APPENDIX B-2: DRAFT SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT WORK PLAN FOR THE PIT LAKE OPERABLE UNIT

Yerington Mine Site

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ACRONYMS AND ABBREVIATIONS

ARC	Atlantic Richfield Company
BAF	bioaccumulation factor
BCG	Biota Concentration Guide
bgs	below ground surface
COPEC	chemical of potential ecological concern
CSM	conceptual site model
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FIR	food ingestion rate
Integral	Integral Consulting Inc.
LOAEL	lowest-observed-adverse-effects level
MDA	minimum detectable activity
MDL	method detection limit
NOAEL	no-observed-adverse-effects level
Order	Unilateral Administrative Order
ORNL	Oak Ridge National Laboratory
OU	operable unit
PCB	polychlorinated biphenyl
PEC	probable effect concentration
PRG	preliminary remediation goal
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
Site	Yerington Mine Site
SLERA	screening level ecological risk assessment
SLV	screening level value
TEC	threshold effect concentration
TRV	toxicity reference value
VOC	volatile organic compound

1 INTRODUCTION

This screening level ecological risk assessment (SLERA) work plan has been prepared by Integral Consulting Inc. (Integral), Foxfire Scientific, Inc., and Brown and Caldwell on behalf of Atlantic Richfield Company (ARC), in partial fulfillment of the requirements of Unilateral Administrative Order (Order), Docket number 9-2007-0005, which was issued by the U.S. Environmental Protection Agency (EPA) to ARC in January 2007. Among other requirements, the 2007 Order directs ARC to prepare a remedial investigation work plan for the Pit Lake operable unit (OU) of the Yerington Mine Site in Yerington, Nevada (the Site) (Figure 1-1).

This introduction provides a brief review of the setting and history of the Site, current and future land use, the overall approach and applicable guidance followed in conducting the SLERA, and the sources of data that will be used in the risk assessment. The remainder of the document consists of the following sections:

- Section 2—Data Evaluation
- Section 3—Screening Level Problem Formulation
- Section 4—Screening Level Ecological Effects Evaluation
- Section 5—Screening Level Exposure Assessment
- Section 6—Screening Level Risk Characterization
- Section 7—Uncertainty Assessment
- Section 8—Summary and Risk Management Recommendations
- Section 9—References.

1.1 ENVIRONMENTAL SETTING

The physical setting of the Yerington Mine Site is within the Basin and Range physiographic province, which is part of the Great Basin sagebrush-steppe ecosystem. Mason Valley occupies a structural graben (i.e., down-dropped faulted basin) immediately east of the Singatse Range, an uplifted mountain block. Plant communities in the area vary from relatively dense associations along the Walker River immediately east of the Site to sparse brush found on the alluvial fans derived from the Singatse Range, immediately west of the Site.

The Anaconda Mining Company ("Anaconda") conducted mining, milling, and leaching operations for oxide and sulfide copper ores from the open pit in the southern portion of the Site between 1953 and 1978. The open pit was mined in 25-ft benches with a pit wall slope of approximately 45 degrees. The final mined pit was approximately 6,200 ft long, 2,500 ft wide,

and 800 ft deep. Waste rock piles were constructed to the south and north of the open pit. Tailings impoundments and process solution evaporation ponds were constructed north of the Yerington Pit and the process areas, where the milling of oxide and sulfide ores took place.

A qualitative study of wildlife, and an effort to determine fish presence, in the Yerington Pit Lake was undertaken as part of Weimeyer et al.'s (2004) assessment of wildlife hazards associated with five mine pit lakes in Nevada. The authors described qualitative observations of the vegetative community, including terrestrial trees and shrubs such as tamarisk, cottonwoods, and willows that were concentrated in seep areas, and aquatic vegetation (*Cladophora* algae) collected for chemical analysis. Canada geese, grebes, ducks, bank swallows, killdeer, cormorants, and unidentified passerines were among the birds qualitatively observed, in addition to unspecified lizard species. Mule deer were the only mammals observed during this study. A two-day gillnetting effort did not collect any fish from the lake (Weimeyer et al. 2004).

At a broader scale, plant and animal species expected to occur in the vicinity of the Site as a whole are discussed in the site-wide conceptual site model (Integral and Brown and Caldwell 2007). Vegetative, fish, and wildlife surveys are proposed in Appendix B-1 of the work plan to characterize the quantity and quality of potential plant and wildlife habitat in the pit lake and to supplement the conceptual site model (CSM) for the SLERA.

1.2 SLERA APPROACH

The SLERA is used to obtain a general indication of the potential ecological risk, or lack thereof. Although less detailed than a baseline ERA, a SLERA is still a complete risk assessment, allowing for the calculation of ecological risk and assisting in identifying the need for site-specific ecological risk assessments. The risk assessment will provide conservative estimates of risks to potentially exposed wildlife; the methodology is designed to avoid underestimation of risks to provide a conservative basis for evaluating the need for additional site-specific risk assessment, remedial action, and options for future land use.

The SLERA will be conducted in accordance with national guidance, including but not limited to the following:

- USEPA. 1997. *Ecological risk assessment guidance for Superfund: Process for designing and conducting ecological risk assessments.* 540-R-97-006.
- USEPA. 2001. *The role of screening-level risk assessments and refining contaminants of concern in baseline ecological risk assessments.* EPA 540/F-01/014.

1.3 SLERA STUDY AREA

The Pit Lake OU is the area to be evaluated by this SLERA. The horizontal and vertical boundaries of this study area are defined in Section 1 of the body of the remedial investigation Work Plan for the pit lake.

1.4 SOURCES OF DATA TO BE USED IN THE SLERA

Data from previous and ongoing investigations will be included in the SLERA. Use of data from previous and future pit lake investigations is described in Section 3 and in Appendix B-1 of the work plan. Other data sources will be identified in the SLERA report.

The exposure scenarios to be evaluated in the SLERA will be based on a CSM developed specifically for the Pit Lake OU. This OU-specific CSM is based on the revised Site-wide CSM (Integral and Brown and Caldwell 2007). The CSM and list of chemicals to be evaluated in the pit lake will lay the foundation for the exposure and toxicity assessment portions of the risk assessment. The exposure assessment will quantify the potential intake of chemicals for each receptor population via any significant, complete exposure pathways, while the toxicity assessment will provide an estimate of the toxicity of chemicals of potential concern. The final component, the risk characterization, will combine information from the exposure and toxicity assessments to provide estimates of potential risk to wildlife populations.

2 DATA EVALUATION

The objective of the data evaluation is to define appropriate data that are relevant and of acceptable quality for use in the SLERA. The first step is to compile all available data for the OU and select the datasets that are relevant for characterizing OU conditions and assessing potential risks to receptors. Existing data sources to be considered in the SLERA were identified previously in Section 1.4. The second step is to develop data quality criteria to assess the usability of individual data within these datasets for risk assessment purposes. These quality criteria are introduced in Section 2.1. The third step is to individually evaluate all selected data for use in the SLERA according to those criteria. Once data are evaluated for usability as described in Section 2.2, they will be considered with respect to site-specific habitat conditions, as discussed in Section 2.3. Finally, Section 2.4 discusses the evaluation of chemical concentrations within the study area with respect to concentrations in background reference areas.

2.1 DATA EVALUATION AND SELECTION CRITERIA

Relevant data that meet the established quality criteria outlined in the Site Quality Assurance Project Plan (QAPP) (ESI and Brown and Caldwell 2007) will be considered for use in the risk assessment. Data will be evaluated according to Guidance for Data Usability for Risk Assessment (USEPA 1992b), which provides minimum data requirements to ensure that data will be appropriate for risk assessment use. The guidance addresses the following primary issues pertinent to assessing data quality for risk assessment:

- Data sources—Evaluate the type of data collected (e.g., screening data, fixed laboratory data, etc.) and whether quality assurance/quality control (QA/QC) samples are available to provide data quality information.
- Consistency of data collection methods—Evaluate sample collection methods for appropriateness for the chemical, media, and analysis; review field logs to assess quality of sample collection; and determine whether sample collection differs between sampling events and investigations.
- Analytical methods and detection limits—Evaluate methods for appropriateness and sensitivity and determine if detection limits are low enough for risk-based screening; evaluate results with elevated detection limits for relevance.
- Data quality indicators—Review data validation reports for data quality issues.
- Background samples—Assess whether appropriate quantity and location of background samples were collected.

Acceptable samples will be those collected according to approved sampling plans. When it is necessary to deviate from the sampling plan, those deviations will be documented and justified.

QA/QC samples, including field duplicates, equipment rinsate blanks, and laboratory method blanks and spikes will be evaluated to ensure that samples prepared in the field or laboratory include data quality information.

All laboratory analytical data considered for use in the risk assessment will be reviewed and validated in accordance with the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (USEPA 2002a), as described in the Site QAPP (ESI and Brown and Caldwell 2007).

The adequacy of the available background data will be assessed as discussed in Section 2.4.

2.2 RISK ASSESSMENT DATA SELECTION CONSIDERATIONS

This section describes how the analytical results from the datasets will be evaluated and selected for the risk assessment. Specifically, the treatment of detected and undetected results, data qualifiers, duplicate and split samples, and elevated detection limits is described.

2.2.1 Detected Analytical Results

Detected results may be qualified because of QA/QC problems encountered during the laboratory analysis and identified during the validation process. These problems are typical with site investigation data and are usually associated with chemical identity and/or concentration (USEPA 1998).

Data qualifiers are described in detail in the QAPP and are briefly discussed here as they relate to use of the data. The "J" qualifier indicates that the chemical identity is certain, but the concentration is estimated by the laboratory. Because of a high degree of certainty in the identity of the chemical, all results flagged with a J qualifier will be included in the quantitative risk assessment and statistical analyses for the remedial investigation. However, inclusion of estimated concentrations adds uncertainty to the risk assessment results.

All results flagged with "R," indicating rejection of the data during the data validation process, will be excluded from the SLERA.

SLERA guidance recommends use of the highest measured or estimated contaminant concentration for each analyte and medium for comparison to screening level values (USEPA 1997). All usable data, as described in Section 2.1, will be evaluated for each medium and analyte to determine the maximum detected value for use in the SLERA.

2.2.2 Non-Detected Data

Non-radiochemical results that are flagged with a "U" qualifier will be reported as "<X", where "X" is the method detection limit (MDL). If an analyte is not detected in any samples for a particular medium, then it will be assumed that the chemical is not present in that medium at the site, and the chemical will be dropped from further consideration in the risk assessment. For calculation of media concentrations, results flagged with a "U" qualifier generally will be assumed to be present at one-half of the MDL. The MDL is the lowest concentration that can be seen above the normal "noise" associated with the analytical method (USEPA 1998).

2.2.3 Treatment of Radiochemical Data

For radiochemical analyses, results not rejected during data validation will be retained for use in the risk assessment. This includes results that are less than the sample-specific minimum detectable activity (MDA), including zero and negative results. The results, associated measurement error, and sample-specific MDA data will be retained, per the QAPP (ESI and Brown and Caldwell 2007).

2.2.4 Treatment of Duplicate Samples

As part of the quality assurance process, field duplicates will be collected with a subset of investigative samples. Results of duplicate analyses will be compared to investigative samples as part of the QA/QC evaluation (ESI and Brown and Caldwell 2007). Following this comparison, duplicate analyses will not be included in the risk assessment; only investigative samples will be included in the risk assessment database. This practice is consistent with the QAPP (ESI and Brown and Caldwell 2007).

2.2.5 Treatment of Split Samples

Split samples may be collected by EPA during the various sampling events. Only one result, either investigative or split, will be selected for each analyte for a given sample. Pairs of split sample results will not be averaged, due to the potential for inter-laboratory differences (e.g., equipment differences, differing detection limits) that could affect the comparability of the results. If split sample results are available at the time the SLERA is being conducted, a decision framework for evaluating split samples will be developed in consultation with EPA. The impact of including split sample results that are not in agreement with one another will be addressed in the uncertainty analysis.

2.3 ECOLOGICAL CONSIDERATIONS FOR CATEGORIZING DATA

Although ecological investigations to characterize the ecological habitat in the Pit Lake OU have not yet been conducted, it is likely that the distribution of habitat in the pit lake is heterogeneous in both current and future potential land use scenarios. Patchy distribution in turn influences the opportunities for exposure to contaminants, as exposure will likely be concentrated in areas with appropriate habitat (e.g., vegetated areas fringing seeps, littoral areas of the lake that are capable of supporting algae and macrophytes). Pending the results of ecological investigations to characterize habitat distribution, methods including spatial weighting of results or evaluation of subsets of data concentrated in ecological habitat may be used to evaluate how risks may change depending on the exposure area evaluated.

2.4 EVALUATION OF BACKGROUND CONCENTRATIONS

The term "background" refers to substances present in the environment that are not influenced by releases from the site under investigation and that are either naturally occurring or anthropogenic (USEPA 2002b). Naturally occurring substances are those present in the environment in forms that have not been influenced by human activity. Anthropogenic substances are those chemicals, whether natural (e.g., metals) or human-made, present in the environment as a result of human activities but not specifically related to the site in question.

The term "reference" generally refers to a relatively uncontaminated area that is suitable for sampling to evaluate background chemical concentrations. Such areas are typically identified as "background reference areas" (USEPA 2002b). According to USEPA's (2002b) *Guidance for Comparing Background and Chemical Concentrations in Soil for CERCLA Sites,* a background investigation is appropriate when certain chemicals that pose risks and may drive an action are believed to be attributable to background. In addition, USEPA (1998) states:

> It is imperative to select, collect, and analyze an appropriate number of background samples to be able to distinguish between onsite sources of radionuclide contaminants from radionuclides expected normally in the environment.[1]

Soil, sediment, and surface water samples from multiple background reference areas have been and will be collected throughout the environmental investigations to differentiate the natural or anthropogenic background concentrations of the chemicals analyzed from those associated with processes specific to the pit lake. Because the pit lake is not a naturally occurring water body, background conditions will be judged from available data for similar pit lakes or other water bodies in the Great Basin that have been evaluated in the past and which show a viable ecosystem that is not affected by chemical stressors. Background samples will be analyzed, depending on the investigation, for metals and radiochemicals. General procedures for

[1] The term "radiochemical" is technically more accurate than "radionuclide" and is used throughout this SLERA work plan.

evaluating and selecting the background dataset for use in this risk assessment will be identical to those for Site data, as described in Section 2.2, and will be consistent with procedures outlined in the Pit Lake OU work plan.

To make appropriate comparisons between background reference and pit lake chemical data, the statistical distribution of concentrations of chemicals from site-specific background samples will be characterized consistent with USEPA guidance (2002b) and the Pit Lake OU work plan. The site-specific background reference datasets will be evaluated to determine whether they fit normal, lognormal, or other distributions. Additional discussion of the use of the background datasets will be provided in the SLERA report.

3 SCREENING LEVEL PROBLEM FORMULATION

This section describes known and potential unconfirmed sources of chemicals in the pit lake, chemical release mechanisms, chemical transport pathways, mechanisms of ecological toxicity and potentially affected receptors, the completeness of exposure pathways to these receptors, and assessment and measurement endpoints. The Site-wide chemical sources, release mechanisms, transport pathways, and potential routes of human exposure are summarized in the Site-wide CSM (Brown and Caldwell and Integral 2007). A more detailed CSM specific to sources of chemicals in the Pit Lake OU and potential transport pathways and human health exposure routes is provided in this SLERA (Figure 3-1).

One purpose of the SLERA is to determine which, if any, of the potential routes of ecological exposure may be complete now or in the future. This determination is made according to whether an exposure pathway contains the following elements (USEPA 1998):

- A source and mechanism for release of constituents
- A transport or retention medium
- A point of potential receptor contact (exposure point) with the affected medium
- An exposure route at the exposure point.

If any one of these elements is missing, the pathway is not considered complete and exposure will not occur. For example, if receptor habitat requirements and/or the location of potentially exposed receptors relative to the location of an affected exposure medium prevent contact or proximity for external radiation sources, then that exposure pathway is not complete. Similarly, if a pathway to contact was initially considered in the CSM but no chemicals are identified in the environmental medium at the point of contact, the pathway is incomplete and is not carried further into the screening-level ecological risk assessment.

3.1 POTENTIAL SOURCES AND RELEASE MECHANISMS

Pursuant to the Order and development of the statement of work, USEPA (2007a) has divided the Site into seven OUs. The Pit Lake OU (OU-2) is the subject of this SLERA. A detailed discussion of historical mining operations and chemical releases associated with past operations is provided in Section 3 of the Pit Lake remedial investigation work plan.

The only chemical sources intrinsic to the Pit Lake OU are naturally occurring metals and radiochemicals in sediments of the lake, and surface soils and subsurface soils around the lake, and the wall rock. Chemicals could migrate into the Pit Lake OU from other areas of the Site through surface runoff, on-site and off-site airborne particulates, and groundwater transport

including wall-rock geochemical processes. The sources in these other site areas include the following:

- Naturally occurring and technically enhanced concentrations of metals and radiochemicals present in waste rock, tailings piles, and surface soils
- Surface units and groundwater intrusion from outside the Pit Lake OU.

These sources are discussed in further detail in the remedial investigation work plans for the other OUs.

3.2 CONTAMINANT FATE AND TRANSPORT PATHWAYS

Chemicals resulting from mining activities may originate from various source areas within the Pit Lake OU. Transport mechanisms for chemicals from primary impacted media to secondary and tertiary impacted media are depicted in the pit lake CSM (Figure 3-1). Potential exposure media for the ecological model include the following:

- Airborne particulates
- Surface and subsurface soil (surface soil is defined as soil found from ground surface to 2 ft below ground surface (bgs); subsurface soil is found from 2 to 10 ft bgs)
- Sediment
- Surface water
- Seep water
- Groundwater

In addition to migration of chemicals from their sources to other media, radiation may exist anywhere that radiochemicals accumulate in soils, sediment, or water. Transport of the material may occur by any of the transport pathways listed above. Exposure to external radiation is limited to materials within the upper 6 in. of soil or sediment thickness; radiochemicals found below this level are shielded by the top layer of soil (Cember 1996). Geometric attenuation limits the external radiation from materials with no interposed shielding materials to within a few meters, typically less than 5 m and often less than 1 to 2 m from the source (Cember 1996).

3.2.1 Surface and Subsurface Soils

As shown in Figure 3-1, chemicals present in surface soils, either naturally occurring or as a result of migration from other Site areas, may be transported by wind, surface water runoff, erosion of pit sidewalls into the lake, or leaching and percolation to subsurface soil and groundwater.

The presence of natural physical barriers, such as vegetation, will inhibit or reduce the transport of particles as wind-blown dust. Particulates or fugitive dust transported by wind might also be deposited on surface water in the lake.

Low precipitation rates in this arid desert terrain limit opportunities for surface water erosion, runoff, and leaching of chemicals in soil as mechanisms for transport. Geochemical processes such as mobilization via wall-rock geochemical processes, adsorption, and attenuation may modify the concentration of chemicals in percolating leachate through soils or the underlying vadose zone. Proposed sampling locations for soils are described in Section 5 of the Work Plan and Appendix B-1.

3.2.2 Groundwater

During the active mining period, wells drilled along the eastern edge of the pit dewatered the pit to allow mining to occur below the water table. Since mining stopped in 1978, groundwater has been filling the pit at about 5 ft per year (Hershey 2002). The relationship between groundwater and surface water is discussed in more detail in Section 3.2.3. Physical and chemical transport pathways in groundwater are discussed in more detail in the *Site-wide Groundwater Remedial Investigation Work Plan* (Brown and Caldwell and Integral 2007).

The Walker River passes within 1,200 ft of the eastern edge of the pit. Prior to 1997, an intervening granite range front fault on the east edge of the pit formed a barrier between the pit and the saturated alluvium adjacent to the river (Hershey 2002). In response to a flood on January 1, 1997, mining equipment was used to cut a channel between the river and the pit to drain water from the river that was flooding the town of Yerington. Since then, groundwater from the alluvial aquifer flows into the pit at about 100–120 gpm, varying seasonally. On the western pit wall, there are several small springs or seeps flowing into the pit at about 50–60 gpm, varying seasonally. Groundwater currently enters the lake via seeps within the OU both above and below the lake surface, providing pathways of potential ecological exposure to groundwater.

3.2.3 Surface Water

The pit was created by mining activities, which ceased in 1978. Since that time, groundwater and springs have been recharging the pit, creating a lake that is currently about 400 ft deep. In about 40 years, the pit lake is expected to attain the elevation of the water table prior to dewatering (Hershey 2002).

The groundwater inflows and the seep water can be sources of chemicals to the lake, or they can serve to dilute chemicals present in the lake. Precipitation also can dilute chemicals present in the lake; though, given low precipitation rates, this process is not expected to contribute significantly to changing chemical concentrations in the lake. Evaporation from the lake surface

can concentrate chemicals in the surface water. When the lake has reached its final water level, it could become a flow-through system, in which chemicals present in the surface water migrate to groundwater downgradient of the lake. As indicated in the remedial investigation work plan, surface water migration into the alluvial aquifer is already suspected at the west end of the pit lake. These pathways are discussed in more detail in the *Site-wide Groundwater Remedial Investigation Work Plan* (Brown and Caldwell and Integral 2007). Proposed sampling locations for surface water are described in Section 5 of the Work Plan and Appendix B-1.

3.2.4 Sediment

Sediments are defined for the Pit Lake OU as substrate materials that are permanently or usually covered by surface water. Depending on the future balance of groundwater recharge and evaporation, fringing sediments along the edge of the lake may become exposed and dry to become soils, or fringing soils may be inundated over time and be considered sediments. The pit lake recovery curve indicates that the surface water elevation will increase by about another 75 ft until a steady-state condition is reached within the next 15 years (Section 3.2.3 in the *Draft Remedial Investigation Work Plan for Yerington Pit Lake*). Consequently, soils currently fringing the pit lake to an elevation approximately 75 ft above the surface of the lake will become sediments and will be treated as both soils and sediments in the SLERA (Section 4.3 below). Naturally occurring chemicals within the surface waters and sediments of the lake may also partition between these two media. Chemicals in the sediments of the lake may also leach into groundwater and be transported within and outside of the Pit Lake OU (see the *Site-wide Groundwater Remedial Investigation Work Plan* (Brown and Caldwell and Integral 2007). Proposed sampling locations for sediments are described in Section 5 of the Work Plan and Appendix B-1.

3.3 POTENTIALLY COMPLETE EXPOSURE ROUTES

This section describes in general terms the potential routes of exposure of plants and animals to chemicals at the Site, as follows:

- Respiration/inhalation
- Dermal contact/uptake
- Ingestion
- Trophic transfer
- External radiation exposure.

These routes of exposure are discussed further in the following subsections.

3.3.1 Respiration/Inhalation

Respiration is a potentially complete pathway for invertebrates by passive exchange of air and for vertebrates by inhaling airborne particulates or volatilized chemicals. There are no identified sources of volatile chemicals in the Pit Lake OU. In addition, volatile chemicals are not expected to be present in surface soil in meaningful concentrations for risk, so inhalation of vapors in outdoor air is not a complete pathway. Inhalation is generally considered a relatively minor pathway for exposure compared to direct ingestion by wildlife of chemicals of concern. For example, the USEPA (2005) did not use inhalation of soil particles in deriving the national ecological soil-screening levels, because exposure is accounted for by the soil-ingestion route. Therefore, inhalation of chemicals is considered a potentially complete but insignificant exposure route for ecological receptors in the Pit Lake OU.

3.3.2 Dermal Contact/Uptake

Plants can accumulate chemicals through direct deposition of airborne particulates on their absorptive surfaces (e.g., leaves) and through uptake from the soil via their roots. The former pathway is not expected to be a substantial source of exposure to the plant itself, as the majority of chemical uptake by a plant is accomplished through its root system. The potential for chemicals to accumulate in plants is affected by the specific properties of the chemical, the soil physical/chemical properties, and biophysical properties of the plant. For example, large-molecular-weight chemicals (e.g., dioxins, polychlorinated biphenyls [PCBs]) have a low potential to be taken up by the roots of plants.

Many animals are equipped with protective outer coverings that reduce or prevent the absorption of environmental chemicals.[2] For this reason, dermal exposure is usually considered a less important pathway than oral ingestion in accounting for exposure to contaminants (USEPA 2003). In developing soil screening levels, USEPA (2003) indicates that conditions likely to increase contact with soil and therefore potential exposure to chemicals include the following:

- Species with little or no fur or feathers
- Species that spend long periods of time exposed to soil (i.e., in burrows)
- Where the contaminants of concern may be significantly more toxic via the dermal pathway compared to the oral pathway
- Where dermal exposures may be substantially higher compared to oral exposures (e.g., pesticides applied directly to an organism or soil surfaces).

[2] For example, the hardened exoskeleton of many invertebrates, the fur of mammals, the feathers of birds, the scales of reptiles.

For the Pit Lake OU, the dermal exposure route is potentially complete for a variety of ground-dwelling animals, especially for infaunal invertebrates and burrowing animals (e.g., shrew) that live predominantly within the soil. However, the dermal exposure route is not considered significant and will not be quantified for these receptors because trace metals have a low potential for dermal uptake or dermal toxicity and because pesticides or other organic compounds that have a high potential for dermal uptake or dermal toxicity are not likely to be present at elevated levels (USEPA 2003).

Dermal exposure to airborne particulates is not a complete pathway for either terrestrial or aquatic animals. Dermal contact with formerly airborne particulates is expected to occur primarily via contact with surface soil or surface water onto which particulates have settled and is addressed in exposure routes associated with those media.

Dermal exposure to surface water is expected to be limited to those receptors that are purely aquatic and live within the lake waters; those that come to surface water bodies to drink; and those that spend a significant amount of time on or in the surface water of the pit lake, such as dabbling and diving ducks. Dermal exposure for receptors visiting surface water to drink is not expected to be a significant pathway of exposure.

3.3.3 Direct Ingestion

Direct ingestion of chemicals and absorption via the alimentary canal is an important route of exposure for biota. Invertebrates can ingest soil and sediment directly while burrowing or foraging. Mammals and birds can ingest soil and sediment directly while foraging and cleaning their fur or feathers, respectively (Beyer et al. 1994). While some terrestrial receptors (e.g., jackrabbits, chukars and shrews) derive much of their water through their diet, others, such as deer and coyotes, may regularly seek out surface water to drink and therefore may be exposed to chemicals in the surface water medium. The seeps and the surface waters of the pit lake provide a potentially complete pathway of exposure to receptors that seek out surface water for drinking.

3.3.4 Trophic Transfer

Trophic transfer refers to chemical exposure via consumption of other plants or animals. Any animal that eats another plant or animal that contains chemicals of concern in turn may be exposed to those chemicals of concern. The extent to which trophic transfer occurs depends on a number of factors, including the exposure of lower trophic level plants or prey to chemicals of concern, their ability to bioaccumulate those chemicals, the extent to which those chemicals are partitioned in their tissues, and which parts are eaten by the higher trophic level consumer. Trophic transfer may be of particular importance for hydrophobic, bioaccumulative chemicals like PCBs or DDT that are not readily metabolized or eliminated and may biomagnify in higher

trophic level consumers. Consequently, the receptors of interest in the CSM (Figure 3-1) represent a variety of trophic guilds[3] and trophic levels.

Exposure to airborne particulates via trophic transfer is considered a potentially complete but insignificant pathway for all receptors, because direct contact of airborne particulates with vegetation and inhalation exposure routes from airborne particulates to potential prey for this medium are considered insignificant pathways (see discussion above).

3.3.5 External Radiation Exposure

Plants and animals can receive external radiation exposure from the materials in the vicinity of the receptor for extended periods of time. Plants may receive external exposure from radiochemicals in the surface soils and/or in deeper soils comprising the plant's root zone. For animals, external exposure from surface soils may occur for animals that burrow, roost, sleep, or otherwise routinely inhabit an area close to the soil. Surface waters may be a source of external exposure to aquatic plants and animals, and to migrating waterfowl that are in or on the water for significant periods of time. Although a potentially complete exposure pathway, external exposure in general is a minor contributor to a receptor's overall radiation dose and therefore is represented as a potentially complete but insignificant exposure route for all media and all receptors.

3.4 MECHANISMS OF ECOTOXICITY AND POTENTIALLY AFFECTED RECEPTORS

The ecological conceptual site model (Figure 3-1) uses known or expected ecological relationships of flora and fauna at the Site to present a suite of potential receptors that represent the various trophic guilds within the biological communities and that have the potential to be exposed to chemicals of concern in the Pit Lake OU by the pathways described earlier. The ecological communities expected in the vicinity of the Site from which these representative receptors are chosen are discussed in the Site-wide CSM (Integral and Brown and Caldwell 2007).

This section discusses the receptors chosen to represent trophic guilds of the biological communities of the Pit Lake OU and the exposure pathways relevant to each guild. Terrestrial receptors include terrestrial plants, invertebrates, and several trophic levels of mammals and birds. Terrestrial animal receptors are expected to be concentrated around habitats and media that provide forage and cover, including seeps and the fringing vegetation of the lake's surface water. Aquatic receptors, including aquatic plants, invertebrates, bank swallows, and a variety of waterfowl, have been documented at the pit lake and may be expected to be primarily associated with seeps and/or surface waters of the lake. Ecological investigations intended to

[3] A trophic guild consists of a group of related species or taxa that exploit similar food resources.

document plant and animal communities in terrestrial and aquatic habitat are presented in Appendix B-1, the results of which may be used to modify the receptors and pathways described herein.

3.4.1 Plants

Aquatic plants include rooted (e.g., cattails) and floating (e.g., green algae) vegetation. Complete exposure pathways for aquatic plants are as follows:

- Dermal contact with airborne particulates, sediment, surface water, and seep water
- Absorbed external radiation via sediment, surface water, and seep water.

Terrestrial plants are separated into two categories because different exposure media and pathways are important for these groups.

Forbs and grasses are herbaceous annual and perennial plants that are consumed by a variety of herbivorous and omnivorous animals of the sagebrush-steppe habitat. Median rooting depth for forbs and grasses in arid conditions with an approximate mean annual precipitation of 125 mm (5 in.) is less than 0.5 m (1.6 ft) of soil (Schenk and Jackson 2002). Complete exposure routes for terrestrial forbs and grasses include the following:

- Dermal contact with airborne particulates
- Dermal contact with and uptake from surface soil and groundwater. Uptake from groundwater is expected to be limited to those areas where forbs and grasses are directly adjacent to seeps where groundwater is near the surface.
- Absorbed external radiation via surface soil and groundwater.

Woody plants are perennial plants that continue to add to their above-ground growth in successive years. These plants tend to be somewhat less palatable and therefore less preferred by some herbivores compared to forbs and grasses. This category includes sagebrush, rabbitbrush, bitterbrush, and similar woody shrubs. In general, woody plants in semi-arid conditions have deeper rooting depths than the grasses and forbs (Schenk and Jackson 2002). Median rooting depth for shrubs and semi-shrubs in arid conditions, with an approximate mean annual precipitation of 125 mm (5 in.) is less than 1.5 m (5 ft); although some shrubs may have root depths of 5 m (16.5 ft). Complete exposure pathways for woody plants include the following:

- Dermal contact with airborne particulates
- Dermal contact with and uptake from surface soil, subsurface soil, and groundwater
- Absorbed external radiation via surface soil, subsurface soil and groundwater.

3.4.2 Invertebrates

Aquatic invertebrates spend part or all of their life cycle in an aquatic environment. Examples include true bugs, beetles, dragonflies, mayflies, midges, and mosquitoes. Complete exposure pathways for aquatic invertebrates are as follows:

- Direct contact with sediment, surface water, and seep water
- Ingestion of sediment, surface water, and seep water
- Trophic transfer by consuming vegetation or prey that may have been exposed via sediment and surface water
- Absorbed external radiation from sediment, surface water, and seep water.

Terrestrial invertebrates are divided into epifauna that live at the surface (e.g., grasshoppers, many spiders, true flies), and infauna that live part or all of their life cycle underground (e.g., some spiders, ants, beetle larvae). Complete exposure pathways for epifaunal invertebrates include the following:

- Inhalation of airborne particulates
- Direct contact with surface soil
- Incidental ingestion of surface soil while consuming food
- Trophic transfer by consuming vegetation or prey that may have been exposed via airborne particulates, surface soil, subsurface soil, and groundwater. Trophic transfer from subsurface soil and groundwater are considered potentially complete but insignificant pathways because these pathways would be restricted to ingestion of woody plant material.
- Absorbed external radiation from surface soil.

Although many infaunal invertebrates live in the first several inches of soil below ground, some species that may be present in the area can have much deeper burrows. For example, several species of ants in the Great Basin-Mojave desert ecosystem are known to have burrows extending a meter or more deep (Jensen and Hooten 2000). Complete exposure pathways for infaunal invertebrates include the following:

- Inhalation of airborne particulates
- Direct contact with surface and subsurface soil
- Incidental ingestion of surface and subsurface soil while consuming food

- Trophic transfer by consuming vegetation or prey that may have been exposed via airborne particulates, surface soil, subsurface soil, and groundwater. The groundwater pathway is considered to be potentially complete but insignificant because this pathway is restricted to the ingestion of woody plant materials
- Absorbed external radiation from surface and subsurface soil

3.4.3 Mammals and Birds: Primary Consumers

Trophic relationships among species can provide insight into many ecological processes, particularly with respect to chemical exposure via ingestion and trophic transfer. Potential bird and mammal receptors of concern for the ecological model were chosen as representatives of feeding guilds likely to be present at the Site. Primary consumers include herbivorous birds and mammals. Feeding guilds include browsers and grazers/granivores.

Browsers feed on woody and herbaceous vegetation. The mule deer and black-tailed jackrabbit were chosen as representatives of this feeding guild. Both species will consume green, leafy vegetation when available, such as forbs and grasses, but will readily switch to woody plants particularly in the drier months when forbs and grasses are not as abundant (Reid 2006; UMMZ 2007b). Jackrabbits do not create deep burrows, but they may create shallow depressions in the first few inches of soil for thermoregulation and cover (Reid 2006). Complete exposure routes for mule deer include the following:

- Inhalation of airborne particulates
- Direct contact with surface soil, surface water and seep water
- Direct ingestion of surface water and seep water, and incidental ingestion of surface soil while consuming food
- Trophic transfer by consuming vegetation that may have been exposed via airborne particulates, surface soil, subsurface soil, and groundwater
- Absorbed external radiation from surface water, seep water, and surface soil.

Complete exposure pathways for the jackrabbit include the following:

- Inhalation of airborne particulates
- Direct contact with surface soil, surface water, and seep water
- Direct ingestion of surface water and seep water and incidental ingestion of surface soil while consuming vegetation
- Trophic transfer by consuming vegetation that may have been exposed via airborne particulates, surface soil, subsurface soil, and groundwater
- Absorbed external radiation from surface soil, surface water, and seep water.

Granivores/herbivores feed on a combination of herbaceous vegetation, including stems, leaves, and seeds. A bird and a mammal were chosen to represent vertebrate taxa in this feeding guild.

The chukar, a ground-nesting bird that has been observed on the Site, eats a combination of seeds and herbaceous plants, and may seasonally incorporate insects in its diet. Complete exposure pathways for the chukar include the following:

- Inhalation of airborne particulates.
- Dermal contact with surface water, seep water, and surface soil.
- Direct ingestion of surface water and seep water (chukars may ingest surface water at least seasonally [RRCIA 2007]) and incidental ingestion of surface soil while consuming food.
- Trophic transfer by consuming vegetation that may have been exposed via airborne particulates, surface and subsurface soil, and groundwater. Because the diet of the chukar is primarily forbs and grasses that are not typically exposed to deep (>3 ft) subsurface soils (Seattle Audubon Society 2007), the subsurface soil trophic transfer pathway is considered potentially complete but insignificant.
- Absorbed external radiation from surface soil, surface water, and seep water.

Long-tailed voles were chosen as mammalian representatives of the grazer/granivore feeding guild. These animals are herbivores and their diet is largely made up of green plant material (Smolen and Keller 1987). Seeds and fungi are also main components. The bark and leaves of sagebrush plants are consumed during the winter periods when green plants are less abundant. Potentially complete pathways for long-tailed voles include the following:

- Inhalation of airborne particulates
- Direct contact with surface soil and subsurface soil
- Direct ingestion of surface and subsurface soils incidental to consuming food
- Trophic transfer by consuming vegetation that may have been exposed via airborne particulates, surface and subsurface soil, and groundwater
- Absorbed external radiation from surface and subsurface soil.

3.4.4 Birds and Mammals: Secondary Consumers

Secondary consumers feed primarily on animal matter. Feeding guilds include invertivores, predators, and scavengers.

Invertivores obtain most of their energy by consuming insects and other arthropods. Three birds (bank swallow, eared grebe, and killdeer) and a mammal (Merriam's shrew) displaying a variety of nesting and feeding strategies were chosen to represent this feeding guild.

Killdeer are primarily upland birds that forage primarily at the soil surface on a wide variety of terrestrial invertebrates. They may also forage at the edge of water bodies in shallow sediments for aquatic invertebrates. Complete exposure pathways for killdeer include the following:

- Inhalation of airborne particulates
- Dermal contact with surface soil, sediment, surface water, and seep water
- Direct ingestion of surface water and seep water, and incidental ingestion of surface soil and sediment while consuming food
- Trophic transfer by consuming prey that may have been exposed via airborne particulates, surface soil, sediment, surface water, seep water, and groundwater
- Absorbed external radiation from surface soil, sediment, surface water, and seep water.

Bank swallows are gregarious birds often seen in flocks near aquatic habitat. During nesting periods, monogamous pairs construct small burrows along the shore of water bodies. Their diet is composed almost entirely of flying insects (SAS 2007). Complete exposure pathways for the bank swallow include the following:

- Inhalation of airborne particulates.
- Dermal contact with surface soil, subsurface soil, and surface water.
- Direct ingestion of surface water and incidental ingestion of surface and subsurface soil while building burrows. Burrow building is expected to be a brief but intense activity in the life cycle of this species and is accomplished by excavating soil with bill, wings, and feet (Garrison 1999). Consequently, ingestion of surface and subsurface soil are considered potentially complete and significant, but unquantifiable, exposure routes.
- Trophic transfer by consuming prey that may have been exposed via airborne particulates, surface and subsurface soil, sediment, surface water, and seep water.
- Absorbed external radiation from surface soil, subsurface soil, and surface water.

Eared grebes are waterfowl that represent diving invertivorous avian receptors. They are the most abundant grebe in the world, and are found in the vicinity of the Yerington Site during the breeding (summer) season. Eared grebes feed on aquatic insects, primarily brine shrimp and brine flies, at the surface as well as by diving to the bottom, and are believed to use their tongues as baleen whales do, crushing prey against the palate and extruding water (Cullen et al. 1999). Complete exposure pathways for the eared grebe include the following:

- Inhalation of airborne particulates
- Dermal contact with sediment and surface water
- Direct ingestion of sediment and surface water

- Trophic transfer by consuming prey that may have been exposed via airborne particulates, sediment, and surface water
- Absorbed external radiation from sediment and surface water.

Merriam's shrew is an invertivore that inhabits the sagebrush-steppe habitat of the Great Basin. This small, aggressive mammal is typically found under cover of vegetation and may use the burrows of other rodents. Shrews are rarely eaten by mammalian predators because they have bad-tasting scent glands, although snakes and owls may prey on them. Complete exposure pathways for shrew include the following:

- Inhalation of airborne particulates
- Dermal contact with surface and subsurface soil
- Ingestion of surface and subsurface soil incidental to consuming food
- Trophic transfer by consuming prey that may have been exposed via airborne particulates, surface soil, subsurface soil, and groundwater
- Absorbed external radiation from surface and subsurface soil.

Predators/scavengers: Many raptors, canids, and felids, are predators and opportunistic scavengers and omnivores. The coyote and kit fox represent this group, as their diet in the Great Basin ecosystem is focused largely around small mammals but also incorporates a wide range of other foods, including human garbage, carrion, and invertebrates. Complete exposure pathways for the coyote and kit fox include the following:

- Inhalation of airborne particulates
- Dermal contact with surface soil, subsurface soil (when denning[4]) surface water, and seep water
- Direct ingestion of surface water and seep water, and ingestion of surface soil incidental to consuming food
- Trophic transfer by consuming prey that may have been exposed via airborne particulates, surface soil, subsurface soil, surface water, seep water, and groundwater
- Absorbed external radiation from surface soil, subsurface soil, surface water, and seep water.

Predators consume many types of organisms including different trophic levels of mammals. The American kestrel, which has been observed at the Site, eats a variety of animals, including mice, birds, and lizards. Complete exposure pathways for the American kestrel include the following:

[4] Coyotes and kit foxes may use underground dens and may potentially be exposed to subsurface soil in association with this activity; however, unlike kit foxes, coyotes do not tend to dig for their prey (UMMZ 2007a) and therefore predation is not viewed as a potential mechanism for ingestion exposure to subsurface soil for coyotes.

- Inhalation of airborne particulates
- Dermal contact with surface soil
- Ingestion of surface soil incidental to consuming food
- Trophic transfer by consuming prey that may have been exposed via airborne particulates, surface soil, subsurface soil, surface water, seep water, and groundwater
- Absorbed external radiation from surface soil.

3.5 ASSESSMENT AND MEASUREMENT ENDPOINTS

Assessment endpoints are explicit expressions of the environmental value that is to be protected, operationally defined by an ecological entity and its attributes (USEPA 1998).

Assessment endpoints need to be ecologically relevant, susceptible (as defined by exposure and sensitivity), and relevant to management goals for the site. Each assessment endpoint is framed as a risk statement, with associated measurement attributes, including measurement of exposure and measurement of effects. Initial assessment endpoints proposed for the pit lake SLERA include the following:

- Viability of the avian and mammalian wildlife community[5]: Are concentrations of chemicals and radiochemicals of concern present in on-site media sufficient to adversely affect any of the birds and mammals within the Pit Lake OU?
- Viability of terrestrial plant and terrestrial invertebrate communities: Are concentrations of chemicals and radiochemicals of concern present in on-site media sufficient to adversely affect plants and invertebrates within the Pit Lake OU?

Two kinds of measurements will be used to evaluate each of these assessment endpoints:

- Measurements of Exposure: Determine concentrations of site-related chemicals and radiochemicals in on-site matrices of the Pit Lake OU.
- Measurements of Effects: Determine if maximum concentrations of site-related chemicals and radiochemicals exceed screening level values that are protective of survival, growth, and reproduction of the exposed receptors.

[5] Viability refers to the maintenance of sufficient survival, growth, and reproduction rates to sustain species populations typical of the area. Community is defined as an assemblage of interacting species within a geographic area.

3.6 PIT LAKE CONCEPTUAL SITE MODEL

Sections 3.1 through 3.4 have described the chemical sources and transport mechanisms, exposure media and routes, and representative ecological receptors for the Pit Lake OU. A conceptual site model diagram depicts these processes, pathways, and relationships in Figure 3-1.

4 SCREENING LEVEL ECOLOGICAL EFFECTS EVALUATION

The ecological effects evaluation provides a method for linking concentrations of contaminants to ecotoxicological effects on receptors. Section 4.1 discusses the selection of toxicity data, Section 4.2 discusses dose conversions and substitutions used in the effects evaluation, Section 4.3 presents screening level values for relevant media and exposure pathways, and Section 7 discusses uncertainties associated with the effects evaluation.

4.1 SELECTION OF TOXICITY DATA

The results of the screening-level problem formulation will be used to develop a screening-level exposure estimate and risk calculations. Aqueous and soil exposure concentrations will be compared with ecotoxicity screening level values (SLVs). This comparison will provide the basis for eliminating from further comparison contaminants and exposure pathways that pose negligible risks, and identify whether exposure pathways and contaminants of concern exist that suggest the need for additional site management options.

Consistent with USEPA (1997) guidance, ecotoxicological screening values should be no-observed-adverse-effects levels (NOAELs) for chronic exposure to a contaminant. SLVs will be developed for soil, sediment, and surface water matrices and additional parameters consistent with Site-related receptors and exposure conditions. For soils and sediment, conservative SLVs will be identified as a point of departure and further refined, consistent with wildlife receptors present at the site and which may be exposed to soil or sediment as a result of foraging behavior. For water, conservative wildlife SLVs developed by Sample et al. (1996) are used as an initial point of departure in this work plan to: 1) place existing data in a wildlife framework, and to 2) preliminarily identify chemicals of interest for potential avian and mammalian receptors. Finally, guidance establishing threshold acceptable radiochemical doses to ecological receptors will be used as a starting point for evaluating exposure of ecological receptors to radiochemicals that may be present in the OU.

4.2 DOSE CONVERSIONS

For some data reported in the literature, conversions are necessary to allow the data to be used for species other than those tested or for measures of exposure other than those reported. In Section 4.3, toxicity reference values (TRVs) used as a basis for calculating threshold levels of contaminants in Site media were expressed as a dose (units of mg/kg body weight d), so no conversions were necessary. However, supplementary exposure parameters (e.g., food ingestion rate) used to develop these calculations necessitated transformations including unit

conversion from a wet-weight basis to a dry-weight basis for the food ingestion rate and use of allometric equations to calculate ingestion rate (USEPA 1993). Exposure parameters were not always available for the species in question, in which case the parameter was selected for a similar species using best professional judgment. These dose conversions and substitutions are clearly identified in the tables supporting the development of the screening values.

4.3 SCREENING LEVEL VALUES

The selection and, where appropriate, derivation from toxicity values, of aqueous, sediment, and soil screening level values for chemicals and radiochemicals are presented in this section.

4.3.1 Soil Screening Level Values for Plants and Terrestrial Invertebrates

Consistent with recommendations from Region 9 EPA, Eco-SSL values (USEPA 2007b) were considered as a primary source for use as screening level values. Eco-SSL methods are used to derive risk-based soil screening levels (as mg chemical/kg soil) that are broadly applicable to the evaluation of frequently encountered chemicals of potential ecological concern (COPECs) at hazardous waste sites across the United States. However, Eco-SSLs are available for a limited number of metals, and are unavailable for VOCs and other classes of organic chemicals. Secondary sources of screening level values from the Oak Ridge National Laboratory (ORNL) for plants (Efroymson et al. 1997a) and for soil invertebrates (Efroymson et al. 1997b) were therefore used to supplement the Eco-SSLs. The final list of selected SLVs for plants and invertebrates is presented in Table 4-1.

4.3.2 Soil Screening Level Values for Wildlife

Consistent with recommendations from Region 9 EPA, Eco-SSL values were considered as a primary source for use as screening level values. Eco-SSL methods are used to derive risk-based soil screening levels (as mg chemical/kg soil) that broadly apply to the evaluation of frequently encountered COPECs at hazardous waste sites across the United States.

4.3.2.1 Back-calculation of threshold soil concentrations for wildlife using TRVs

As discussed in Section 4.3.1, Eco-SSLs are available for a limited number of metals, and are unavailable for VOCs and other classes of organic chemicals. In these cases, conservative TRVs were used as a starting point in order to back-calculate to a chemical concentration in soil that is not expected to pose risk to wildlife. This screening-level ecological risk assessment focuses on exposure to the soil and biota in the Pit Lake OU. This approach is consistent with Eco-SSL guidance in generating threshold effects values for wildlife (USEPA 2005).

Soil screening values are generated by solving for soil concentrations from an exposure equation that defines the hazard quotient. The hazard quotient relates the estimated dose of a

contaminant by a receptor via the incidental soil ingestion pathway to a threshold acceptable dose:

$$HQ = \frac{\left\{\left[S_j \times P_s \times AF_{sj} \times FIR\right] + \sum_i^N \left[B_{ij} \times P_i \times AF_{ij} \times FIR\right]\right\} \times AUF}{TRV_j} \qquad \text{Equation 1}$$

Where:

S_j = Contaminant concentration for contaminant (j) in soil (mg/kg dry weight)

P_s = Soil ingestion as proportion of diet (kg sed dry weight/kg diet dry weight)

FIR = Food ingestion rate (kg diet dry weight/kg bw/day)

AF_{sj} = Absorbed fraction of contaminant (j) from soil (s) (unitless)

B_{ij} = Contaminant concentration (j) in biota type (i) (mg/kg dry weight)

P_i = Proportion of biota type (i) in diet (kg biota dry weight/kg diet dry weight)

AF_{ij} = Absorbed fraction of contaminant (j) from biota type (i) (unitless)

TRV_j = Toxicity reference value (mg/kg bw/day)

AUF = Area use factor (unitless).

The following parameters are set to 1:

- HQ, so that the estimated dose is equal to the threshold acceptable dose
- AUF, receptors assumed to reside and forage exclusively within the site
- AF_{sj}, assuming all of the contaminant is absorbed
- AF_{ij}, assuming all of the contaminant is absorbed
- P_i, assuming a single food type for the predator (and therefore a single value for B_{ij})

Given these assumptions, the equation reduces to:

$$TRV_j = FIR\,(S_j \times P_s + B_{ij}) \qquad \text{Equation 2}$$

Where the parameters are assigned using:

S_j = The variable that is solved for, that will yield the screening level for the concentration of contaminant in soil

P_s = Available from USEPA 1993 and Beyer 1994

FIR = Available in USEPA 1993 and USEPA 2005 both for individual species and allometric equations

TRV_j = No observed adverse effects level (NOAELs) based on a hierarchical selection approach.

Consistent with recommendations from Region 9 EPA, TRVs developed for Ecological SSLs (USEPA 2003) were given first priority in calculation of SLVs for the pit lake. Secondary sources for TRVs were San Francisco Bay Regional TRVs (DeVries 2007), and finally ORNL values (Sample et al. 1996) were used if no Eco-SSL or San Francisco Bay Regional TRVs were available (Table 4-2). NOAELs provide a threshold level at or below which no adverse effect is expected in the receptor, and were available for all three data sets. ORNL NOAELs are based on chronic toxicity endpoints or, if only a subchronic endpoint was available, an uncertainty factor equal to or less than 10 was applied (Sample et al. 1996).

B_{ij} is defined for bioaccumulation from soil by plants:

For plant uptake from soil, USEPA 2005 provides B_{ij} in two formats:

$B_{ij} = a^* S_j + b$ Equation 3

$\ln B_{ij} = a^* \ln(S_j) + b$ Equation 4

Where:

a = slope of relationship in uptake equation

b = y-intercept of relationship in uptake equation.

Solving for Sj in Equation 2 using Equation 3:

$$S_j = \frac{TRV_j - FIR(b)}{FIR\,(P_s + a)}$$ Equation 5

Solving for S_j in Equation 2 using Equation 4.
Step 1: Untransforming Equation 4 yields: $B_{ij} = S_j^{\,a} \times e^b$
Step 2: Substituting the untransformed B_{ij} yields:

$$\frac{TRV_j}{FIR} = \mathrm{S_j} \times P_s + (\mathrm{S_j}^{\,a} \times e^b) \qquad \text{Equation 6}$$

This equation can be solved for S_j using Excel's solver utility, by solving for Sj. Using the solver utility, the left side of Equation 6 (which is known) can be used to solve for the right side (which has the unknown parameter S_j).

4.3.2.2 Representative Receptors for Calculating Threshold Soil Concentrations

Soil screening level values were calculated for herbivorous avian and mammalian receptors that may occur within the Pit Lake OU. The herbivore feeding guilds were selected because they are directly linked to plant uptake from soils and are likely to have higher exposure via food consumption than higher trophic level carnivores. The available toxicity information was reviewed for surrogate bird and mammal species similar to those that may be present in the Pit Lake OU. Conservative values were selected and screening level values were calculated as described in Section 4.3.2.1.

Avian receptors

A potential pathway of exposure to contaminants of concern is by birds visiting the site and consuming soil incidental to foraging for food. A ground-foraging bird is used for modeling exposure in this case, because it is expected that these birds will forage on food items in close contact with the soil, such as seeds, grasses, and insects, and thus display a high probability for incidental soil ingestion. The chukar was used as the surrogate receptor for this class of organisms. Wildlife exposure parameters (e.g., food ingestion rate [FIR], Ps) that were used to support the calculation of soil screening level values for birds are provided in Table 4-3. Calculated screening level values for birds are presented in Table 4-4.

Mammalian Receptors

For mammals, exposure routes of concern are consumption of terrestrial prey, incidental ingestion of soil while foraging, and inhalation in subsurface burrows. For the soil and food ingestion route, mule deer was selected as a representative large mammal receptor, and long-tailed vole was the selected small mammal. Screening level values were calculated for both of these receptors and the lower of the two was selected for initial site screening. For the inhalation route, long-tailed vole was the selected receptor for exposure to chemicals in burrows.

Wildlife exposure parameters (e.g., food ingestion rate [FIR], Ps) used to support the calculation of soil screening level values for mammals are provided in Table 4-3. Calculated soil screening level values for mammals are presented in Table 4-4.

4.3.3 Sediment Screening Level Values for Aquatic Invertebrates

Consensus-based threshold effect concentrations (TECs) (MacDonald et al. 2000) were considered as a primary source for use as screening level values for aquatic invertebrates exposed to chemicals in sediment. TECs are Sediment Quality Guidelines (SQGs) developed for 28 chemicals in freshwater sediments that have been evaluated for reliability by matching chemistry and toxicity data from field studies throughout the United States (MacDonald et al. 2000). TECs provide concentrations (as mg chemical/kg sediment dw) below which harmful effects on sediment-dwelling organisms are not expected. TECs are broadly applicable to the evaluation of frequently encountered COPECs) in sediments at hazardous waste sites across the United States. In addition, probable effect concentrations (PECs), representing a concentration of chemical in sediment above which effects on sediment-dwelling organisms are expected to occur more often than not, were also evaluated to provide a higher-end value for effects concentrations. The final list of selected TECs and PECs for aquatic invertebrates is presented in Table 4-5.

4.3.4 Sediment Screening Level Values for Wildlife

There is no broadly accepted, published set of screening values (such as those available for soils by using Eco-SSLs), for estimating risks to wildlife from exposure to chemicals of concern in sediments. Therefore, conservative TRVs were used as a starting point and representative Site receptors were chosen in order to back-calculate threshold sediment concentrations for wildlife, as described below.

4.3.4.1 Back-calculation of Threshold Sediment Concentrations for Wildlife Using TRVs

Conservative TRVs were used as a starting point in order to back-calculate to a chemical concentration in sediment that is not expected to pose risks to wildlife. This screening-level ecological risk assessment focuses on exposure to the sediment and biota present in the Pit Lake OU.

Similar to the process described for soils in section 4.3.2.1, sediment screening values are generated by solving for sediment concentrations from an exposure equation that defines the hazard quotient. The hazard quotient relates the estimated dose of a contaminant for a receptor via the incidental sediment ingestion pathway to a threshold acceptable dose:

$$HQ = \frac{\left\{\left[S_j \times P_s \times AF_{sj} \times FIR\right] + \sum_i^N \left[B_{ij} \times P_i \times AF_{ij} \times FIR\right]\right\} \times AUF}{TRV_j} \qquad \text{Equation 7}$$

Where:

S_j = Contaminant concentration for contaminant (j) in sediment (mg/kg dry weight)

P_s = Sediment ingestion as proportion of diet (kg sed dry weight/kg diet dry weight)

FIR = Food ingestion rate (kg diet dry weight/kg bw-day)

AF_{sj} = Absorbed fraction of contaminant (j) from sediment (s) (unitless)

B_{ij} = Contaminant concentration (j) in biota type (i) (mg/kg dry weight)

P_i = Proportion of biota type (i) in diet (kg biota dry weight/kg diet dry weight)

AF_{ij} = Absorbed fraction of contaminant (j) from biota type (i) (unitless)

TRV_j = Toxicity reference value (mg/kg bw-day)

AUF = Area use factor (unitless).

The following parameters are set to 1:

- HQ, so that the estimated dose is equal to the threshold acceptable dose
- AUF, receptors assumed to reside and forage exclusively within the site
- AF_{sj}, assuming all of the contaminant is absorbed
- AF_{ij}, assuming all of the contaminant is absorbed
- P_i, assuming a single food type for the predator (and therefore a single value for B_{ij})

Given these assumptions, the equation reduces to:

$$TRV_j = FIR\,(S_j \times P_s + B_{ij}) \qquad \text{Equation 8}$$

Where the parameters are assigned using:

S_j = The variable that is solved for, that will yield the screening level for the concentration of contaminant in sediment

P_s = Available from USEPA (1993) and Beyer (1994)

FIR = Available in USEPA (1993) and USEPA (2005) both for individual species and allometric equations

TRV_j = No observed adverse effects level (NOAELs) based on a hierarchical selection approach.

Consistent with recommendations from Region 9 EPA, TRVs developed for Ecological SSLs (USEPA 2003) were given first priority in calculation of SLVs for the Pit Lake. The screening values for wildlife based on uptake of contaminants in soil that are provided in the Eco-SSLs should not be extrapolated to sediments, because the exposure calculations rely on parameters for representative receptors that are specific to terrestrial wildlife. However, the TRVs that form the starting point for these calculations are dosing values for laboratory animals, and as such have been used as starting points for extrapolating exposure to both terrestrial (e.g., USEPA 2007b) and aquatic (e.g., Sample et al. 1996) wildlife. Therefore, it is appropriate to consider the Eco-SSL TRVs as a primary source of toxicity values for calculating sediment SLVs.

Secondary sources for TRVs were San Francisco Bay Regional TRVs (DeVries 2007), and finally ORNL values (Sample et al. 1996) were used if no Eco-SSL or San Francisco Bay Regional TRVs were available (Table 4-2). NOAELs provide a threshold level at or below which no adverse effect is expected in the receptor, and were available for all three data sets. ORNL NOAELs are based on chronic toxicity endpoints or, if only a subchronic endpoint was available, an uncertainty factor of equal to or less than 10 was applied (Sample et al. 1996).

B_{ij} is defined for bioaccumulation from soil by aquatic invertebrates:

For invertebrate uptake from sediment, Bechtel 1998 provides B_{ij} in two formats:

$B_{ij} = a^* S_j + b$ Equation 9

$\ln B_{ij} = a^* \log(S_j) + b$ Equation 10

Where:

a = slope of relationship in uptake equation

b = y-intercept of relationship in uptake equation.

Solving for Sj in Equation 2 using Equation 3:

$$S_j = \frac{TRV_j - FIR(b)}{FIR\,(P_s + a)}$$ Equation 11

Solving for S_j in Equation 2 using Equation 4.
Step 1: Untransforming Equation 4 yields: $B_{ij} = S_j^{\,a} \times 10^b$
Step 2: Substituting the untransformed B_{ij} yields:

$$\frac{TRV_j}{FIR} = \mathrm{S_j} \times P_s + (\mathrm{S_j}^{a} \times 10^{b}) \qquad \text{Equation 12}$$

This equation can be solved for S_j using Excel's solver utility, by solving for Sj. Using the solver utility, the left side of Equation 12 (which is known) can be used to solve for the right side (which has the unknown parameter S_j).

4.3.4.2 Representative Receptors for Calculating Threshold Sediment Concentrations

Sediment screening level values were calculated for invertivorous avian receptors that may occur within the Pit Lake. Avian invertivore feeding guilds were selected because several receptors in this feeding guild have been documented in the Pit Lake OU (e.g., bank swallows, killdeer, and grebes [Section 1.1]), and uptake via incidental sediment ingestion and invertebrate ingestion is considered a likely exposure pathway for this OU. The available toxicity information was reviewed for surrogate bird species similar to those that may be present in the pit lake. Conservative values were selected and screening level values were calculated as described in Section 4.3.4.1.

A potential pathway of exposure to contaminants of concern is by birds visiting the site and consuming sediment incidental to foraging for food at the Site. Three receptors were chosen to represent a variety of foraging strategies by which chemicals could be taken up: bank swallow, an aerial invertivore; killdeer, a probing invertivore that may forage both on the ground surface and in sediments at the margin of the lake; and eared grebe, which forages primarily on the surface and in the water column for surface and pelagic invertebrates. Wildlife exposure parameters (e.g., food ingestion rate [FIR], Ps) for each of these receptors that were used to support the calculation of sediment screening level values are provided in Table 4-3. The lowest screening level value calculated for each chemical for each of these receptors was chosen (Table 4-6).

4.3.5 Surface Water Screening Level Values

The lake surface water, as well as groundwater seeps emerging on the side walls of the pit lake, represent potentially complete exposure pathways for wildlife in the Pit Lake OU. ARC has adopted the NOAEL and LOAEL values in Table 4-7 as preliminary SLVs to screen existing aqueous samples for risks to birds and mammals via water consumption and to facilitate development of this work plan.

4.3.6 Screening Level Values for Radiochemicals

Screening levels values for radiochemicals (radium 226 and 228)[6] are presented in Table 4-8. These screening level values are based on USDOE (2002) guidance for evaluating radiological doses to biota. DOE's graded approach for evaluating radiation doses to biota consists of a three-step process designed to guide a user from an initial, conservative general screening to, if needed, a more rigorous analysis using site-specific information. The three-step process includes:

1. Assembling radiochemical concentration data and knowledge of sources, receptors, and routes of exposure for the area to be evaluated
2. Applying a general screening methodology that provides limiting radiochemical concentration values (i.e., Biota Concentration Guides - BCGs) in soil, sediment, and water
3. If needed, conducting an analysis through site-specific screening, site-specific analysis, or an actual site-specific biota dose assessment conducted within an ecological risk assessment.

The problem formulation section of this SLERA includes a discussion of Step 1, and the screening level methodology described in Step 2 is applied here using BCGs for terrestrial birds and mammals (Table 4-8), consistent with guidance for SLERA and with USDOE's (2002) recommendation for screening.

[6] Uranium screening levels are presented in Table 4-3 for soil and Table 4-6 for sediment.

5 SCREENING LEVEL EXPOSURE ASSESSMENT

The sources of chemicals in the pit lake, release and transport mechanisms for chemicals found or thought to exist in the pit lake, and the media in and pathways by which receptors may contact the chemicals of concern are discussed in the previous sections. The ecological characteristics, or exposure parameters, of the receptors that influence the magnitude and duration of exposure are presented here.

5.1 EXPOSURE PARAMETERS FOR RECEPTORS OF CONCERN

Consistent with the Site-wide CSM (Integral and Brown and Caldwell 2007), potential receptors of concern were selected to represent trophic guilds of animals expected to be present in the ecological communities of the Great Basin sagebrush-steppe ecosystem. Exposure parameters for the receptors evaluated in this SLERA are designed to be conservative so as not to underestimate potential risks to the ecological communities of the pit lake. Such conservative assumptions include the following:

- Area Use Factors (the ratio of habitat area available to the receptor's estimated home range area): This SLERA assumes that the home range of receptors is entirely within the contaminated area; thus, the animals are exposed 100 percent of the time. This is a conservative assumption. However, the results of the habitat study (Appendix B-1) may provide additional information regarding the proportion of the OU that could support ecological receptors and may be used to refine this assumption. Should a full ERA be conducted for the pit lake, information from the habitat survey, as well as species- and site-specific home range information would be needed to accurately estimate the percentage of time an animal would use an area.
- Conservative FIR: Conservative estimates for food ingestion rates, such as Eco-SSL high-end estimates of FIR (USEPA 2005), were selected when available in order to maximize estimated dose to receptors.
- Bioaccumulation: Anticipated Site chemicals include primarily metals; therefore, biomagnification via trophic transfer is not expected. If, however, the investigation does reveal the presence of bioaccumulative contaminants of concern, bioaccumulation models will be incorporated into the SLERA and reasonably conservative bioaccumulation factors (BAFs) will be used to assess the potential for transfer of chemicals through the food web.

5.2 MAGNITUDE, DURATION, AND FREQUENCY OF EXPOSURE

Exposure analysis quantifies the magnitude and spatial and temporal patterns of exposure as they relate to the assessment endpoints and risk questions (USEPA 1997). At the level of the screening level ecological risk assessment, the magnitude of exposure is set conservatively by using maximum concentrations for sampled media. Similarly, the duration and frequency of exposure are conservatively estimated by assuming that the AUFs are one and that exposure is continuous (Section 5.1). In addition, conservative assumptions about exposure have been built into the calculation of screening level values by using TRVs based on chronic exposures to contaminants (Section 4.3). The degree to which these assumptions affect the risk characterization will be addressed in Section 7.

6 SCREENING LEVEL RISK CHARACTERIZATION

6.1 CALCULATION OF THE HAZARD QUOTIENT

The hazard quotient is the ratio of the representative exposure concentration of a COPC in a given medium to a threshold effect concentration of the same constituent in the medium of concern. For a given exposure medium, the hazard quotient is calculated as:

$$HQ = \frac{\text{exposure concentration}}{\text{effects concentration}}$$

Screening level guidance describes a conservative approach in using maximum concentrations for comparison to the threshold effect concentration for a given medium and analyte. Therefore, maximum detected concentrations will be used for comparison to screening level values to calculate analyte-specific hazard quotients.

6.2 CALCULATION OF THE HAZARD INDEX

If there is more than one COPC in a given medium or in multiple media, the hazard index provides an estimation of the potential cumulative effects of multiple contaminants. The summary effects index is the hazard index , and is simply the sum of the hazard quotients for all COPCs in the medium of concern that share a common toxicological endpoint. The mathematical expression for the HI is:

$$HI_j = \sum_i HQ_{i,j}$$

where,

$HQ_{i,j}$ is the receptor-specific HQ for each COPC in medium *j*

HI_j is the receptor-specific HI for medium *j*.

6.3 CRITERIA FOR COPEC SELECTION

Screening for the selection of COPECs will follow a process that includes:

1. Using validated analytical processes, maximum detected chemical concentrations in the medium of interest are compared to screening concentrations as described above.
2. For naturally occurring chemicals, concentrations in the pit lake will be compared to concentrations in the background chemical data set.

3. For chemicals exceeding screening values and/or background area concentrations, an evaluation of the frequency and distribution of threshold exceedances will be performed, including the following specific criteria:
    a. Chemicals not exceeding screening values (HQ < 1) will not be carried forward as COPECs unless they share a common toxicity endpoint with other chemicals and collectively exceed an HI = 1, in which case all will be re-evaluated in a more detailed SLERA or in the BERA.
    b. If a chemical concentration is greater than the screening benchmark, but is not significantly different from background concentrations, the chemical will not be carried forward as a COPEC.

7 UNCERTAINTY ASSESSMENT

An uncertainty analysis is an important part of risk estimation, and includes summarizing the uncertainties identified during all phases of the risk assessment, evaluating the impact of those uncertainties on the risk assessment, and identifying (to the extent possible) actions that could reduce uncertainty. USEPA (1992a; 1998) identifies four overlapping areas where uncertainty could occur:

- The CSM—assumptions are made regarding stressor effects, impacted environment selection, and target species selection.
- Site information and data—in the absence of information or data necessary to conduct the risk assessment (e.g., characteristics of the physical or biological environment), assumptions may be necessary.
- Natural Variability—natural variability is a basic characteristic of stressors, receptors, habitat, and other factors influencing the distribution of ecological components; thus, uncertainty resulting from natural variability can be acknowledged and described but not reduced.
- Error—errors can be introduced during any phase of the investigation, including design, sampling, and analysis.

Uncertainties may be evaluated qualitatively and quantitatively. An evaluation of uncertainties will be provided in the SLERA report, including a table identifying specific factors that may result in an over- or under-estimation of risks.

8 SUMMARY AND RISK MANAGEMENT RECOMMENDATIONS

The results of the SLERA for the pit lake will be used to eliminate any contaminants and exposure pathways that pose negligible risks and to identify any exposure pathways and preliminary contaminants of concern that exceed *de minimis* levels for inclusion in a baseline ecological risk assessment, if needed. EPA and ARC shall subsequently determine if a Site-wide ecological risk assessment is required given the results of the OU-specific SLERAs.

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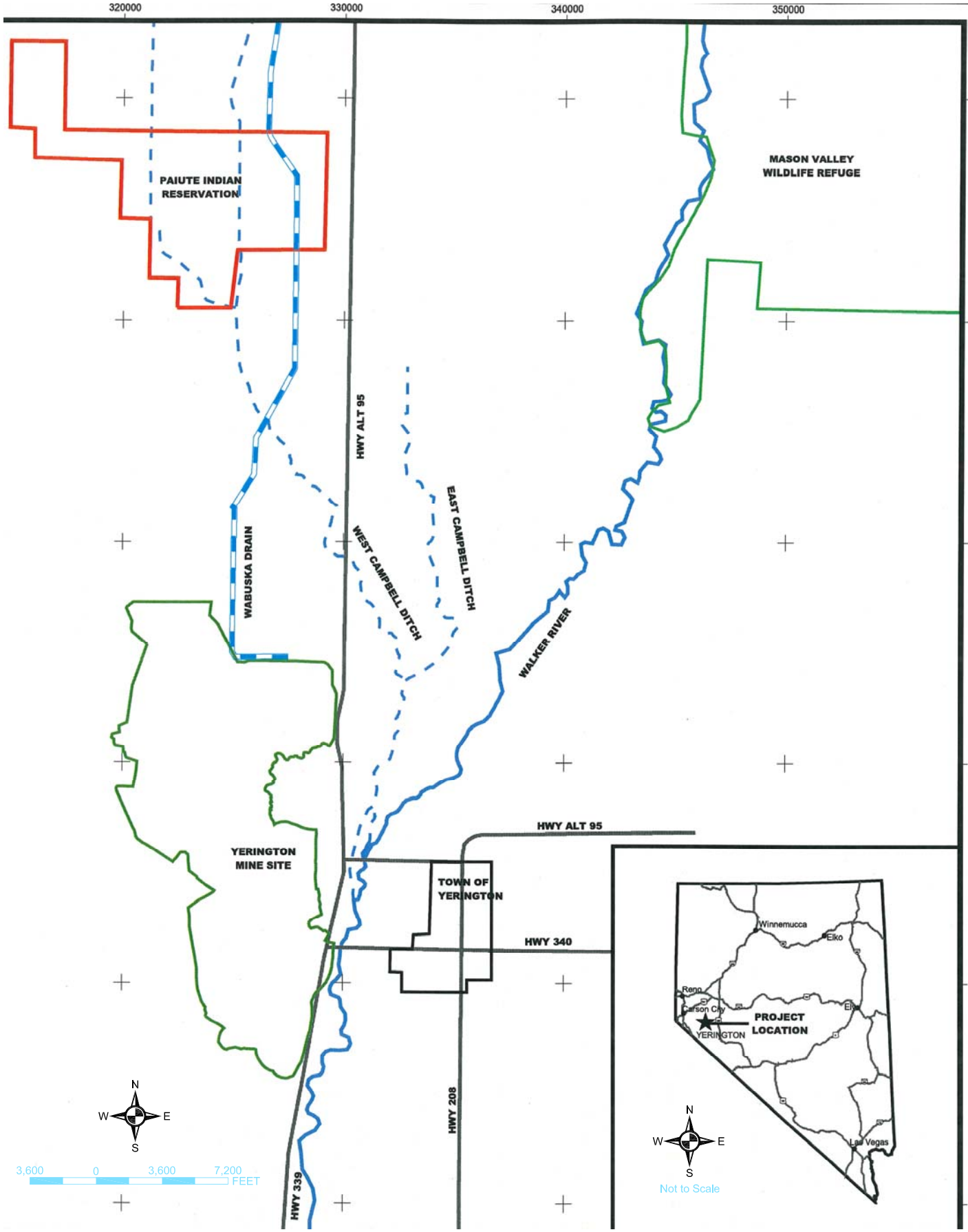
FIGURES



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Date: May 2007

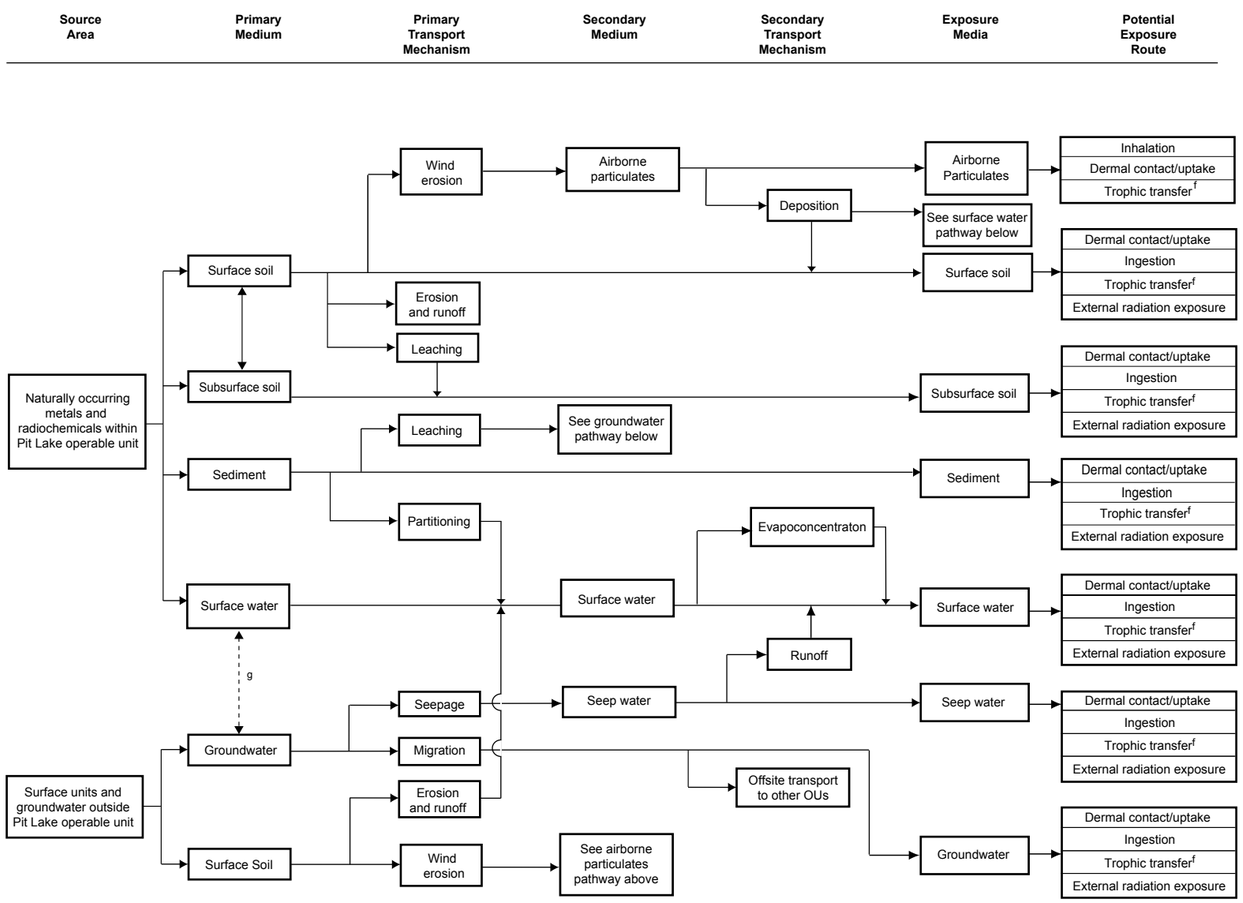
Atlantic Richfield Company

Project Number: 132034

Figure 1-1

Project Location

Carson City Cad: P:\ARCO\132034 – Project Management - Technical Support\CAD\Site CSM 5-10-07\Figure 1.dwg (1=1) 05/04/2007 13:34:20 RJJ



Potential Receptor of Concern[a]

Potential Exposure Route	Primary Producers: Aquatic plants	Primary Producers: Forbs and grasses[a]	Primary Producers: Woody plants[b]	Invertebratres: Primary and Secondary Consumers: Aquatic Invertebrates[c]	Invertebratres: Terrestrial Invertebrates: Epifaunal	Invertebratres: Terrestrial Invertebrates: Infaunal[d]	Mammals and Birds: Primary Consumers: Browsers: Mule deer	Mammals and Birds: Primary Consumers: Browsers: Jackrabbit	Mammals and Birds: Primary Consumers: Grazers/Granivores: Long-tailed vole	Mammals and Birds: Primary Consumers: Grazers/Granivores: Chukar	Mammals and Birds: Secondary Consumers: Invertivores: Bank swallow	Mammals and Birds: Secondary Consumers: Invertivores: Merriam's shrew	Mammals and Birds: Secondary Consumers: Invertivores: Eared grebe	Mammals and Birds: Secondary Consumers: Invertivores: Killdeer	Mammals and Birds: Secondary Consumers: Predators/Scavengers: Coyote/Kit fox[e]	Mammals and Birds: Secondary Consumers: Predators: American kestrel
Inhalation	--	--	--	–	○	○	○	○	○	○	○	○	○	○	○	○
Dermal contact/uptake	○	○	○	–	–	–	--	--	–	–	--	–	--	--	--	–
Trophic transfer[f]	--	--	--	–	○	○	○	○	○	○	○	○	○	○	○	○
Dermal contact/uptake	--	●	●	–	○	○	○	--	○	○	○	○	--	○	○	○
Ingestion	--	--	--	–	●	●	●	●	●	●	●	●	--	●	●	●
Trophic transfer[f]	--	--	--	–	●	●	●	●	●	●	●	●	--	●	●	●
External radiation exposure	--	○	○	–	○	○	○	--	○	○	○	○	--	○	○	○
Dermal contact/uptake	--	--	●	–	–	○	--	○	○	–	○	○	--	--	○	–
Ingestion	--	--	--	–	–	●	--	--	●	–	○	●	--	--	--	–
Trophic transfer[f]	--	--	--	–	○	●	●	●	●	○	●	●	--	--	●	●
External radiation exposure	--	--	○	–	–	○	--	○	○	–	○	○	--	--	○	–
Dermal contact/uptake	●	--	--	●	–	–	--	--	–	–	--	–	●	○	--	–
Ingestion	--	--	--	●	–	–	--	--	–	–	--	–	●	●	--	–
Trophic transfer[f]	--	--	--	●	–	–	--	--	–	–	○	–	●	●	--	–
External radiation exposure	○	--	--	○	–	–	--	--	–	–	--	–	○	○	--	–
Dermal contact/uptake	●	--	--	●	–	–	○	○	–	○	○	–	●	○	○	–
Ingestion	--	--	--	●	–	–	●	●	–	●	●	–	●	●	●	–
Trophic transfer[f]	--	--	--	●	–	–	--	--	–	–	●	–	●	●	●	●
External radiation exposure	○	--	--	○	–	–	○	○	–	○	○	–	○	○	○	–
Dermal contact/uptake	●	--	--	○	–	–	○	○	–	○	--	–	--	○	○	–
Ingestion	--	--	--	●	–	–	●	●	–	●	--	–	--	●	●	–
Trophic transfer[f]	--	--	--	–	–	–	--	--	–	–	●	–	--	●	●	●
External radiation exposure	○	--	--	○	–	–	○	○	–	○	--	–	--	○	○	–
Dermal contact/uptake	--	●	●	–	–	–	--	--	–	–	--	–	--	--	--	–
Ingestion	--	--	--	–	–	–	--	--	–	–	--	–	--	--	--	–
Trophic transfer[f]	--	--	--	–	○	○	●	●	●	●	--	○	--	○	○	○
External radiation exposure	--	○	○	–	–	–	--	--	–	–	--	–	--	--	--	–

Notes:

a: Root depths, and therefore exposure to soil, of forbs and grasses in this ecosystem is generally limited to soil depths of less than 2 ft. It is assumed that forbs and grasses may contact shallow groundwater where it emerges to form seeps.

b: A survey of woody plant species has not been conducted on the Site, and therefore the lower depth to which roots of these species extend is not known.

c: Aquatic invertebrates include emergent insects which become terrestrial adults, but this grouping considers exposure only to the aquatic portion of the lifecycle. Exposure during the terrestrial portion of the lifecycle is considered in the terrestrial invertebrates grouping.

d: Infaunal invertebrates include ants, beetles, spiders and other burrowing arthropods. Species assemblage, and therefore depth of activity in soil, is not understood for this site.

e: Coyotes and kit fox may use underground dens and may potentially be exposed to subsurface soil in association with this activity; however, unlike kit fox, coyote do not tend to dig for their prey and therefore predation is not viewed as a potential mechanism for ingestion exposure to subsurface soil for coyote.

f: Trophic Transfer refers to transfer of chemicals by the consumption of lower trophic level species containing these chemicals.

g: It is not known whether the Pit Lake will ultimately reach a level where it is hydraulically connected to groundwater and become a steady-state "flow through" system; for now, the potential interchange of surface and groundwater is indicated generally by this dashed line.

LEGEND
● Potentially significant exposure route
○ Potentially complete but insignificant exposure route
-- Incomplete exposure route

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Date: September 2007

Atlantic Richfield Company

Project Number: 132034

Conceptual Site Model for Yerington Mine

Figure 3-1

Ecological Receptors of the Pit Lake Operable Unit

TABLES

Table 4-1. Soil Screening Level Values for Plants and Soil Invertebrates for the Pit Lake OU

Parameter	Soil Screening levels for Plants[a] (mg/kg)	Soil screening levels for Invertebrates[a] (mg/kg)
Benzene	--	--
Bromobenzene	--	--
Bromochloromethane	--	--
Bromodichloromethane	--	--
Bromoform	--	--
Bromomethane	--	--
n-Butylbenzene	--	--
sec-Butylbenzene	--	--
tert-Butylbenzene	--	--
Carbon tetrachloride	--	--
Chlorobenzene	--	40 [c,d]
Chloroethane	--	--
2-Chlorotoluene	--	--
4-Chlorotoluene	--	--
Chloroform	--	--
Chloromethane	--	--
1,2-Dibromo-3-chloropropane	--	--
Dibromochloromethane	--	--
1,2-Dibromoethane	--	--
Dibromomethane	--	--
1,2-Dichlorobenzene	--	--
1,3-Dichlorobenzene	--	--
1,4-Dichlorobenzene	--	20 [c,d]
Dichlorodifluoromethane	--	--
1,1-Dichloroethane	--	--
1,2-Dichloroethane	--	--
1,1-Dichloroethene	--	--
cis-1,2-Dichloroethene	--	--
trans-1,2-Dichloroethene	--	--
Dichlorofluoromethane	--	--
1,2-Dichloropropane	--	700 [c,d]
1,3-Dichloropropane	--	--

Table 4-1. Soil Screening Level Values for Plants and Soil Invertebrates for the Pit Lake OU

Parameter	Soil Screening levels for Plants[a] (mg/kg)	Soil screening levels for Invertebrates[a] (mg/kg)
2,2-Dichloropropane	--	--
1,1-Dichloropropene	--	--
Ethylbenzene	--	--
Hexachlorobutadiene	--	--
Isopropylbenzene	--	--
p-Isopropyltoluene	--	--
Methylene chloride	--	--
Naphthalene	--	--
n-Propylbenzene	--	--
Styrene	300 [b]	--
tert-butyl methyl ether	--	--
1,1,2,2-Tetrachloroethane	--	--
1,1,2,2-Tetrachloroethene	--	--
1,1,1,2-Tetrachloroethane	--	--
Toluene	200 [b]	--
1,2,3-Trichlorobenzene	--	20 [c,d]
1,2,4-Trichlorobenzene	--	20 [c,d]
1,1,1-Trichloroethane	--	--
1,1,2-Trichloroethane	--	--
Trichloroethene	--	--
Trichlorofluoromethane	--	--
1,2,3-Trichloropropane	--	--
1,2,4-Trimethylbenzene	--	--
1,3,5-Trimethylbenzene	--	--
Vinyl chloride	--	--
Xylene (total)	--	--
o-Xylene	--	--
m-Xylene	--	--
p-Xylene	--	--
Aluminum	50 [b]	--
Antimony	5 [b]	78
Arsenic	18	60 [c,d]

Table 4-1. Soil Screening Level Values for Plants and Soil Invertebrates for the Pit Lake OU

Parameter	Soil Screening levels for Plants[a] (mg/kg)	Soil screening levels for Invertebrates[a] (mg/kg)
Barium	500 [b]	330
Beryllium	10 [b]	40
Boron	0.5 [b]	--
Cadmium	32	140
Calcium	--	--
Chromium	1 [b]	0.4 [c,d]
Cobalt	13	--
Copper	70	80
Iron	--	--
Lead	120	1,700
Magnesium	--	--
Manganese	220	450
Mercury	0.3 [b]	0.1 [c,d]
Molybdenum	2 [b]	--
Nickel	38	280
Potassium	--	--
Selenium	1 [b]	70 [c,d]
Silver	560	--
Sodium	--	--
Thallium	1 [b]	--
Thorium	--	--
Uranium	5 [b]	--
Vanadium	2 [b]	--
Zinc	50 [b]	200 [c,d]

Notes:

[a] Unless otherwise indicated, source of value is USEPA. 2007. Ecological Soil Screening Levels. http://www.epa.gov/ecotox/ecossl/. Accessed on August 21, 2007. Last updated on August 14, 2007. U.S. Environmental Protection Agency, Washington, DC.

[b] Efroymson et al.1997a.

[c] Efroymson et al. 1997b.

[d] Efroymson et al. benchmark for invertebrates based on earthworms.

Table 4-2. Final TRVs Used for the Calculation of Soil and Sediment Screening Level Values for the Pit Lake OU[a].

Parameter	NOAEL- Birds (mg/kg bw d)	NOAEL- large mammals (mg/kg bw d)	NOAEL- small mammals (mg/kg bw d)
Benzene	--	4 [b]	24 [b]
Bromobenzene	--	--	--
Bromochloromethane	--	--	--
Bromodichloromethane	--	--	--
Bromoform	--	--	--
Bromomethane	--	--	--
n-Butylbenzene	--	--	--
sec-Butylbenzene	--	--	--
tert-Butylbenzene	--	--	--
Carbon tetrachloride	--	4.5 [b]	26.9 [b]
Chlorobenzene	--	--	--
Chloroethane	--	--	--
2-Chlorotoluene	--	--	--
4-Chlorotoluene	--	--	--
Chloroform	--	4.2 [b]	25.2 [b]
Chloromethane	--	--	--
1,2-Dibromo-3-chloropropane	--	--	--
Dibromochloromethane	--	--	--
1,2-Dibromoethane	--	--	--
Dibromomethane	--	--	--
1,2-Dichlorobenzene	--	--	--
1,3-Dichlorobenzene	--	--	--
1,4-Dichlorobenzene	--	--	--
Dichlorodifluoromethane	--	--	--
1,1-Dichloroethane	--	--	--
1,2-Dichloroethane	17.2 [b]	7.9 [b]	47.2 [b]
1,1-Dichloroethene	--	8.4 [b]	50.4 [b]
cis-1,2-Dichloroethene	--	6.9 [b,c]	51.1 [b,c]
trans-1,2-Dichloroethene	--	6.9 [b,c]	51.1 [b,c]
Dichlorofluoromethane	--	--	--
1,2-Dichloropropane	--	--	--
1,3-Dichloropropane	--	--	--

Table 4-2. Final TRVs Used for the Calculation of Soil and Sediment Screening Level Values for the Pit Lake OU[a].

Parameter	NOAEL- Birds (mg/kg bw d)	NOAEL- large mammals (mg/kg bw d)	NOAEL- small mammals (mg/kg bw d)
2,2-Dichloropropane	--	--	--
1,1-Dichloropropene	--	--	--
Ethylbenzene	--	--	--
Hexachlorobutadiene	--	--	--
Isopropylbenzene	--	--	--
p-Isopropyltoluene	--	--	--
Methylene chloride	--	1.6 [b]	9.8 [b]
Naphthalene	--	--	--
n-Propylbenzene	--	--	--
Styrene	--	--	--
tert-butyl methyl ether	--	--	--
1,1,2,2-Tetrachloroethane	--	--	--
1,1,2,2-Tetrachloroethene	--	0.21 [b]	1.27 [b]
1,1,1,2-Tetrachloroethane	--	--	--
Toluene	--	--	--
1,2,3-Trichlorobenzene	--	--	--
1,2,4-Trichlorobenzene	--	--	--
1,1,1-Trichloroethane	--	158 [b]	944 [b]
1,1,2-Trichloroethane	--	--	--
Trichloroethene	--	0.106 [b]	0.636 [b]
Trichlorofluoromethane	--	--	--
1,2,3-Trichloropropane	--	--	--
1,2,4-Trimethylbenzene	--	--	--
1,3,5-Trimethylbenzene	--	--	--
Vinyl chloride	--	0.048 [b]	0.285 [b]
Xylene (total)	--	0.319 [b]	1.908 [b]
o-Xylene	--	--	--
m-Xylene	--	--	--
p-Xylene	--	--	--
Aluminum	109.7 [b]	0.293 [b]	1.754 [b]
Antimony	--	0.019 [b]	0.114 [b]
Arsenic	2.24	1.04	0.32
Barium	20.8 [b]	1.5 [b]	9 [b]

Table 4-2. Final TRVs Used for the Calculation of Soil and Sediment Screening Level Values for the Pit Lake OU[a].

Parameter	NOAEL- Birds (mg/kg bw d)	NOAEL- large mammals (mg/kg bw d)	NOAEL- small mammals (mg/kg bw d)
Beryllium	--	0.19 [b]	1.11 [b]
Boron	28.8 [b]	7.9 [b]	47 [b]
Cadmium	1.47	0.77	0.06 [e]
Calcium	--	--	--
Chromium	2.66 [b,d]	2.4 [b,d]	4597 [b,d]
Cobalt	7.61	1.2	1.2
Copper	2.3 [e]	2.67 [e]	2.67 [e]
Iron	--	--	--
Lead	1.63	4.7	1 [e]
Magnesium	--	--	--
Manganese	77.6 [e]	13.7 [e]	13.7 [e]
Mercury	0.039 [e]	0.027 [e,f]	0.25 [e,g]
Molybdenum	3.5 [b]	0.04 [b]	0.24 [b]
Nickel	6.71	1.7	0.133 [e]
Potassium	--	--	--
Selenium	0.23 [e]	0.05 [e]	0.05 [e]
Silver	--	--	--
Silver	--	--	--
Sodium	--	--	--
Thallium	--	0.48 [e]	0.48 [e]
Thorium	--	--	--
Uranium	16 [b]	0.458 [b]	2.742 [b]
Vanadium	0.344	4.16	0.327 [b]
Zinc	17.2	9.6	9.6 [e]

Notes:

[a] Eco-SSL is used as the primary source for the TRV unless noted otherwise. Secondary sources in order of priority were Region 9 BTAG values (DeVries 2007) and ORNL values (Sample et al. 1996).

[b] ORNL (Sample et al. 1996).

[c] TRV for 1,2-dichloroethene used for both cis- and trans-

[d] Chromium III TRV.

[e] Regiona 9 BTAG (DeVries 2007).

[f] Value is for large mammals.

[g] Value is for rodents.

Table 4-3. Supporting Values for Representative Ecological Receptors Used for Calculating Soil and Sediment TRVs for the Pit Lake OU

Receptor	Fraction soil in diet (Ps)[a]	FIR	BW (kg)
Chukar	0.104 [b]	0.074 [c]	0.50 [d]
Mule deer	0.02 [e]	0.035 [f]	43 [g]
Long-tailed vole	0.032 [h]	0.088 [i]	0.020 [j]
Bank swallow	0.02 [k]	0.252 [c]	0.015 [l]
Eared Grebe	0.02 [m]	0.087 [c]	0.32 [n]
Killdeer	0.104 [b]	0.136 [c]	0.088 [o]

Notes:
[a] unless otherwise indicated, source is Beyer 1994.
[b] soil in diet not available for this species; American woodcock used as substitute.
[c] 0.0582*(BW 0.651)/BW (kg) Equation 3-3 USEPA 1993.
[d] average body weight of females reported in Christenson 1970.
[e] chosen as upper bound of estimates provided for both white-tailed and mule deer.
[f] 0.0687*BW(kg) 0.822))/BW (kg) Equation 3-7 USEPA 1993.
[g] UMMZ 2007: Lower bound of range reported for adult female mule deer.
[h] 90th% soil ingestion rate for meadow vole, USEPA 2005 Table 3.
[i] USEPA 2005, Table 2 (high end estimate data for meadow vole used).
[j] lower bound of weight reported for long-tailed vole (UMMZ 2007c).
[k] lowest of values available for avian receptors in Beyer et al. 1994 based on assumption that bank swallow ingests little soil b/c of primarily aerial foraging technique.
[l] value for adult female birds from southeastern Wisconsin (MacBriar 1988).
[m] soil in diet not available for eared grebe; upper bound of estimate for ring-necked duck used.
[n] Average weights of 18 adult eared grebe wintering on the Salton Sea, Feb-Mar 1993 (Jehl 1997).
[o] Average weight of adults reported for killdeer (UMMZ 2007d).

Table 4-4. Final Soil Screening Level Values for Wildlife in the Pit Lake OU and Comparison to Background Soil Concentrations for Washington State

Parameter	Avian[a] SLV (mg/kg)	Mammalian[b] SLV (mg/kg)	Comparisons to Background[c]
Benzene	--	111 [d]	--
Bromobenzene	--	--	--
Bromochloromethane	--	--	--
Bromodichloromethane	--	--	--
Bromoform	--	--	--
Bromomethane	--	--	--
n-Butylbenzene	--	--	--
sec-Butylbenzene	--	--	--
tert-Butylbenzene	--	--	--
Carbon tetrachloride	--	125 [d]	--
Chlorobenzene	--	--	--
Chloroethane	--	--	--
2-Chlorotoluene	--	--	--
4-Chlorotoluene	--	--	--
Chloroform	--	117 [d]	--
Chloromethane	--	--	--
1,2-Dibromo-3-chloropropane	--	--	--
Dibromochloromethane	--	--	--
1,2-Dibromoethane	--	--	--
Dibromomethane	--	--	--
1,2-Dichlorobenzene	--	--	--
1,3-Dichlorobenzene	--	--	--
1,4-Dichlorobenzene	--	--	--
Dichlorodifluoromethane	--	--	--
1,1-Dichloroethane	--	--	--
1,2-Dichloroethane	210 [d]	220 [d]	--
1,1-Dichloroethene	--	234 [d]	--
cis-1,2-Dichloroethene	--	192 [d]	--
trans-1,2-Dichloroethene	--	192 [d]	--
Dichlorofluoromethane	--	--	--
1,2-Dichloropropane	--	--	--
1,3-Dichloropropane	--	--	--

Table 4-4. Final Soil Screening Level Values for Wildlife in the Pit Lake OU and Comparison to Background Soil Concentrations for Washington State

Parameter	Avian[a] SLV (mg/kg)	Mammalian[b] SLV (mg/kg)	Comparisons to Background[c]
2,2-Dichloropropane	--	--	--
1,1-Dichloropropene	--	--	--
Ethylbenzene	--	--	--
Hexachlorobutadiene	--	--	--
Isopropylbenzene	--	--	--
p-Isopropyltoluene	--	--	--
Methylene chloride	--	45 [d]	--
Naphthalene	--	--	--
n-Propylbenzene	--	--	--
Styrene	--	--	--
tert-butyl methyl ether	--	--	--
1,1,2,2-Tetrachloroethane	--	--	--
1,1,2,2-Tetrachloroethene	--	6 [d]	--
1,1,1,2-Tetrachloroethane	--	--	--
Toluene	--	--	--
1,2,3-Trichlorobenzene	--	--	--
1,2,4-Trichlorobenzene	--	--	--
1,1,1-Trichloroethane	--	4404 [d]	--
1,1,2-Trichloroethane	--	--	--
Trichloroethene	--	3 [d]	--
Trichlorofluoromethane	--	--	--
1,2,3-Trichloropropane	--	--	--
1,2,4-Trimethylbenzene	--	--	--
1,3,5-Trimethylbenzene	--	--	--
Vinyl chloride	--	1 [d]	--
Xylene (total)	--	9 [d]	--
o-Xylene	--	--	--
m-Xylene	--	--	--
p-Xylene	--	--	--
Aluminum	1340 [d]	8 [d]	66078
Antimony	--	0.27	1
Arsenic	43	46	9

Table 4-4. Final Soil Screening Level Values for Wildlife in the Pit Lake OU and Comparison to Background Soil Concentrations for Washington State

Parameter	Avian[a] SLV (mg/kg)	Mammalian[b] SLV (mg/kg)	Comparisons to Background[c]
Barium	1079 [d]	2000	822
Beryllium	--	21	1.3
Boron	352 [d]	220 [d]	--
Cadmium	0.8	0.36	1
Calcium	--	--	--
Chromium	26	34	--
Cobalt	120	230	8.4
Copper	28	49	25
Iron	--	--	22725
Lead	11	56	25
Magnesium	--	--	--
Manganese	5720 [d]	1411 [d]	481
Mercury	0.5 [d]	0.8 [d]	0.02
Molybdenum	43 [d]	1 [d]	--
Nickel	210	130	15
Potassium	--	--	--
Selenium	4	1	0.3
Silver	4	14	--
Silver	--	--	--
Sodium	--	--	--
Thallium	--	5	--
Thorium	--	--	--
Uranium	196	13	--
Vanadium	8	280	78
Zinc	210	106	69

Notes:
Values are eco-ssl SLVs unless otherwise indicated. Bolded SLVs are lower than background values.
[a] Value is lowest Eco-SSL avian SLV unless otherwise indicated.
[b] Value is lowest Eco-SSL mammalian SLV unless otherwise indicated.
[c] Background value is for State of Nevada from Eco-SSL guidance (USEPA 2007b) unless otherwise indicated.
[d] Calculated SLV based on literature-based TRVs and exposure equations.
[e] If no NV state value available, Spokane Basin value used for comparison (WDOE 1994).

Table 4-5. Sediment Screening Levels for Aquatic Macroinvertebrates

Parameter	Analytical Method	Reporting Limit	Unit	Consensus-based TEC (mg/kg dw)	Consensus-based PEC (mg/kg dw)
Benzene	5035A-8260B	1.0	mg/kg	--	--
Bromobenzene	5035A-8260B	2.0	mg/kg	--	--
Bromochloromethane	5035A-8260B	2.0	mg/kg	--	--
Bromodichloromethane	5035A-8260B	1.0	mg/kg	--	--
Bromoform	5035A-8260B	2.0	mg/kg	--	--
Bromomethane	5035A-8260B	2.0	mg/kg	--	--
n-Butylbenzene	5035A-8260B	2.0	mg/kg	--	--
sec-Butylbenzene	5035A-8260B	2.0	mg/kg	--	--
tert-Butylbenzene	5035A-8260B	2.0	mg/kg	--	--
Carbon tetrachloride	5035A-8260B	2.0	mg/kg	--	--
Chlorobenzene	5035A-8260B	1.0	mg/kg	--	--
Chloroethane	5035A-8260B	2.0	mg/kg	--	--
2-Chlorotoluene	5035A-8260B	2.0	mg/kg	--	--
4-Chlorotoluene	5035A-8260B	2.0	mg/kg	--	--
Chloroform	5035A-8260B	1.0	mg/kg	--	--
Chloromethane	5035A-8260B	2.0	mg/kg	--	--
1,2-Dibromo-3-chloropropane	5035A-8260B	10	mg/kg	--	--
Dibromochloromethane	5035A-8260B	1.0	mg/kg	--	--
1,2-Dibromoethane	5035A-8260B	1.0	mg/kg	--	--
Dibromomethane	5035A-8260B	1.0	mg/kg	--	--
1,2-Dichlorobenzene	5035A-8260B	1.0	mg/kg	--	--
1,3-Dichlorobenzene	5035A-8260B	1.0	mg/kg	--	--
1,4-Dichlorobenzene	5035A-8260B	1.0	mg/kg	--	--
Dichlorodifluoromethane	5035A-8260B	1.0	mg/kg	--	--
1,1-Dichloroethane	5035A-8260B	1.0	mg/kg	--	--
1,2-Dichloroethane	5035A-8260B	1.0	mg/kg	--	--
1,1-Dichloroethene	5035A-8260B	2.0	mg/kg	--	--
cis-1,2-Dichloroethene	5035A-8260B	1.0	mg/kg	--	--
trans-1,2-Dichloroethene	5035A-8260B	1.0	mg/kg	--	--
Dichlorofluoromethane	5035A-8260B	1.0	mg/kg	--	--
1,2-Dichloropropane	5035A-8260B	1.0	mg/kg	--	--

Table 4-5. Sediment Screening Levels for Aquatic Macroinvertebrates

Parameter	Analytical Method	Reporting Limit	Unit	Consensus-based TEC (mg/kg dw)	Consensus-based PEC (mg/kg dw)
1,3-Dichloropropane	5035A-8260B	1.0	mg/kg	--	--
2,2-Dichloropropane	5035A-8260B	1.0	mg/kg	--	--
1,1-Dichloropropene	5035A-8260B	1.0	mg/kg	--	--
Ethylbenzene	5035A-8260B	1.0	mg/kg	--	--
Hexachlorobutadiene	5035A-8260B	2.0	mg/kg	--	--
Isopropylbenzene	5035A-8260B	1.0	mg/kg	--	--
p-Isopropyltoluene	5035A-8260B	1.0	mg/kg	--	--
Methylene chloride	5035A-8260B	10	mg/kg	--	--
Naphthalene	5035A-8260B	2.0	mg/kg	--	--
n-Propylbenzene	5035A-8260B	1.0	mg/kg	--	--
Styrene	5035A-8260B	1.0	mg/kg	--	--
tert-butyl methyl ether	5035A-8260B	2.0	mg/kg	--	--
1,1,2,2-Tetrachloroethane	5035A-8260B	2.0	mg/kg	--	--
1,1,2,2-Tetrachloroethene	5035A-8260B	1.0	mg/kg	--	--
1,1,1,2-Tetrachloroethane	5035A-8260B	2.0	mg/kg	--	--
Toluene	5035A-8260B	1.0	mg/kg	--	--
1,2,3-Trichlorobenzene	5035A-8260B	2.0	mg/kg	--	--
1,2,4-Trichlorobenzene	5035A-8260B	2.0	mg/kg	--	--
1,1,1-Trichloroethane	5035A-8260B	1.0	mg/kg	--	--
1,1,2-Trichloroethane	5035A-8260B	1.0	mg/kg	--	--
Trichloroethene	5035A-8260B	1.0	mg/kg	--	--
Trichlorofluoromethane	5035A-8260B	1.0	mg/kg	--	--
1,2,3-Trichloropropane	5035A-8260B	2.0	mg/kg	--	--
1,2,4-Trimethylbenzene	5035A-8260B	1.0	mg/kg	--	--
1,3,5-Trimethylbenzene	5035A-8260B	1.0	mg/kg	--	--
Vinyl chloride	5035A-8260B	2.0	mg/kg	--	--
Xylene (total)	5035A-8260B	4.0	mg/kg	--	--
o-Xylene	5035A-8260B	4.0	mg/kg	--	--
m-Xylene	5035A-8260B	4.0	mg/kg	--	--
p-Xylene	5035A-8260B	4.0	mg/kg	--	--

Table 4-5. Sediment Screening Levels for Aquatic Macroinvertebrates

Parameter	Analytical Method	Reporting Limit	Unit	Consensus-based TEC (mg/kg dw)	Consensus-based PEC (mg/kg dw)
Aluminum	6010B	10	mg/kg	--	--
Antimony	6020	1000	mg/kg	--	--
Arsenic	6020	0.5	mg/kg	9.79	33
Barium	6020	500	mg/kg	--	--
Beryllium	6020	300	mg/kg	--	--
Boron	6010B	5.0	mg/kg	--	--
Cadmium	6020	500	mg/kg	0.99	4.98
Calcium	6010B	15	mg/kg	--	--
Chromium	6020	1	mg/kg	43.4	111
Cobalt	6020	500	mg/kg	--	--
Copper	6020	1	mg/kg	31.6	149
Iron	6010B	5.0	mg/kg	--	--
Lead	6020	500	mg/kg	35.8	128
Magnesium	6010B	10	mg/kg	--	--
Manganese	6020	0.5	mg/kg	--	--
Mercury	7471A	0.02	mg/kg	0.18	1.06
Molybdenum	6020	1000	mg/kg	--	--
Nickel	6020	1000	mg/kg	22.7	48.6
Potassium	6010B	50	mg/kg	--	--
Selenium	6020	1	mg/kg	--	--
Silver	6010B	1000	mg/kg	--	--
Silver	6020	500	mg/kg	--	--
Sodium	6010B	50	mg/kg	--	--
Thallium	6020	0.5	mg/kg	--	--
Thorium	6020	0.5	mg/kg	--	--
Uranium	6020	0.5	mg/kg	--	--
Vanadium	6020	1	mg/kg	--	--
Zinc	6020	10	mg/kg	121	459

Source: MacDonald et al. 2000.

Table 4-6. Final Sediment Screening Level Values for Wildlife in the Pit Lake OU

Parameter	Sediment SLV (mg/kg dw)[a]
Benzene	--
Bromobenzene	--
Bromochloromethane	--
Bromodichloromethane	--
Bromoform	--
Bromomethane	--
n-Butylbenzene	--
sec-Butylbenzene	--
tert-Butylbenzene	--
Carbon tetrachloride	--
Chlorobenzene	--
Chloroethane	--
2-Chlorotoluene	--
4-Chlorotoluene	--
Chloroform	--
Chloromethane	--
1,2-Dibromo-3-chloropropane	--
Dibromochloromethane	--
1,2-Dibromoethane	--
Dibromomethane	--
1,2-Dichlorobenzene	--
1,3-Dichlorobenzene	--
1,4-Dichlorobenzene	--
Dichlorodifluoromethane	--
1,1-Dichloroethane	--
1,2-Dichloroethane	67
1,1-Dichloroethene	--
cis-1,2-Dichloroethene	--
trans-1,2-Dichloroethene	--
Dichlorofluoromethane	--
1,2-Dichloropropane	--
1,3-Dichloropropane	--
2,2-Dichloropropane	--

Table 4-6. Final Sediment Screening Level Values for Wildlife in the Pit Lake OU

Parameter	Sediment SLV (mg/kg dw)[a]
1,1-Dichloropropene	--
Ethylbenzene	--
Hexachlorobutadiene	--
Isopropylbenzene	--
p-Isopropyltoluene	--
Methylene chloride	--
Naphthalene	--
n-Propylbenzene	--
Styrene	--
tert-Butyl methyl ether	--
1,1,2,2-Tetrachloroethane	--
1,1,2,2-Tetrachloroethene	--
1,1,1,2-Tetrachloroethane	--
Toluene	--
1,2,3-Trichlorobenzene	--
1,2,4-Trichlorobenzene	--
1,1,1-Trichloroethane	--
1,1,2-Trichloroethane	--
Trichloroethene	--
Trichlorofluoromethane	--
1,2,3-Trichloropropane	--
1,2,4-Trimethylbenzene	--
1,3,5-Trimethylbenzene	--
Vinyl chloride	--
Xylene (total)	--
o-Xylene	--
m-Xylene	--
p-Xylene	--
Aluminum	427
Antimony	--
Arsenic	158
Barium	81
Beryllium	--

Table 4-6. Final Sediment Screening Level Values for Wildlife in the Pit Lake OU

Parameter	Sediment SLV (mg/kg dw)[a]
Boron	112
Cadmium	104
Calcium	--
Chromium	51
Cobalt	30
Copper	1.1
Iron	--
Lead	115
Magnesium	--
Manganese	302
Mercury	0.04
Molybdenum	14
Nickel	475
Potassium	--
Selenium	0.89
Silver	--
Silver	--
Sodium	--
Thallium	--
Thorium	--
Uranium	62
Vanadium	1.3
Zinc	1217

Notes:
[a] Value is the minimum calculated SLV from three avian receptors evaluated: aerial invertivore, probing invertivore, and diving/surface invertivore.

Table 4-7. Screening Level Values for Wildlife Drinking Water and Freshwater Aquatic Life

		Avian SLVs			Mammalian SLVs			Aquatic Life Criteria		
Chemical	Units	NOAEL[a]	LOAEL	Notes	NOAEL	LOAEL	Notes	CMC	CCC	Notes
Aluminum	mg/L	471	--	b	4	45	e	--	--	
Antimony	mg/L	--	--		0.29	2.90	e	--	--	
Arsenic	mg/L	22	55	b	0.29	2.92	e	--	--	
Barium	mg/L	--	--		23	--	e	--	--	
Beryllium	mg/L	3.77	--	c	3	--	e	--	--	
Bismuth	mg/L	--	--		--	--		--	--	
Boron	mg/L	124	430	b	120	401	e	--	--	
Cadmium	mg/L	6.23	86	b	4.13	41	e	0.005	0.0005	g
Calcium	mg/L	--	--		--	--		--	--	
Chloride	mg/L	--	--		--	--		--	--	
Chromium, Total	mg/L	4.30	21	b,d	11,725	--	e	1.317	0.171	b,g,i
Cobalt	mg/L	--	--		--	--		--	--	
Copper	mg/L	202	265	b	65	86	e	0.035	0.021	g
Fluoride	mg/L	34	138	b	175	294	e	--	--	
Gallium	mg/L	--	--		--	--		--	--	
Iron	mg/L	--	--		--	--		--	--	
Lead	mg/L	4.86	49	b	34	343	e	0.193	0.0075	g
Lithium	mg/L	--	--		--	--		--	--	
Magnesium	mg/L	--	--		--	--		--	--	
Manganese	mg/L	4,284	--	b	377	1,217	e	--	--	
Mercury	mg/L	1.93	3.87	b	--	--		0.001	0.001	
Molybdenum	mg/L	15	152	b	0.60	6.03	e	--	--	

Table 4-7. Screening Level Values for Wildlife Drinking Water and Freshwater Aquatic Life

		Avian SLVs			Mammalian SLVs			Aquatic Life Criteria		
Chemical	Units	NOAEL[a]	LOAEL	Notes	NOAEL	LOAEL	Notes	CMC	CCC	Notes
Nickel	mg/L	333	460	b	171	343	e	1.112	0.124	g
Potassium	mg/L	--	--		--	--		--	--	
Scandium	mg/L	--	--		--	--		--	--	
Selenium	mg/L	2.15	4.30	b	0.86	1.41	e	0.020	0.005	h
Silicon	mg/L	--	--		--	--		--	--	
Silver	mg/L	--	--		--	--		0.019	--	g
Sodium	mg/L	--	--		--	--		--	--	
Strontium	mg/L	1,127	--	e	--	--		--	--	
Thallium	mg/L	0.03	0.32	e	0.03	0.32	e	--	--	
Tin	mg/L	29	73	b	54	81	e	--	--	
Titanium	mg/L	--	--		--	--		--	--	
Uranium	mg/L	69	--		7.00	14	e	--	--	
Vanadium	mg/L	49	--	b	0.84	8.35	e	--	--	
Zinc	mg/L	62	563	b	685	1,371	e	0.279	0.281	g

Notes:

a No-observed-adverse-effect level (NOAEL) and lowest-observed-adverse effect level (LOAEL).

b The most sensitive avian receptor is the rough-wing swallow unless otherwise noted.

c River otter. No data were available for birds.

d Based on Cr+3.

e White-tail deer.

f Depleted metallic uranium.

g The freshwater criterion for this metal is expressed as a function of hardness (mg/L) in the water column. The value given here corresponds to an average pit lake hardness of 278 mg/L and is calculated according to the procedures provided in by USEPA (2006).

h USEPA's (2006) recommended water quality criterion for selenium is expressed in terms of total recoverable metal in the water column. It is scientifically acceptable to use the conversion factor (0.996- CMC or 0.922- CCC) that was used in the GLI to convert this to a value that is expressed in terms of dissolved metal.

i AWQC expressed for Cr III.

Sources: Avian values (Sample et al. 1996); Aquatic Life Criteria (EPA 2006).

Table 4-8. US Department of Energy Biota Concentration Guidelines (BCGs) for Soil and Surface Water

Parameter	Terrestrial Animal, soil BCG (pCi/g)	Terrestrial Animal, surface water BCG (pCi/L)	Riparian Animal, sediment BCG (pCi/g)	Riparian Animal, surface water BCG (pCi/L)
Radium-226	50	8107	101	4.1
Radium-228	44	6752	88	3.4

Source: US DOE 2002