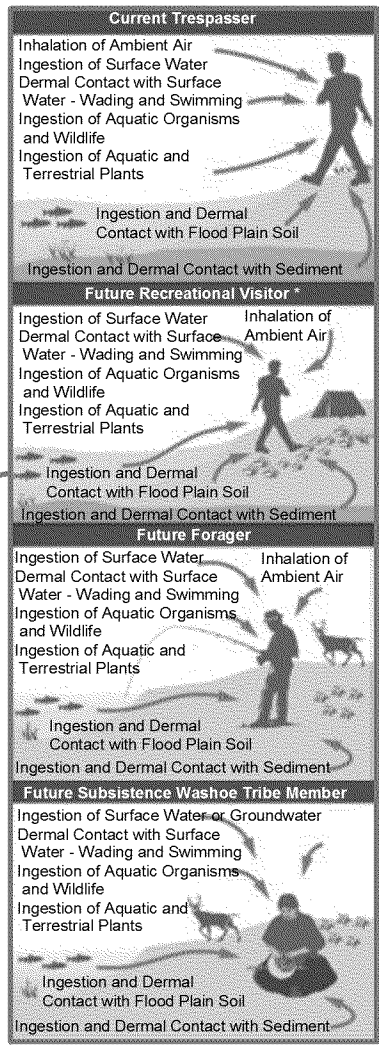
Date: 02/24/2017 | Project No. 0013091

Figure 4

P:\Project\13000s\13091 Leviathan\14000 Database_CAD\CAD\DrawingFiles\HHRA\ACSAr.mxd







0 1,000 Feet

Explanation

Creek

On-Property Study Area

* If institutional controls restricting on-property access are sufficiently documented as final remedies, these exposure scenarios may no longer be relevant for the HHRA.

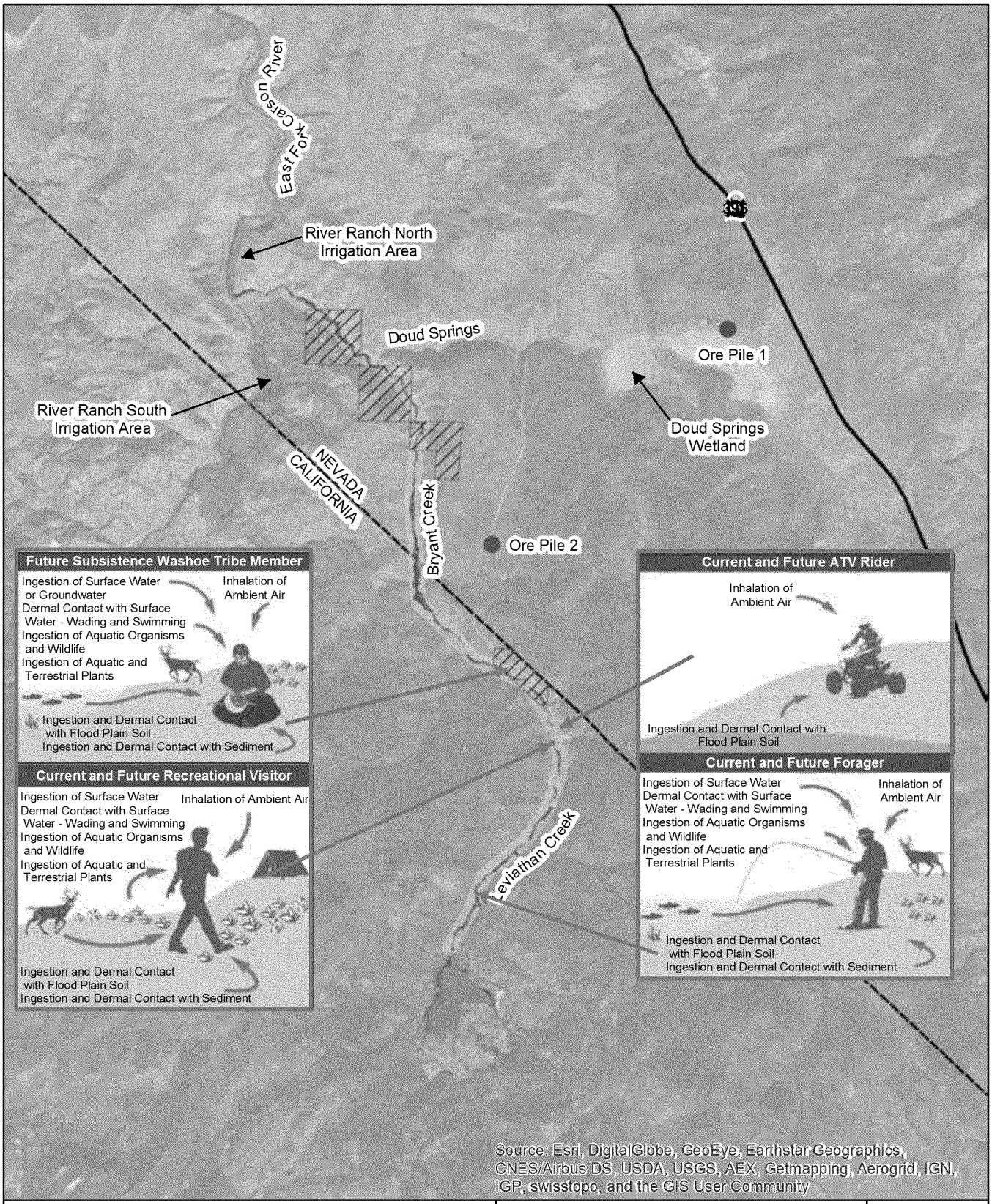
CONCEPTUAL SITE MODEL - ASPEN CREEK STUDY AREA
Leviathan Mine Site
Alpine County, California

amec foster wheeler

Date: 02/24/2017 | Project No. 0013091

Figure 5

ED_001709_00002224-00094



Explanation

- Downstream Study Area (Bounded by Extent of Floodplain Soil)
- On Property Study Area
- Floodplain Terraces
- Pine Nut Allotments
- Creek

0 4,000 Feet

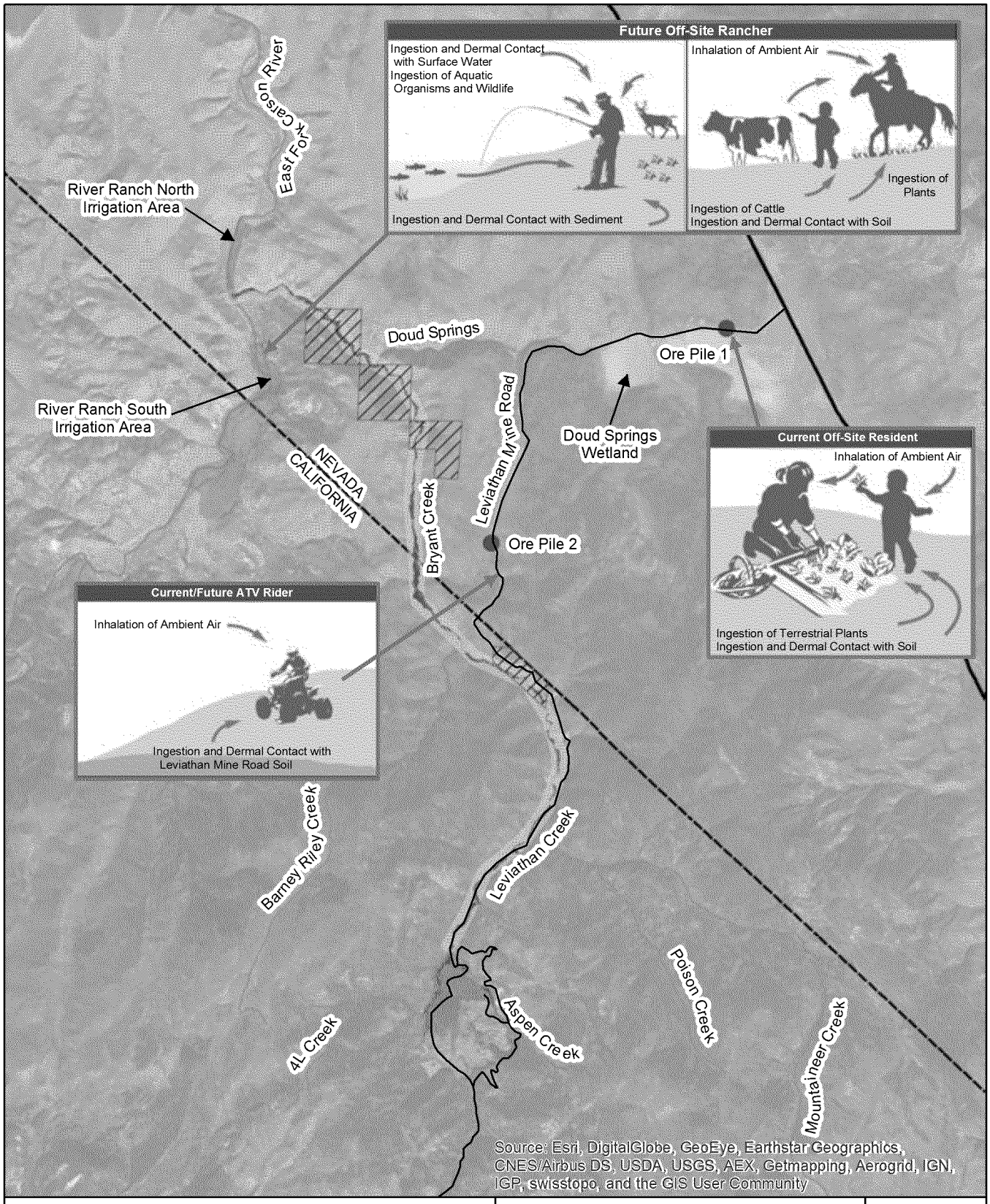
CONCEPTUAL SITE MODEL - DOWNSTREAM STUDY AREA
Leviathan Mine Site
Alpine County, California

amec foster wheeler

Date: 02/24/2017 | Project No. 0013091

Figure 6

P:\Project\13000s\13091 Leviathan\14000 Database_CAD\CAD\DrawingFiles\HHRA\DownstreamSA.mxd



Explanation

- Downstream Study Area (Bounded by Extent of Floodplain Soil)
- On Property Study Area
- Floodplain Terraces
- Pine Nut Allotments
- Creek

0 4,000 Feet

CONCEPTUAL SITE MODEL - SUPPLEMENTAL STUDY AREAS
Leviathan Mine Site
Alpine County, California

amec foster wheeler

Date: 02/28/2017 | Project No. 0013091

Figure 7

P:\Project\13000s\13091 Leviathan\14000 Database_CAD\CAD\DrawingFiles\HHRA\SupplementalSA.mxd

APPENDIX A

Specific Descriptions of the Exposure Scenarios

APPENDIX A-1
DETAILED DESCRIPTION OF EXPOSURE PARAMETERS – CURRENT TRESPASSER
Leviathan Mine Site
Alpine County, California

Nevertheless, it is assumed an adult trespasser could access the mine on foot since it is a large area that is not always monitored or occupied. The trespasser would be anticipated to be present for up to one week in a single year. The likelihood of this exposure scenario is limited by the restricted roadway access, winter weather conditions, the remote location, periodic activities related to remediation, and unrestricted access to alternative areas outside the mine operations area. The Current Trespasser is assumed to be an adult with a body weight of 80 kilograms (DTSC, 2014; U.S. EPA, 2014).

A Current Trespasser potentially could be exposed directly to soil via incidental ingestion, dermal contact, and inhalation of airborne particulates. The Current Trespasser may also consume plants and wildlife exposed to soil. Where surface water is present, this receptor potentially could be exposed directly to COPCs in surface water and sediment via dermal contact (during swimming[1] or wading) and incidental ingestion. Also, in areas where surface water is present, this receptor may ingest aquatic organisms, plants, and wildlife potentially affected by COPCs in surface water and sediment. It is conservatively assumed that this receptor may be exposed by all of these exposure pathways each day at the site. The specific RME exposure parameters for these exposure pathways relevant to a Current Trespasser are described below. These conservative parameters will be re-evaluated if RME exposures for this receptor appear to be of concern.

Ingestion of surface water: The exposure parameter specific to this exposure pathway is surface water ingestion rate. The surface water ingestion rate for a Current Trespasser is assumed to be 2.5 liters per day (L/day) (DTSC, 2014; U.S. EPA, 2014).

Dermal contact with surface water via wading: The three exposure parameters specific to this exposure pathway are body surface area, event duration, and event frequency. The body surface area for a Current Trespasser assumed to be in contact with surface water during wading is based on the assumption that the head, hands, lower legs, and feet are in contact with water. The surface area for these body parts is assumed to be 6,032 square centimeters (cm^2) (DTSC, 2014; U.S. EPA, 2014). A Current Trespasser was assumed to wade for one hour per day, which is also consistent with the assumptions in the Public Health Assessment

[1] Swimming will only be considered applicable if an area of pooled water greater than 3-foot in depth is identified.

(ATSDR, 2003). The frequency of wading was assumed to be one event per day at the overall exposure frequency, 7 days.

Dermal contact with surface water while swimming: The three exposure parameters specific to this exposure pathway are body surface area, event duration, and event frequency. The body surface area for an adult is assumed to be 20,900 cm^2 (DTSC, 2014; U.S. EPA, 2014). A Current Trespasser was assumed to swim for 0.71 hours per day (U.S. EPA, 2014). The frequency of swimming was assumed to be one event per day for two days out of the total exposure frequency of 7 days (approximately 30 percent of the time) based on assumptions in the Public Health Assessment (ATSDR, 2003) and the U.S. EPA's Exposure Factors Handbook (U.S. EPA, 2011c).

Ingestion of aquatic organisms: The two exposure parameters specific to this exposure pathway are fraction of aquatic organisms from the study area and ingestion rate. The fraction of organisms from the study area will be developed based on data collected regarding size and abundance of edible fish in the on-property and off-property creeks and reference creeks. This data will be collected as part of the FRI work plans. The Current Trespasser aquatic ingestion rate is assumed to be the 95th percentile aquatic organism ingestion rate for a freshwater recreational fisherman in Washington State of 42 grams per day (g/day) (U.S. EPA, 2011).

Ingestion of wildlife: The two exposure parameters specific to this exposure pathway are fraction of wildlife from the study area and ingestion rate. The fraction of wildlife from the study area will be assumed to be 100% unless an alternative approach is approved by U.S. EPA, and the concentration in wildlife will consider the wildlife's home range. The wildlife ingestion rate for a Current Trespasser is assumed to be 86 g/day based on 50 percent of the total daily mean meat consumption published in U.S. EPA's Exposure Factors Handbook (U.S. EPA, 2011c). The wildlife ingestion rate may be subdivided by type of wildlife depending on the data available.

Ingestion of plants: The two exposure parameters specific to this exposure pathway are fraction of plants from the study area and ingestion rate. The fraction of plants from the study area will be developed based on data collected regarding the presence of edible plants (both aquatic and terrestrial) observed in the study areas. This data will be collected as part of the FRI work plans. The plant ingestion rate for a Current Trespasser is assumed to be 132 g/day based on 50 percent of the total daily mean fruit and vegetable consumption published in U.S. EPA's Exposure Factors Handbook (U.S. EPA, 2011c) multiplied by an 80-kilogram body weight. We have assumed 50 percent of the total assuming that some food is brought to the area in

preparation for the excursion. The plant ingestion rate may be subdivided by type of plant depending on the data available.

Ingestion of soil: The exposure parameter specific to this exposure pathway is the soil ingestion rate. The soil ingestion rate for a Current Trespasser is assumed to be 150 mg/day based on the standard adult soil ingestion rate (U.S. EPA, 2014) increased by 50 percent to account for the increase from a campground (U.S. EPA, 2011c).

Dermal contact with soil: The exposure parameters specific to this exposure pathway are skin surface area, soil/skin adherence factor, and event frequency. The skin surface area is assumed to be 6,032 cm^2 per exposure event based on DTSC and U.S. EPA (DTSC, 2014; U.S., EPA, 2014). The soil/skin adherence factor is assumed to be 0.2 mg/cm^2 based on the default value for an industrial worker (DTSC, 2014). The event frequency is assumed to be one event per day.

Inhalation of soil particulates in ambient air: The exposure parameters specific to this exposure pathway are the particulate emission factor and exposure time. The particulate emission factor is assumed to be a default value for wind erosion (1.316×10^9 cubic meters per kilogram) published by U.S. EPA (U.S., EPA, 2002c). Site-specific air dispersion modeling may be developed as part of the FRI to replace this value. The exposure time is assumed to be an entire day (24 hours).

Ingestion of sediment: The exposure parameters specific to this exposure pathway are ingestion rate and exposure frequency. Ingestion of sediment is assumed to potentially occur while the Current Trespasser is wading in creeks. The ingestion rate is assumed to be 10 percent of the value for soil ingestion as sediment would be readily washed of the skin by surface water while wading before incidental ingestion occurs. The specific ingestion rate for the Current Trespasser is 15 mg/day, which is 10 percent of the soil ingestion rate for a camper as published by VDEQ (VDEQ, 2016). Since sediment ingestion would occur while wading, the exposure frequency is the same as for wading (7 days).

Dermal contact with sediment: The exposure parameters specific to this exposure pathway are skin surface area, sediment/skin adherence factor, and event frequency. The body surface area for a Current Trespasser who is assumed to be in contact with sediment during wading is based on the assumption that the lower leg, feet, and hands are in contact with sediment. The 50th percentile surface area for these body parts is 5,120 cm^2 per exposure event based on values published for lower leg, feet and hands of an adult male in U.S. EPA's Exposure Factors

Handbook (U.S. EPA, 2011c). The sediment/skin adherence factor was assumed to be 0.2 mg/cm^2 based on a 95th percentile value for landscape workers and pipe layers published by U.S. EPA (2004a). A Current Trespasser was assumed to wade for one hour per day also consistent with the assumptions in the Public Health Assessment (ATSDR, 2003). Since sediment contact would occur while wading, the exposure frequency is the same as for wading (7 days).

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APPENDIX A-2
DETAILED DESCRIPTION OF EXPOSURE PARAMETERS – CURRENT AND FUTURE RECREATIONAL VISITOR

Leviathan Mine Site
Alpine County, California

The Current or Future Recreational Visitor is assumed to be a child/adult who is present at the site for 14 days per year for a two-week vacation period. The assumptions in this evaluation assume a child is brought to the area with their parents for a vacation every year for six years and then spends an additional 20 years coming back to the area. The distinction between current and future relates to which portions of the site may be accessed because of fencing that currently limits access; the exposure rates are assumed to be the same. To be conservative, the recreational visitor is assumed to return every year for 26 years (20 years as an adult, 6 years as a child) as a conservative estimate of potential lifetime exposure for an individual (Section 3.2.3). The recreational visitor is assumed to be an adult with a body weight of 80 kilograms or a child with a body weight of 15 kilograms (DTSC, 2014; U.S. EPA, 2014).

A recreational visitor potentially could be exposed directly to COPCs in surface water and sediment via dermal contact (during swimming[1] or wading) and incidental ingestion. This receptor may ingest aquatic organisms, plants, and wildlife potentially affected by COPCs in surface water and sediment. This receptor potentially may be exposed directly to COPCs in soil via ingestion, dermal contact and inhalation of airborne particulates as well as by ingestion of plants and wildlife exposed to soil. It is conservatively assumed that this receptor may be exposed by all of these exposure pathways each day present at the site. The specific RME exposure parameters for these exposure pathways are described below. These conservative parameters will be re-evaluated if RME exposures for this receptor appear to be of concern.

Ingestion of surface water: The exposure parameter specific to this exposure pathway is surface water ingestion rate. The surface water ingestion rate for an adult recreational visitor is assumed to be 2.5 liters per day (L/day) (DTSC, 2014; U.S. EPA, 2014). For a child, the surface water ingestion rate is assumed to be 0.78 (L/day) (DTSC, 2014; U.S. EPA, 2014).

Dermal contact with surface water via wading: The three exposure parameters specific to this exposure pathway are body surface area, event duration, and event frequency. The body surface area for an adult recreational visitor assumed to be in contact with surface water during wading is based on the assumption that the head, hands, lower legs, and feet are in contact with water. The 50th surface area for these body parts is assumed to be 6,032 square centimeters (cm^2) (DTSC, 2014; U.S. EPA, 2014). For the child, the surface area is assumed to

[1] Swimming will only be considered applicable if an area of pooled water greater than 3-foot in depth is identified.

be 2,690 (cm^2) (DTSC, 2014; U.S. EPA, 2014). A recreational visitor was assumed to wade for one hour per day, which is also consistent with the assumptions in the Public Health Assessment (ATSDR, 2003). The frequency of wading was assumed to be one event per day for the same overall exposure frequency (14 days).

Dermal contact with surface water while swimming: The three exposure parameters specific to this exposure pathway are body surface area, event duration, and event frequency. The body surface area for an adult is assumed to be 20,900 cm^2 (DTSC, 2014; U.S. EPA, 2014). For the child, the surface area is assumed to be 6,378 (cm^2) (DTSC, 2014; U.S. EPA, 2014). A recreational visitor was assumed to swim for 0.71 hours per day (U.S. EPA, 2014). The frequency of swimming was assumed to be for four days out of the total exposure frequency of 14 days (approximately 30 percent of the time) based on assumptions made in the Public Health Assessment (ATSDR, 2003) and the U.S. EPA's Exposure Factors Handbook (U.S. EPA, 2011c).

Ingestion of aquatic organisms: The two exposure parameters specific to this exposure pathway are fraction of aquatic organisms from the study area and ingestion rate. The fraction of organisms from the study area will be developed based on data collected regarding size and abundance of edible fish in the on-property and off-property creeks and reference creeks. This data will be collected as part of the FRI work plans. The recreational visitor aquatic ingestion rate is assumed to be the 95th percentile aquatic organism ingestion rate for a visitor freshwater recreational fisherman in Washington State of 42 g/day (U.S. EPA, 2011). For the child, the aquatic organism ingestion rate is assumed to be the 95th percentile aquatic ingestion rate of freshwater recreational anglers in Washington State (29 g/day).

Ingestion of wildlife: The two exposure parameters specific to this exposure pathway are fraction of wildlife from the study area and ingestion rate. The fraction of wildlife from the study area will be assumed to be 100% unless an alternative approach is approved by U.S. EPA, and the concentration in wildlife will consider the wildlife's home range. The wildlife ingestion rate for an adult recreational visitor is assumed to be 86 g/day based on 50 percent of the total mean meat consumption published in U.S. EPA's Exposure Factors Handbook (U.S. EPA, 2011c). For the child, the wildlife ingestion rate is assumed to be 53 g/day based on the weighted average of the mean meat intake for a child from birth to 6 years (U.S. EPA, 2011c). We have assumed 50 percent of the total because typically some food is brought to the area in preparation for the excursion. The wildlife ingestion rate may be subdivided by type of wildlife depending on the data available.

Ingestion of plants: The two exposure parameters specific to this exposure pathway are fraction of plants from the study area and ingestion rate. The fraction of plants from the study area will be developed based on data collected regarding the presence of edible plants (both aquatic and terrestrial) observed in the study areas. This data will be collected as part of the FRI work plans. The plant ingestion rate for an adult recreational user is assumed to be 132 g/day based on 50 percent of the total mean daily consumption of vegetables and fruits published in U.S. EPA's Exposure Factors Handbook (U.S. EPA, 2011c) multiplied by an 80-kilogram body weight. For the child, the plant ingestion rate is the 50 percent of the age-weighted mean (96 g/day). We have assumed 50 percent of the total because typically some food is brought to the area in preparation for the excursion. The plant ingestion rate may be subdivided by type of plant depending on the data available.

Ingestion of soil: The exposure parameter specific to this exposure pathway is the soil ingestion rate. The soil ingestion rate for an adult recreational visitor is assumed to be 150 milligrams per day (mg/day) based on the standard adult soil ingestion rate (U.S. EPA, 2014) increased by 50 percent to account for the increase from a campground (U.S. EPA, 2011c). For the child, the soil ingestion rate is 200 mg/day (DTSC, 2014; U.S. EPA, 2014).

Dermal contact with soil: The exposure parameters specific to this exposure pathway are skin surface area, soil/skin adherence factor, and event frequency. The skin surface area is assumed to be 6,032 cm^2 based on DTSC and U.S. EPA (DTSC, 2014; U.S., EPA, 2014). For the child, the surface area is 2,900 cm^2 (DTSC, 2014). The soil/skin adherence factor for the adult recreation visitor is assumed to be 0.2 mg/cm^2 based on the default value for an industrial worker. For the child, the soil/skin adherence factor also is assumed to be 0.2 mg/cm^2 (DTSC, 2014). The event frequency is assumed to be one event per day.

Inhalation of soil particulates in ambient air: The exposure parameters specific to this exposure pathway are the particulate emission factor and exposure time. The particulate emission factor is assumed to be a default value for wind erosion (1.316×10^9 cubic meters per kilogram) published by U.S. EPA (U.S., EPA, 2002c). Site-specific values may be developed as part of the BHHRA to replace this value. The exposure time is assumed to be an entire day (24 hours).

Ingestion of sediment: The exposure parameters specific to this exposure pathway are ingestion rate and exposure frequency. Ingestion of sediment is assumed to potentially occur while the recreational visitor is wading in creeks. The ingestion rate is assumed to be 10 percent of the value for soil ingestion as sediment would be readily washed of the skin by surface water while wading before incidental ingestion occurs. The specific ingestion rate for the recreational

visitor is 15 mg/day, which is 10 percent of the soil ingestion rate for an adult as published by VDEQ (VDEQ, 2016). For the child, the sediment ingestion factor is assumed to be 20 mg/day which is 10 percent of the soil ingestion rate for a child as published by VDEQ (VDEQ, 2016). Since sediment ingestion would occur while wading, the exposure frequency is the same as for wading (14 days).

Dermal contact with sediment: The exposure parameters specific to this exposure pathway are skin surface area, sediment/skin adherence factor, and event frequency. The body surface area for a recreational visitor who is assumed to be in contact with sediment during wading assumes that the lower leg, feet, and hands are in contact with sediment. The 50th percentile surface area for these body parts is 5,120 cm^2 per exposure event based on values published for an adult male in U.S. EPA's Exposure Factors Handbook (U.S. EPA, 2011c). For the child, the surface area is assumed to be 2,900 cm^2 (DTSC, 2014). The sediment/skin adherence factor for the adult was assumed to be 0.2 mg/cm^2 based on the default industrial worker (DTSC, 2014). The sediment/skin adherence factor for the child also was assumed to be 0.2 mg/cm^2 (DTSC, 2014).A recreational visitor was assumed to wade for one hour per day also consistent with the assumptions in the Public Health Assessment (ATSDR, 2003). Since sediment contact would occur while wading, the exposure frequency is the same as for wading (14 days).

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APPENDIX A-3
DETAILED DESCRIPTION OF EXPOSURE PARAMETERS – CURRENT AND FUTURE ATV RIDER

Leviathan Mine Site
Alpine County, California

The Current or Future ATV Rider is assumed to be an adult who is present at the site for 52 days per year, one visit per week for the year. This is a conservative assumption considering that snow is present on parts of the site for months during the winter. The distinction between current and future relates to which portions of the site may be accessed because of fencing that currently limits access; the exposure rates are assumed to be the same. To be conservative, the ATV Rider is assumed to return every year for 26 years as a conservative estimate of potential lifetime exposure for an individual (Section 3.2.3). The ATV Rider is assumed to be an adult with a body weight of 80 kilograms (DTSC, 2014; U.S. EPA, 2014).

An ATV Rider potentially may be exposed directly to COPCs in soil via ingestion, dermal contact and inhalation of airborne particulates. It is conservatively assumed that this receptor may be exposed by all of these exposure pathways each day present at the site. The specific RME exposure parameters for these exposure pathways are described below. These conservative parameters will be re-evaluated if RME exposures for this receptor appear to be of concern.

Ingestion of soil: The exposure parameter specific to this exposure pathway is the soil ingestion rate. The soil ingestion rate for an adult ATV Rider is assumed to be 150 milligrams per day (mg/day) based on the standard adult soil ingestion rate (U.S. EPA, 2014) increased by 50 percent to account for the increased exposure at a campground (U.S. EPA, 2011c).

Dermal contact with soil: The exposure parameters specific to this exposure pathway are skin surface area, soil/skin adherence factor, and event frequency. The skin surface area is assumed to be 6,032 cm^2 based on DTSC and U.S. EPA (DTSC, 2014; U.S., EPA, 2014). The soil/skin adherence factor is assumed to be 0.2 mg/cm^2 based on the Default value for an industrial worker. The event frequency is assumed to be one event per day.

Inhalation of soil particulates in ambient air: The exposure parameters specific to this exposure pathway are the particulate emission factor and exposure time. The particulate emission factor of 2.9×10^5 cubic meters per kilogram (m^3/kg) is based on particulate emissions related to all-terrain vehicle (ATV).[1] The exposure time is assumed to be four hours a day.

[1] Based on a 3.4×10^{-6} kg/m^3 concentration in air. (http://www.atsdr.cdc.gov/HAC/pha/StandardMine051508/StandardMineHC050808.pdf)

APPENDIX A-4
DETAILED DESCRIPTION OF EXPOSURE PARAMETERS – FUTURE OFF-SITE RANCHER

Leviathan Mine Site
Alpine County, California

As described in the Revised BHHRA Work Plan, water from Bryant Creek has been diverted to two ranch irrigation ditches close to 8 miles downstream from the mine property. One ditch is several miles long and appears to be unlined. Surface water is distributed to the ranch via overland flow. Currently the irrigation ditches are not being used. The pH of water that would enter the diversion has been neutral for some time, and the irrigation ditches are less likely to attract receptors because fish are not present and water is only present intermittently.

Based on information available for the site, seeps and springs are likely to provide drinking water or water for the cattle, which are not related to the Leviathan Mine Site at this location. There does not appear to be a conveyance/plumbing system that would support use of diverted water from Bryant Creek as a water supply. However, COPCs may accumulate or may have accumulated in the irrigated soil over time resulting in the potential for direct contact exposure and inhalation of airborne particulates. Exposure to sediment and surface water in the irrigation ditches via dermal exposure and incidental ingestion (via wading or swimming[1]) will be evaluated based on sediment samples in the ditch and COPC concentrations in Bryant Creek, which is near River Ranch and may be accessed on occasion. As this receptor may also be exposed via consumption of plants grown in soil at the River Ranch. Due to the proximity of River Ranch to Bryant Creek, EPA has requested that we assume this receptor could be exposed to sediment and surface water in the creek, and may consume aquatic organisms and wildlife. Consumption of wildlife and consumption of cattle will be assessed independently, but not cumulatively.

For the RME, the Future Off-Site Rancher is assumed to be present for 350 days per year, assuming the rancher lives at the site. This scenario is listed as a “future” potential exposure scenario because there is a residential building on the property; however, it is in disrepair and not currently livable, and cattle operations have been discontinued. For the Revised BHHRA Work Plan, we have assumed that the rancher consumes cattle raised at the River Ranch although this is not occurring now and may or may not have occurred in the past or in the future. To define this possible scenario, we have assumed that the ranch personnel could have children that would be exposed via the same exposure pathways.

A Future Off-Site Rancher is assumed to be an adult or child who is present at the ranch for 350 days within a one year period for a total of 26 years (6 years as a child and 20 years as an

[1] Swimming will only be considered applicable if an area of pooled water greater than 3-foot in depth is identified.

adult) (Section 3.2.3 of the Revised BHHRA Work Plan). The body weight for the Future Off-Site Rancher is assumed to be 80 kilograms for an adult (DTSC, 2014; U.S. EPA, 2011c) and 15 kilograms for a child (DTSC, 2014; U.S. EPA, 2014). The specific RME exposure parameters for the exposure pathways relevant to a Future Off-Site Rancher are described below. These very conservative parameters will be re-evaluated if RME exposures for this receptor appear to be of concern.

Ingestion of surface water: The exposure parameter specific to this exposure pathway is surface water ingestion rate. Surface water would only be consumed while the Rancher was swimming or wading in Bryant Creek or the irrigation ditches (12 days per year). This incidental level of ingestion is at a much lower rate than standard consumption, with 0.053 and 0.09 L/day for an adult and child, respectively (U.S. EPA, 2011c).

Dermal contact with surface water via wading: The three exposure parameters specific to this exposure pathway are body surface area, event duration, and event frequency. The body surface area for a Future Off-Site Rancher as an adult assumed to be in contact with surface water during wading assumes that the head, hands, lower legs, and feet are in contact with water. The 50th percentile surface area for these body parts is assumed to be 6,032 square centimeters (cm^2) (DTSC, 2014; U.S. EPA, 2014). For the child, the surface area is assumed to be 2,690 (cm^2) (DTSC, 2014; U.S. EPA, 2014). A rancher was assumed to wade for one hour per day, which is also consistent with the assumptions in the Public Health Assessment (ATSDR, 2003). The frequency of wading was assumed to be one event per day for the same overall exposure frequency (12 days; 1 day per week for 12 weeks of summer).

Dermal contact with surface water while swimming: The three exposure parameters specific to this exposure pathway are body surface area, event duration, and event frequency. The body surface area for a Future Off-Site Rancher as an adult is assumed to be 20,900 cm^2 (DTSC, 2014; U.S. EPA, 2014). For the child, the surface area is assumed to be 6,378 (cm^2) (DTSC, 2014; U.S. EPA, 2014). A rancher was assumed to swim for 0.71 hours per day (U.S. EPA, 2014). The frequency of swimming was assumed to be for 12 days, with one swim per week for 12 weeks of summer.

Ingestion of aquatic organisms: The two exposure parameters specific to this exposure pathway are fraction of aquatic organisms from the study area and ingestion rate. The fraction of organisms from the study area will be developed based on data collected regarding size and abundance of edible fish in the on-property and off-property creeks and reference creeks. This data will be collected as part of the FRI work plans. The Future Off-Site rancher aquatic ingestion rate is assumed to be the 95th percentile aquatic organism ingestion rate for a visitor

freshwater recreational fisherman in Washington State of 42 g/day (U.S. EPA, 2011). For the child, the aquatic organism ingestion rate is assumed to be the 95th percentile aquatic ingestion rate of freshwater recreational anglers in Washington State (29 g/day).

Ingestion of plants: The two exposure parameters specific to this exposure pathway are fraction of plants from the study area and ingestion rate. The fraction of plants from the study area will be developed based on data collected regarding the presence of edible plants (both aquatic and terrestrial) observed in the study areas. This data will be collected as part of the FRI work plans. The plant ingestion rate for an adult rancher is assumed to be 132 g/day based on 50 percent of the total mean daily consumption of vegetables and fruits published in U.S. EPA's Exposure Factors Handbook (U.S. EPA, 2011c) multiplied by an 80-kilogram body weight. For the child, the plant ingestion rate is the 50 percent of the age-weighted mean We have assumed 50 percent of the total assuming some food is brought to the area in preparation for the excursion. The plant ingestion rate may be subdivided by type of plant depending on the data available.

Ingestion of beef: The one parameter specific to this exposure pathway is the beef ingestion rate. The beef ingestion rate for a Future Off-Site Rancher is assumed to be 62 g/day for an adult based on western consumption rate for home-produced beef published in U.S. EPA's Exposure Factors Handbook (U.S. EPA, 2011c, Table 11-5). For children, the beef ingestion rate is assumed to be 22 g/day based on weighted-average beef consumption from birth to five years old (U.S. EPA, 2008b).

Ingestion of soil: The exposure parameter specific to this exposure pathway is the soil ingestion rate. The soil ingestion rate for a Future Off-Site Rancher as an adult is assumed to be 100 mg/day based on a commercial/industrial scenario (DTSC, 2014; U.S. EPA, 2014). For a child, the soil ingestion rate is assumed to be 100 mg/day based on a central tendency estimate of exposure to soil and dust (EPA, 2008b).

Dermal contact with soil: The exposure parameters specific to this exposure pathway are skin surface area, soil/skin adherence factor, and event frequency. For the adult rancher, the skin surface area is assumed to be 6,032 cm^2 (DTSC, 2014; U.S. EPA, 2014). The soil/skin adherence factor is assumed to be 0.2 mg/cm^2 based on reference default industrial worker. The event frequency is assumed to be one event per day. For the child at the ranch, a surface area of 2,900 (DTSC, 2014) was assumed with a soil adherence factor of 0.2 mg/cm^2 (DTSC, 2014; U.S. EPA, 2014). The event frequency for children was assumed to be one event per day.

Inhalation of soil particulates in ambient air: The exposure parameters specific to this exposure pathway are the particulate emission factor and exposure time, which are the same for adults and children. The particulate emission factor is assumed to be a default value for wind erosion (1.316×10^9 cubic meters per kilogram) published by U.S. EPA (U.S., EPA, 2002c). Site-specific air dispersion modeling may be developed as part of the FRI to replace this value. The exposure time is assumed to be an entire day (24 hours).

Ingestion of sediment: The exposure parameters specific to this exposure pathway are ingestion rate and exposure frequency. Ingestion of sediment is assumed to potentially occur while the rancher is wading in creeks. The ingestion rate is assumed to be 10 percent of the value for soil ingestion as sediment would be readily washed of the skin by surface water while wading before incidental ingestion occurs. The specific ingestion rate for the rancher is 15 mg/day, which is 10 percent of the soil ingestion rate for an adult as published by VDEQ (VDEQ, 2016). For the child, the sediment ingestion factor is assumed to be 20 mg/day which is 10 percent of the soil ingestion rate for a child as published by VDEQ (VDEQ, 2016). Since sediment ingestion would occur while wading, the exposure frequency is the same as for wading (12 days).

Dermal contact with sediment: The exposure parameters specific to this exposure pathway are skin surface area, sediment/skin adherence factor, and event frequency. The body surface area for a rancher who is assumed to be in contact with sediment during wading assumes that the lower leg, feet, and hands are in contact with sediment. The 50th percentile surface area for these body parts is 5,120 cm^2 per exposure event based on values published for an adult male in U.S. EPA's Exposure Factors Handbook (U.S. EPA, 2011c). For the child, the surface area is assumed to be 2,900 cm^2 (DTSC, 2014). The sediment/skin adherence factor for the adult was assumed to be 0.2 mg/cm^2 based on the default industrial worker (DTSC, 2014). The sediment/skin adherence factor for the child was assumed to be 0.2 mg/cm^2 (DTSC, 2014). A recreational visitor was assumed to wade for one hour per day also consistent with the assumptions in the Public Health Assessment (ATSDR, 2003). Since sediment contact would occur while wading, the exposure frequency is the same as for wading (12 days).

APPENDIX A-5
DETAILED DESCRIPTION OF EXPOSURE PARAMETERS – CURRENT AND FUTURE OFF-SITE RESIDENT

Leviathan Mine Site
Alpine County, California

The RME Current and Future Off-Site Resident is assumed to be present for 350 days per year. These receptors are considered both current and future because they are off-site and not directly affected by access restrictions at the mine. In the Revised BHHRA Work Plan we have assumed that the resident consumes homegrown fruits or vegetables although it is not clear from available data whether this occurs. To define the possible scenario, we have assumed children could reside at the residence and would be exposed via the same exposure pathways. The Current and Future Off-Site Resident is assumed to be an adult or child who is present at the off-site residence for 350 days within a one year period for a total of 26 years (6 years as a child and 20 years as an adult) (Section 3.2.3). The body weight for the Current and Future Off-Site Resident is assumed to be 80 kilograms for an adult (DTSC, 2014; U.S. EPA, 2014) and 15 kilograms for a child (DTSC, 2014; U.S. EPA, 2014).

Although it is unclear whether waste rock and overburden from the site were used for construction of relevant portions of Leviathan Mine Road adjacent to the residential area, the inhalation pathway assumes that a Current or Future Off-Site Resident could be exposed to windblown dust and dust from road traffic that originates on Leviathan Mine Road near the residential area. If the windblown dust has deposited over time, the Current or Future Off-Site Resident could be exposed via direct contact with soil and ingestion of plants. This receptor is included to address exposures specific to an off-site residence in the supplemental study area; other exposure pathways, such as ingestion of wildlife, are addressed by other receptors.

Ingestion of plants: The two exposure parameters specific to this exposure pathway are fraction of plants from the study area and ingestion rate. The fraction of plants consumed from the residences is assumed to be 100 percent pending further analysis and concurrence by U.S. EPA. The plant ingestion rate for a Current and Future Off-Site Resident as an adult is assumed to be 237 grams per day (g/day) based on mean consumption rates of home-produced fruits and vegetables in the West (Table 13-14) and the weighted average home-produced fruit and vegetables in the West (Table 13-9) (U.S. EPA, 2011c). For a child, the plant ingestion rate was 144 g/day based on an age-weighted average ingestion rate for home-produced vegetables and fruits for a child 1 to 6 years old (U.S. EPA, 2008b). The plant ingestion rate may be subdivided by type of plant depending on the data available.

Ingestion of soil: The exposure parameter specific to this exposure pathway is the soil ingestion rate. The soil ingestion rate for a Current and Future Off-Site Resident as an adult is

assumed to be 100 mg/day based on a standard residential scenario (DTSC, 2014; U.S. EPA, 2014). For a child, the soil ingestion rate is assumed to be 200 mg/day based on a default child (DTSC, 2014; U.S. EPA, 2014).

Dermal contact with soil: The exposure parameters specific to this exposure pathway are skin surface area, soil/skin adherence factor, and event frequency. For the adult resident, the skin surface area is assumed to be 6,032 square centimeters (cm^2) based on DTSC and U.S. EPA (DTSC, 2014; U.S., EPA, 2014). The soil/skin adherence factor for an adult is assumed to be 0.07 mg/cm^2 for residents based on the same U.S. EPA reference. The event frequency is assumed to be one event per day. For the child at the off-site residence, the surface area is assumed to be 2,900 cm^2 (DTSC, 2014); the soil/skin adherence factor is assumed to be 0.2 (DTSC, 2014; U.S. EPA, 2014). The event frequency for children was assumed to be one event per day.

Inhalation of soil particulates in ambient air: The exposure parameters specific to this exposure pathway are the particulate emission factor and exposure time, which are the same for adults and children. The particulate emission factor will be calculated using air dispersion modeling based on the soil concentration. The exposure time is assumed to be an entire day (24 hours).

APPENDIX A-6
DETAILED DESCRIPTION OF EXPOSURE PARAMETERS – CURRENT AND FUTURE FORAGER

Leviathan Mine Site
Alpine County, California

A Current or Future Forager is assumed to be an adult and child who may be present near the mine for 60 days during the summer months every year for a 70-year lifetime (Section 3.2.3 of the Revised BHHRA Work Plan). The distinction between current and future relates to which portions of the site may be accessed because of fencing that currently limits access; the exposure rates are assumed to be the same. Although institutional controls that restrict on-property access are likely to continue, future foraging is included in this evaluation at this time. A Current and Future Forager could potentially be exposed directly to chemicals in surface water and sediment via dermal contact (during swimming[1] or wading) and ingestion during periodic visits to the site. The Forager could potentially also be exposed directly to soil via ingestion, dermal contact, and inhalation of airborne particulates. The Forager also could ingest fish, plants, and wildlife potentially affected by COPCs in surface water, sediment, and/or soil.

For the purpose of defining the possible scenario, we have assumed children may also be exposed via the same exposure pathways over the first 6 years of the 70-year lifetime. The body weight for the Current and Future Forager is assumed to be 80 kilograms for an adult (DTSC, 2014; U.S. EPA, 2014) and 15 kilograms for a child (DTSC, 2014; U.S. EPA, 2014). It is conservatively assumed that this receptor may be exposed by all of these exposure pathways each day at the site. The specific RME exposure parameters for these exposure pathways relevant to a Current or Future Forager are described below. These conservative parameters will be re-evaluated if RME exposures for this receptor appear to be of concern.

Ingestion of surface water: The exposure parameter specific to this exposure pathway is surface water ingestion rate. The surface water ingestion rate for an adult Forager is assumed to be 2.5 liters per day (L/day) (DTSC, 2014; U.S. EPA, 2014). The surface water ingestion rate for a child Forager is assumed to be 0.78 L/day (DTSC, 2014; U.S. EPA, 2014).

Dermal contact with surface water via wading: The three exposure parameters specific to this exposure pathway are body surface area, event duration, and event frequency. The body surface area assumed to be in contact with surface water during wading assumes that the head, hands, lower legs, and feet are in contact with water. The assumed surface area for these body parts is 6,032 square centimeters (cm^2) (DTSC, 2014; U.S. EPA, 2014). For a child, the surface area was assumed to be 2,690 cm^2 (DTSC, 2014; U.S. EPA, 2014). An adult or child Forager was assumed to wade for one hour per day, which is also consistent with the assumptions in the

[1] Swimming will only be considered applicable if an area of pooled water greater than 3-foot in depth is identified.

Public Health Assessment (ATSDR, 2003). The frequency of wading was assumed to be the same as for overall exposure frequency (60 days).

Dermal contact with surface water while swimming: The three exposure parameters specific to this exposure pathway are body surface area, event duration, and event frequency. The assumed total body surface area for an adult is 20,900 cm^2 (DTSC, 2014; U.S. EPA, 2014). For a child, the assumed total body surface area is 6,378 cm^2 (DTSC, 2014; U.S. EPA, 2014). An adult and child Forager were assumed to swim for one hour per day. The frequency of swimming was assumed to be for 24 days for both adults and children; twice per week for 12 weeks based on assumptions in the Public Health Assessment (ATSDR, 2003).

Ingestion of aquatic organisms: The two exposure parameters specific to this exposure pathway are fraction of aquatic organisms from the study area and ingestion rate. Based on information in the RME document, the fraction of fish available at the site is 0.71 based on data collected regarding size and abundance of edible fish in the on-property and off-property creeks and reference creeks. The aquatic organism daily ingestion rate for an adult Forager is assumed to be 142 grams per day (g/day) (based on the 200 g/day ingestion rate from the RME scenario (AESE, 2005b) multiplied by the fraction of aquatic organisms from the study area of 0.71.) The RME scenario was developed for a Subsistence Washoe Tribe Member rather than for periodic foraging. The aquatic organism ingestion rate for a child Forager is assumed to be 71 g/day based on 50 percent of the ingestion rate for the adult RME scenario (AESE, 2005b) multiplied by the 0.71 fraction of aquatic organisms from the study area.

Ingestion of wildlife: The two exposure parameters specific to this exposure pathway are fraction of wildlife from the study area and ingestion rate. The fraction of wildlife from the study area will be assumed to be 100% unless an alternative approach is approved by U.S. EPA, and the concentration in wildlife will consider the wildlife's home range. The wildlife ingestion rate for an adult Forager is assumed to be 200 g/day (including game and fowl) which is based on the total mean meat consumption rate for American Indians (U.S. EPA, 2011c). The wildlife ingestion rate for a child Forager is assumed to be 53 g/day based on the mean meat intake for a child from birth to 6 years old (Table 11-4, U.S. EPA, 20011c). The wildlife ingestion rate may be subdivided by type of wildlife depending on the data available.

Ingestion of plants: The two exposure parameters specific to this exposure pathway are fraction of plants from the study area and ingestion rate. The fraction of plants from the study area will be developed based on data collected regarding the presence of edible plants (both aquatic and terrestrial) observed in the study areas. This data will be collected as part of the FRI

work plans. The plant ingestion rate for an adult Forager is assumed to be 464 g/day, which is 100 percent of the total mean daily consumption rate of vegetables and fruit for Americans Indians published in U.S. EPA's Exposure Factors Handbook (U.S. EPA, 2011c). The plant ingestion rate for a child is assumed to be 192 g/day, which is the mean consumption rates of vegetables and fruit, weighted-for a child from birth to 6 years old (Table 9-1; U.S. EPA, 2011c). The plant ingestion rate may be aggregated across plants or subdivided by type of plant depending on the data available.

Ingestion of soil: The exposure parameter specific to this exposure pathway is the soil ingestion rate. The soil ingestion rate for an adult Forager is assumed to be 150 mg/day based on the standard adult soil ingestion rate (U.S. EPA, 2014) increased by 50 percent to account for the increase from a campground (U.S. EPA, 2011c). The soil ingestion rate for a child Forager is assumed to be 400 mg/day, based on the RME Scenario (AESE, 2005b) assuming a greater rate of use of natural resources and higher residual soil on grown and gathered plants than a typical resident

Dermal contact with soil: The exposure parameters specific to this exposure pathway are skin surface area, soil/skin adherence factor, and event frequency. The skin surface area for an adult Forager is assumed to be 6,032 cm^2 based on DTSC and U.S. EPA (DTSC, 2014; U.S., EPA, 2014). For the child Forager, the surface area is 2,900 cm^2 (DTSC, 2014). The soil/skin adherence factor for the adult recreation visitor is assumed to be 0.2 mg/cm^2 based on the default value for an industrial worker. For the child, the soil/skin adherence factor is assumed to be 0.2 mg/cm^2 (DTSC, 2014). The event frequency is assumed to be one event per day.

Inhalation of soil particulates in ambient air: The exposure parameters specific to this exposure pathway are the particulate emission factor and exposure time. The particulate emission factor is assumed to be a default value for wind erosion (1.316×10^9 cubic meters per kilogram) published by U.S. EPA (U.S., EPA, 2002c). The exposure time is assumed to be an entire day (24 hours) for both children and adults.

Ingestion of sediment: The exposure parameters specific to this exposure pathway are ingestion rate and exposure frequency. Ingestion of sediment is assumed to potentially occur while the Forager is wading in creeks. The specific ingestion rate for the adult Forager is 15 mg/day, which is 10 percent of the soil ingestion rate for an adult as published by VDEQ (VDEQ, 2016). The ingestion rate for a child Forager is assumed to be 10 percent of the soil ingestion rate for a child as published by AESE (AESE, 2005b). Since sediment ingestion would

occur while wading, the exposure frequency is the same as for wading for both children and adults (60 days).

Dermal contact with sediment: The exposure parameters specific to this exposure pathway are skin surface area, sediment/skin adherence factor, and event frequency. The body surface area for an adult Forager who is assumed to be in contact with sediment during wading assumes that the lower leg, feet, and hands are in contact with sediment. The 50th percentile surface area for these body parts is 5,120 cm^2 per exposure event based on values published for an adult male in U.S. EPA's Exposure Factors Handbook (U.S. EPA, 2011c). For the child Forager, the surface area is assumed to be 2,900 cm^2 (DTSC, 2014). The sediment/skin adherence factor for the adult Forager was assumed to be 0.2 mg/cm^2 based on the default industrial worker (DTSC, 2014). The sediment/skin adherence factor for a child's hands and feet was assumed to be 0.3 mg/cm^2 based on values published by U.S. EPA for a reed gatherer (U.S. EPA, 2004a).

An adult or child Forager was assumed to wade for one hour per day consistent with the assumptions in the Public Health Assessment (ATSDR, 2003). Since sediment contact would occur while wading, the exposure frequency is the same as for wading (60 days).

APPENDIX A-7
DETAILED DESCRIPTION OF EXPOSURE PARAMETERS – FUTURE SUBSISTENCE WASHOE TRIBE MEMBER

Leviathan Mine Site
Alpine County, California

A Future Subsistence Washoe Tribe member is assumed to be an adult and who may be present in the downstream study area on the nearest allotment to the mine for 365 days per year for a 70-year lifetime (Section 3.2.3). As requested by EPA, we are also evaluating Future Subsistence Washoe Tribe member who lives other places on the mine site. For the purpose of defining the possible scenario, we have assumed children may also be exposed via the same exposure pathways during the first six years of the 70-year lifetime. The body weight for the Future Subsistence Washoe Tribe Member is assumed to be 80 kilograms for an adult (DTSC, 2014; U.S. EPA, 2014) and 15 kilograms for a child (DTSC, 2014; U.S. EPA, 2014).

A Future Subsistence Washoe Tribe Member could potentially be exposed directly to COPCs in surface water and sediment via dermal contact (during swimming[1] or wading) and ingestion. The Future Subsistence Washoe Tribe Member also could potentially be exposed directly to soil via ingestion, dermal contact, and inhalation of airborne particulates. The Future Subsistence Washoe Tribe Member also could ingest aquatic organisms, plants, and wildlife potentially affected by COPCs in surface water, sediment, and/or soil. The specific exposure parameters for these exposure pathways relevant to a Future Subsistence Washoe Tribe Member are as follows.

Ingestion of surface water: The exposure parameter specific to this exposure pathway is surface water ingestion rate. The surface water ingestion rate for an adult Future Subsistence Washoe Tribe Member is assumed to be 3 liters per day (L/day) based on the RME Scenario (AESE, 2005b). The surface water ingestion rate for a child Future Subsistence Washoe Tribe is assumed to be 0.78 L/day (DTSC, 2014; U.S. EPA, 2014).

Dermal contact with surface water via wading: The three exposure parameters specific to this exposure pathway are body surface area, event duration, and event frequency. The body surface area for a Future Subsistence Washoe Tribe Member assumed to be in contact with surface water during wading is based on the assumption that the head, hands, lower legs, and feet are in contact with water. The assumed surface area for these body parts is 6,032 square centimeters (cm^2) (DTSC, 2014; U.S. EPA, 2014). For a child, the surface area was assumed to be 2,690 cm^2 (DTSC, 2014; U.S. EPA, 2014). A Future Subsistence Washoe Tribe Member (child or adult) was assumed to wade for one hour per day also consistent with the assumptions

[1] Swimming will only be considered applicable if an area of pooled water greater than 3-foot in depth is identified.

in the Public Health Assessment (ATSDR, 2003). Wading was assumed to occur daily over the 12 weeks of summer or for 84 days for both adults and children.

Dermal contact with surface water while swimming or bathing: The three exposure parameters specific to this exposure pathway are body surface area, event duration, and event frequency. The assumed total body surface area for an adult is 20,900 cm^2 (DTSC, 2014; U.S. EPA, 2014). For a child, the assumed total body surface area is 6,378 cm^2 (DTSC, 2014; U.S. EPA, 2014). A Washoe Tribe member (adult or child) was assumed to swim or bath for one hour per day. The frequency of bathing/swimming was assumed to be twice a week throughout the year (104 days) for both adults and children.

Ingestion of aquatic organisms: The two exposure parameters specific to this exposure pathway are fraction of aquatic organisms from the study area and ingestion rate. A value of 0.71 was selected for the fraction of organisms from the study area based on data collected regarding size and abundance of edible fish in the on-property and off-property creeks and reference creeks. The aquatic organism ingestion rate for an adult Future Subsistence Washoe Tribe Member is assumed to be 142 grams per day (g/day) based on the 200 g/day ingestion rate from the RME Scenario (AESE, 2005b) multiplied by the fraction of aquatic organisms from the study area of 0.71. The aquatic organism ingestion rate for a child Future Subsistence Washoe Tribe Member is assumed to be 71 g/day based on 50 percent of the ingestion rate for an adult Future Subsistence Washoe Tribe Member multiplied by the 0.71 fraction of aquatic organisms from the study area.

Ingestion of wildlife: The two exposure parameters specific to this exposure pathway are fraction of wildlife from the study area and ingestion rate. The fraction of wildlife from the study area will be assumed to be 100% unless an alternative approach is approved by U.S. EPA, and the concentration in wildlife will consider the wildlife's home range. The wildlife ingestion rate for an adult Future Subsistence Washoe Tribe Member is assumed to be 278 g/day based on 238 g/day for game and 40 g/day for fowl as presented in the RME Scenario (AESE, 2005b). The wildlife ingestion rate for a child Future Subsistence Washoe Tribe Member is assumed to be 53 g/day based on the mean meat intake weighted average for a child from birth to 6 years old (Table 11-4; U.S. EPA, 2011c). The wildlife ingestion rate may be subdivided by type of wildlife depending on the data available or may be replaced with the ingestion of livestock raised for subsistence tribal members.

Ingestion of plants: The two exposure parameters specific to this exposure pathway are fraction of plants from the study area and ingestion rate. The fraction of plants from the study

area will be developed based on data collected regarding the presence and biomass of edible plants (both aquatic and terrestrial) observed in the study areas.

The plant ingestion rate for an adult Future Subsistence Washoe Tribe Member is based on RME Scenario (AESE, 2005b). The plant ingestion rates are divided by plant category as follows:

Plant Category	Adult Plant Ingestion Rate (g/day)	Child Plant Ingestion Rate (g/day)
Pine nuts	80	40
Roots/tubers	300	150
Bulbs	300	150
Berries/fruits/garden vegetables	333	167
Greens	833	417
Seeds/grain	50	25
Honey/teas	40	20
Total	1936	968

The plant ingestion rates for a child are 50 percent of the adult ingestion rate (AESE, 2005b). The plant ingestion rate may be aggregated across plants or subdivided by type of plant depending on the data available.

Ingestion of soil: The exposure parameter specific to this exposure pathway is the soil ingestion rate. The soil ingestion rate for an adult Future Subsistence Washoe Tribe Member is assumed to be 400 mg/day based on the RME Scenario (AESE, 2005b) assuming a greater rate of use of natural resources and higher residual soil on grown and gathered plants than a typical resident. The soil ingestion rate for a child Future Subsistence Washoe Tribe Member is also assumed to be 400 mg/day based on the RME Scenario.

Dermal contact with soil: The exposure parameters specific to this exposure pathway are skin surface area, soil/skin adherence factor, and event frequency. The skin surface area for an adult Future Subsistence Washoe Tribe Member is assumed to be 6,032 cm^2 based on DTSC and U.S. EPA (DTSC, 2014; U.S., EPA, 2014). For the child Future Subsistence Washoe Tribe Member, the surface area is 2,900 cm^2 (DTSC, 2014). The soil/skin adherence factor for the Future Subsistence Washoe Tribe Member is assumed to be 0.2 mg/cm^2 based on the default

value for an industrial worker. For the child, the soil/skin adherence factor also is assumed to be 0.2 mg/cm^2 (DTSC, 2014). The event frequency is assumed to be one event per day.

Inhalation of soil particulates in ambient air: The exposure parameters specific to this exposure pathway are the particulate emission factor and exposure time. The particulate emission factor is assumed to be a default value for wind erosion (1.316x10^9 cubic meters per kilogram) published by U.S. EPA (U.S., EPA, 2002c). The exposure time is assumed to be an entire day (24 hours) for both children and adults.

Ingestion of sediment: The exposure parameters specific to this exposure pathway are ingestion rate and exposure frequency. Ingestion of sediment is assumed to potentially occur while the Washoe Tribe member is wading in creeks. The ingestion rate is assumed to be 10 percent of the value for soil ingestion as sediment would be readily washed of the skin by surface water while wading before incidental ingestion occurs. The specific ingestion rate for the Future Subsistence Washoe Tribe Member is 40 mg/day, which is 10 percent of the soil ingestion rate for the Future Subsistence Washoe Tribe Member (AESE, 2005b). The ingestion rate for a child Future Subsistence Washoe Tribe Member also was assumed to be 10 percent of the soil ingestion rate (40 mg/day). Since sediment ingestion would occur while wading, the exposure frequency is the same as for wading for both children and adults (84 days).

Dermal contact with sediment: The exposure parameters specific to this exposure pathway are skin surface area, sediment/skin adherence factor, and event frequency. The body surface area for an adult Future Subsistence Washoe Tribe member who is assumed to be in contact with sediment during wading assumes that the lower leg, feet, and hands are in contact with sediment. The 50th percentile surface area for these body parts is 5,120 cm^2 per exposure event based on values published for an adult male in U.S. EPA's Exposure Factors Handbook (U.S. EPA, 2011c). For the child Future Subsistence Washoe Tribe member, the surface area is assumed to be 2,900 cm^2 (DTSC, 2014). The sediment/skin adherence factor for the adult Future Subsistence Washoe Tribe Member was assumed to be 0.2 mg/cm^2 based on the default industrial worker (DTSC, 2014). The sediment/skin adherence factor for a child's hands and feet was assumed to be 0.3 mg/cm^2 based on values published by U.S. EPA for a reed gatherer (U.S. EPA, 2004a).

An adult or child Washoe Tribe member was assumed to wade for one hour per day consistent with the assumptions in the Public Health Assessment (ATSDR, 2003). Since sediment contact would occur while wading during the summer months, the exposure frequency is the same as for wading (84 days).