Appendix G

Risk Assessments

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G-1.0 INTRODUCTION

This appendix presents the results of the human health and ecological risk-screening assessments conducted in support of the environmental characterization of two sites within the Technical Area 57 (TA-57) Aggregate Area. The areas of concern (AOCs) are located at TA-57, which is west of the main portion of Los Alamos National Laboratory (LANL or the Laboratory) (Figure 1.1-1 of the investigation report). The evaluation of potential risks at the two AOCs is based on decision-level data from the 2014 investigations.

G-2.0 BACKGROUND

Brief descriptions of the AOCs assessed for potential risks are presented below.

G-2.1 Site Descriptions and Operational History

TA-57 was established in 1974 to support the Laboratory's Hot Dry Rock (HDR) program. HDR was an experimental geothermal energy program designed to test the feasibility of extracting heat from deep geologic units near the Valles Caldera. The first location chosen for HDR was in Barley Canyon north of the current TA-57 site. After one test well had been drilled, this location was abandoned because of poor winter access and topographic limitations. Operations were moved to the current TA-57 location, which offered a large flat area with easier access. Operations at the TA-57 site began in 1974.

G-2.1.1 AOC 57-006

AOC 57-006 is the former location of a plastic-lined 55-gal. drum that was buried in the ground at TA-57 beneath a trailer (structure 57-23) that served as an analytical chemistry laboratory. The chemistry trailer was used from about 1976 to 1989 to provide real-time analytical services for the geothermal project. A sink in the trailer was used to dispose of wastewater associated with chemical analyses. The sink drained to a leach field (AOC 57-007) near the trailer. Chemicals that could not be discharged to the leach field because of their toxicity were poured into a special drain connected to the polyethylene drum. When the drum was full, its contents were transported to the Laboratory for disposal. In 1994, the drum was removed as part of a voluntary corrective action (VCA). The chemistry trailer was removed from the site in March 1994.

G-2.1.2 AOC 57-007

AOC 57-007 is a leach field at TA-57 that served a former trailer (structure 57-23) used as an analytical chemistry laboratory. The chemistry trailer was used from about 1976 to 1989 to provide real-time analytical services for the geothermal project. A sink in the trailer drained to the leach field and was used to dispose of wastewater associated with chemical analyses. Chemicals that could not be discharged to the leach field because of their toxicity were poured into a special drain connected to a polyethylene-lined 55-gal. drum (AOC 57-006). The chemistry trailer was removed from the site in March 1994.

G-2.2 Investigation Sampling

The data sets used to identify chemicals of potential concern (COPCs) and evaluate potential risks to human health and the environment for the sites consist of all validated data compiled from the 2014

investigations. Only data determined to be decision-level following the data-quality assessment (Appendix D) are included in the data sets evaluated in this appendix.

G-2.3 Determination of COPCs

Section 5 of the investigation report summarizes the COPC selection process. COPCs were retained only if they were detected above background (inorganic chemicals and radionuclides), had detection limits greater than background values (BVs) (inorganic chemicals), and were detected (organic chemicals and inorganic chemicals with no BVs). The industrial scenario utilizes data from samples collected from 0.0–1.0 ft below ground surface (bgs). The ecological risk screening utilizes data from samples collected from 0.0–5.0 ft bgs. The residential scenario utilizes data from samples collected from 0.0–10.0 ft bgs. However, sampling depths often overlapped because of multiple investigations; therefore, all samples with a starting depth less than the lower bound of the interval for each scenario were included in the risk-screening assessments for a given scenario.

Tables G-2.3-1 to G-2.3-5 summarize the COPCs evaluated for potential risk for the sites. Some of the COPCs identified by the data review may not be evaluated for potential risk under one or more scenarios because they were not COPCs within the specified depth intervals associated with a given scenario.

G-3.0 CONCEPTUAL SITE MODEL

The primary mechanisms of release are related to historical contaminant sources described in detail in the historical investigation report for the TA-57 Aggregate Area (LANL 2012, 214549) and summarized in section 2.3 of the approved investigation work plan (LANL 2012, 214550; NMED 2012, 520936). Releases at the sites may have occurred as a result of subsurface leaks or effluent discharges. Previous sampling results indicated contamination from inorganic chemicals (LANL 2012, 214549).

G-3.1 Receptors and Exposure Pathways

The primary exposure pathway for human receptors is surface soil and subsurface soil/tuff that may be brought to the surface through intrusive activities. Migration of contamination to groundwater through the vadose zone is unlikely given the depth to groundwater (greater than 1000 ft bgs). Human receptors (industrial worker and resident) may be exposed through direct contact with soil or suspended particulates by ingestion, inhalation, dermal contact, and external irradiation pathways. Direct contact exposure pathways from subsurface contamination to human receptors are complete for the resident. The beef ingestion pathway is not complete because the sites are less than 2 acres in size. In addition, the area encompassing TA-57 is behind a locked fence, thereby prohibiting access by cattle. The exposure pathways for subsurface soil are the same as those for surface soil. Sources, exposure pathways, and receptors are shown in the conceptual site model (CSM) (Figure G-3.1-1).

The sites in the TA-57 Aggregate Area are industrial areas on U.S. Forest Service land used by the U.S. Department of Energy (DOE) pursuant to agreements with the Forest Service. The AOCs provide potential habitat and exposure pathways are complete to surface soil and tuff for ecological receptors. Weathering of tuff is the only viable natural process that may result in the exposure of receptors to COPCs in tuff. However, because of the slow rate of weathering expected for tuff, exposure to COPCs in tuff is negligible, although it is included in the assessments. Exposure pathways to subsurface contamination below 5.0 ft are not complete unless contaminated soil or tuff were excavated and brought to the surface. The potential pathways are root uptake by plants, inhalation of vapors (burrowing animals only), inhalation of dust, dermal contact, incidental ingestion of soil, external irradiation, and food web

transport. Pathways from subsurface releases may be complete for plants. Surface water exposure was not evaluated because of the lack of surface water features. Sources, exposure pathways, and receptors are presented in the CSM (Figure G-3.1-1).

G-3.2 Environmental Fate and Transport

The evaluation of environmental fate addresses the chemical processes affecting the persistence of chemicals in the environment and the evaluation of transport addresses the physical processes affecting mobility along a migration pathway. Migration into soil and tuff depends on precipitation or snowmelt, soil moisture content, depth of soil, soil hydraulic properties, and properties of the COPCs. Migration into and through tuff also depends on the unsaturated flow properties of the tuff and the presence of joints and fractures.

The most important factor with respect to the potential for COPCs to migrate to groundwater is the presence of saturated conditions. Downward migration in the vadose zone is also limited by a lack of hydrostatic pressure as well as the lack of a source for the continued release of contamination. Without sufficient moisture and a source, little or no potential migration of materials through the vadose zone to groundwater occurs.

Contamination at depth is addressed in the discussion of nature and extent in the investigation report. Results from the deepest samples collected at most sites showed either no detected concentrations of COPCs or low- to trace-level concentrations of only a few inorganic, radionuclide, and/or organic COPCs in tuff. The limited extent of contamination is related to the absence of the key factors that facilitate migration, as discussed above. Given how long the contamination has been present in the subsurface, the physical and chemicals properties of the COPCs, and the lack of saturated conditions, the potential for contaminant migration to groundwater is very low.

The New Mexico Environment Department (NMED) guidance (NMED 2014, 600115) contains screening levels that consider the potential for contaminants in soil to result in groundwater contamination. These screening levels consider equilibrium partitioning of contaminants among solid, aqueous, and vapor phases and account for dilution and attenuation in groundwater through the use of dilution attenuation factors (DAFs). These DAF soil screening levels (SSLs) may be used to identify chemical concentrations in soil that have the potential to contaminate groundwater (EPA 1996, 059902). Screening contaminant concentrations in soil against these DAF SSLs does not, however, provide an indication of the potential for contaminants to migrate to groundwater. The assumptions used in the development of these DAF SSLs include an assumption of uniform contaminant concentrations from the contaminant source to the water table (i.e., it is assumed migration to groundwater has already occurred). Furthermore, this assumption is inappropriate for the sites where sampling has shown that contamination is vertically bounded near the surface and the distance from the surface to the water table is large. For these reasons, screening of contaminant concentrations in soil against the DAF SSLs was not performed.

The relevant release and transport processes of the COPCs are a function of chemical-specific properties that include the relationship between the physical form of the constituents and the nature of the constituent transport processes in the environment. Specific properties include the degree of saturation and the potential for ion exchange (barium and other inorganic chemicals) or sorption and the potential for natural bioremediation. The transport of volatile organic compounds (VOCs) occurs primarily in the vapor phase by diffusion or advection in subsurface air.

Current potential transport mechanisms that may lead to exposure include:

- dissolution and/or particulate transport of surface contaminants during precipitation and runoff events,
- airborne transport of contaminated surface soil,
- continued dissolution and advective/dispersive transport of chemical contaminants contained in subsurface soil and tuff as a result of past operations,
- disturbance of contaminants in shallow soil and subsurface tuff by Laboratory operations, and
- disturbance and uptake of contaminants in shallow soil by plants and animals.

Contaminant distributions at the sites indicate that after the initial deposition of contaminants from operational activities and historical remediation efforts, elevated levels of COPCs tend to remain concentrated in the vicinity of the original release points. The primary potential release and transport mechanisms identified for the AOCs include direct discharge; precipitation, sorption, and mechanical transport; dissolution and advective transport in water; and volatilization, diffusion, and dispersion. Less significant transport mechanisms include wind entrainment and, given the asphalt pavement covering most sites, dispersal of surface soil and uptake of contaminants from soil and water by biota.

Gas or vapor-phase contaminants such as VOCs are likely to volatilize to the atmosphere from near-surface soil and sediment and/or migrate by diffusion through air-filled pores in the vadose zone. Migration of vapor-phase contaminants from tuff into ambient air may occur by diffusion or advection driven by barometric pressure changes.

G-3.2.1 Inorganic Chemicals

In general, and particularly in a semiarid climate, inorganic chemicals are not highly soluble or mobile in the environment, although there are exceptions. The physical and chemical factors that determine the distribution of inorganic COPCs within the soil and tuff are the soil-water partition coefficient (K_d) of the inorganic chemicals, the pH of the soil, soil characteristics (such as sand or clay content), and the redox potential (Eh). The interaction of these factors is complex, but the K_d values provide a general assessment of the potential for migration through the subsurface; chemicals with higher K_d values are less likely to be mobile than those with lower ones. Chemicals with K_d values greater than 40 are very unlikely to migrate through soil towards the water table (Kincaid et al. 1998, 093270). Table G-3.2-1 presents the K_d values and water solubility for the inorganic COPCs at the AOCs. Based on this criterion, the following COPCs have a low potential to mobilize and migrate through soil and the vadose zone: antimony, barium, chromium, lead, mercury, and zinc. The K_d values for arsenic, cyanide, perchlorate, selenium, and silver are less than 40 and may indicate a greater potential to mobilize and migrate through soil and the vadose zone beneath the sites.

It is important to note that other factors besides the K_d values (e.g., speciation in soil, oxidation-reduction potential, pH, and soil mineralogy) also play significant roles in the likelihood that inorganic chemicals will migrate. The COPCs with K_d values less than 40 are discussed further below. Information about the fate and transport properties of inorganic chemicals was obtained from individual chemical profiles published by the Agency for Toxic Substances and Disease Registry (ATSDR 1997, 056531, and http://www.atsdr.cdc.gov/toxpro2).

Arsenic may undergo a variety of reactions, including oxidation-reduction reactions, ligand exchange, precipitation, and biotransformation. Arsenic forms insoluble complexes with iron, aluminum, and magnesium oxides found in soil and in this form, arsenic is relatively immobile. However, under low pH

and reducing conditions, arsenic can become soluble and may potentially leach into groundwater or result in runoff of arsenic into surface waters. Arsenic is expected to have low mobility under the environmental conditions (neutral to alkaline soil pH and oxidizing near-surface conditions) present at the sites.

Copper movement in soil is determined by physical and chemical interactions with the soil components. Most copper deposited in soil will be strongly adsorbed and remains in the upper few centimeters of soil. Copper will adsorb to organic matter, carbonate minerals, clay minerals, or hydrous iron, and manganese oxides. In most temperate soil, pH, organic matter, and ionic strength of the soil solutions are the key factors affecting adsorption. Soil in the area is alkaline to neutral, so the leaching of copper is not a concern at this site. Copper binds to soil much more strongly than other divalent cations, and the distribution of copper in the soil solution is less affected by pH than other metals. Copper is expected to be bound to the soil and move in the system by way of transport of soil particles by water as opposed to movement as dissolved species.

Cyanide tends to adsorb onto various natural media, including clay and sediment; however, sorption is insignificant relative to the potential for cyanide to volatilize and/or biodegrade. At soil surfaces, volatilization of hydrogen cyanide is a significant mechanism for cyanide loss. Cyanide at low concentrations in subsurface soil is likely to biodegrade under both aerobic and anaerobic conditions. Cyanide is present at the site in trace to low levels and is not expected to be mobile.

Perchlorate is somewhat soluble in water and may migrate with water molecules in saturated soil. As noted above, the subsurface material beneath the sites has low moisture content, which inhibits the mobility of nitrate and perchlorate as well as most other inorganic chemicals.

Selenium is not often found in the environment in its elemental form but is usually combined with sulfide minerals or with silver, copper, lead, and nickel minerals. In soil, pH and Eh are determining factors in the transport and partitioning of selenium. In soil with a pH of greater than 7.5, selenates, which have high solubility and a low tendency to adsorb onto soil particles, are the major selenium species and are very mobile.

Natural processes, such as the weathering of rock and the erosion of soil release silver to air and water. Silver sorbs onto soil and sediment and tends to form complexes with inorganic chemicals and humic substances in soil. Organic matter complexes with silver and reduces its mobility. Silver compounds tend to leach from well-drained soil so that it may potentially migrate into the subsurface. Site conditions are neutral to slightly alkaline and silver is not expected to be mobile.

G-3.2.2 Organic Chemicals

Table G-3.2-2 presents the physical and chemical properties (organic carbon-water partition coefficient [K_{oc}], logarithm to the base 10 octanol-water partition coefficient [log K_{ow}], water solubility, and vapor pressure) of the organic COPCs identified for the sites. The physical and chemical properties of organic chemicals are important when evaluating their fate and transport. The following discussion about the physiochemical properties of organic COPCs is presented to illustrate some aspects of the fate and transport tendencies of the COPCs. The information is summarized from Ney (1995, 058210).

Water solubility is perhaps the most important chemical characteristic used to assess mobility of organic chemicals. The higher the water solubility of a chemical, the more likely it is to be mobile and the less likely it is to accumulate, bioaccumulate, volatilize, or persist in the environment. A highly soluble chemical (water solubility greater than 1000 mg/L) is prone to biodegradation and metabolism that may detoxify the parent chemical. Benzoic acid, methylene chloride, and trichloroethene have water solubilities greater than 1000 mg/L.

The lower the water solubility of a chemical, especially below 10 mg/L, the more likely it will be immobilized by adsorption. Chemicals with lower water solubilities are likely to accumulate or bioaccumulate and persist in the environment, to be slightly prone to biodegradation, and may be metabolized in plants and animals. The COPCs identified as having water solubilities less than 10 mg/L include bis(2-ethylhexyl)phthalate, butylbenzylphthalate, and the polycyclic aromatic hydrocarbons (PAHs).

Vapor pressure is a chemical characteristic used to evaluate the tendency of organic chemicals to volatize. Chemicals with vapor pressure greater than 0.01 mmHg are likely to volatilize and, therefore, concentrations at the site are reduced over time; vapors of these chemicals are more likely to travel toward the atmosphere and not migrate towards groundwater. Dichlorobenzene[1,4-], methylene chloride, and trichloroethene have vapor pressures greater than 0.01 mmHg.

Chemicals with vapor pressures less than 0.000001 mmHg are less likely to volatilize and, therefore, tend to remain immobile. Bis(2-ethylhexyl)phthalate has a vapor pressure less than 0.000001 mmHg.

The K_{ow} is an indicator of a chemical's potential to bioaccumulate or bioconcentrate in the fatty tissues of living organisms. The unitless K_{ow} value is an indicator of water solubility, mobility, sorption and bioaccumulation. The higher the K_{ow} above 1000, the greater the affinity the chemical has for bioaccumulation/bioconcentration in the food chain, the greater the potential for sorption in the soil, and the lower the mobility (Ney 1995, 058210). The PAHs, phthalates, and 1,4-dichlorobenzene have a K_{ow} greater than 1000. A K_{ow} of less than 500 indicates high water solubility, mobility, little to no affinity for bioaccumulation, and degradability by microbes, plants, and animals. Benzoic acid, methylene chloride, and trichloroethene have a K_{ow} much less than 500.

The K_{oc} measures the tendency of a chemical to adsorb to organic carbon in soil. K_{oc} values above 500 cm^3/g indicate a strong tendency to adsorb to soil, leading to low mobility (NMED 2014, 600115). Bis(2-ethylhexyl)phthalate, butylbenzylphthalate, and the PAHs have K_{oc} values above 500 cm^3/g, indicating a very low potential to migrate toward groundwater. The organic COPCs with K_{oc} values less than 500 cm^3/g include benzoic acid, 1,4-dichlorobenzene, methylene chloride, and trichloroethene.

G-3.3 Exposure Point Concentration Calculations

The exposure point concentrations (EPCs) represent upper bound concentrations of COPCs. For comparison to risk-screening levels, the upper confidence limit (UCL) of the arithmetic mean was calculated when possible and used as the EPC. The UCLs were calculated using all available decision-level data within the depth range of interest. If an appropriate UCL of the mean could not be calculated or if the UCL exceeded the maximum concentration, the maximum detected concentration of the COPC was used as the EPC (maximum detection limits were used as the EPCs for some inorganic COPCs). The summary statistics, including the EPC for each COPC for the human health and the ecological risk-screening assessments and the distribution used for the calculation, are presented in Tables G-2.3-1 to G-2.3-5.

Calculation of UCLs of the mean concentrations was done using the EPA ProUCL 5.0.00 software (EPA 2013, 251074), which is based on EPA guidance (EPA 2002, 085640). The ProUCL program calculates 95%, 97.5%, and 99% UCLs and recommends a distribution and UCL. The 95% UCL for the recommended calculation method was used as the EPC. The ProUCL software performs distributional tests on the data set for each COPC and calculates the most appropriate UCL based on the distribution of the data set. Environmental data may have a normal, lognormal, or gamma distribution but are often nonparametric (no definable shape to the distribution). The ProUCL documentation strongly recommends against using the maximum detected concentration for the EPC. The maximum detected concentration

was used to represent the EPC for COPCs only when there were too few detects to calculate a UCL. Input and output data files for ProUCL calculations are provided on CD as Attachment G-1.

G-4.0 HUMAN HEALTH RISK SCREENING ASSESSMENT RESULTS

The human health risk-screening assessments were conducted for each of the sites included in this report. All sites were screened for the residential scenarios using data from 0.0–10.0 ft bgs. Sites were also screened for the industrial scenario using data from 0.0–1.0 ft bgs, where available. The human health risk-screening assessments compare either the 95% UCL of the mean concentration, the maximum detected concentration, or the maximum detection limit of each COPC with SSLs for chemicals.

G-4.1 Human Health SSLs

Human health risk-screening assessments for chemicals were conducted using SSLs for the industrial and residential scenarios obtained from NMED guidance (NMED 2014, 600115). The NMED SSLs are based on a target noncarcinogenic hazard quotient (HQ) of 1 and a target cancer risk of 1×10^{-5} (NMED 2014, 600115). If SSLs were not available from NMED guidance, values from the EPA regional screening tables (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm) were used. The EPA SSLs for carcinogens were multiplied by 10 to adjust from a 10^{-6} cancer risk level to the NMED target cancer risk level of 10^{-5}. Exposure parameters used to calculate the industrial and residential SSLs are presented in Table G-4.1-1.

G-4.2 Results of Human Health Screening Evaluation

The EPC of each COPC in soil was compared with the SSLs for the industrial and residential scenarios. For carcinogenic chemicals, the EPCs were divided by the SSL and multiplied by 1×10^{-5}. The sum of the carcinogenic risks was compared with the NMED target cancer risk level of 1×10^{-5}. For noncarcinogenic chemicals, an HQ was generated for each COPC by dividing the EPC by the SSL. The HQs were summed to generate a hazard index (HI). The HI was compared with the NMED target HI of 1. The results are presented in Tables G-4.2-1 to G-4.2-5 and are described below for each AOC evaluated.

G-4.2.1 AOC 57-006

The samples at AOC 57-006 were collected from depths greater than 0.0−1.0 ft bgs; therefore, no complete exposure pathways exist for the industrial scenario.

The results of the risk-screening assessment for the residential scenario are presented in Tables G-4.2-1 and G-4.2-2. The total excess cancer risk for the residential scenario is 6×10^{-6}, which is less than the NMED target risk level of 1×10^{-5} (NMED 2014, 600115). The residential HI is 0.05, which is less than the NMED target HI of 1 (NMED 2014, 600115).

G-4.2.2 AOC 57-007

The results of the risk-screening assessment for the industrial scenario are presented in Table G-4.2-3. No carcinogen COPCs were identified in the 0.0−1.0 ft bgs depth interval. The industrial HI is 0.001, which is less than the NMED target HI of 1 (NMED 2014, 600115).

The results of the risk-screening assessment for the residential scenario are presented in Tables G-4.2-4 and G-4.2-5. The total excess cancer risk for the residential scenario is 7×10^{-6}, which is less than the

NMED target risk level of 1×10^{-5} (NMED 2014, 600115). The residential HI is 0.3, which is less than the NMED target HI of 1 (NMED 2014, 600115).

G-4.3 Vapor-Intrusion Pathway

NMED guidance (NMED 2014, 600115) requires an evaluation of the vapor-intrusion pathway. The evaluation can be qualitative for a potentially complete pathway if the following criteria are met:

- VOCs are minimally detected,
- concentrations are below NMED's vapor-intrusion screening levels for soil-gas and/or groundwater,
- there is no suspected source(s) for VOCs, and
- concentrations are decreasing with depth (for soil).

Because only bulk soil data are available for the two AOCs, the vapor-intrusion screening levels are not applicable for the evaluation. Residential soil screening values were calculated using the Johnson and Ettinger model (http://www.epa.gov/swerrims/riskassessment/airmodel/johnson_ettinger.htm) for subsurface vapor intrusion into buildings (EPA 2002, 094114). The advanced soil model was used to calculate risk-based soil concentrations for VOCs. The maximum detected concentration of each VOC COPC was compared with the risk-based concentration generated by the model for each site. The model inputs and risk-based concentrations generated are provided in Attachment G-2 on CD. HQs and HIs were calculated for noncarcinogenic COPCs and total excess cancer risks for carcinogenic COPCs. The NMED target risk level of 1×10^{-5} and NMED target HI of 1 were applied.

The vapor-intrusion pathway was qualitatively evaluated as part of the residential scenario for each AOC.

G-4.3.1 AOC 57-006

There is no source for VOCs at AOC 57-006. The waste collection drum was removed as part of a VCA in 1994 (LANL 1995, 054336). Therefore, the potential source of the VOCs was removed approximately 20 yr ago. In addition, no buildings are currently on or near the site, and the Laboratory, DOE, or the Forest Service has no plans to put another trailer, structure, or building of any kind at this site.

VOCs were minimally detected at this AOC. Methylene chloride and trichloroethene were each detected in two samples at concentrations below the estimated quantitation limits (EQLs). In addition, concentrations decreased with depth at all locations. The screening of the bulk soil data using the Johnson and Ettinger model, as presented below, indicates the soil has not been impacted. The vapor-intrusion pathway is therefore potentially complete based on NMED guidance (NMED 2014, 600115) and no additional evaluation is necessary.

The results of the residential vapor-intrusion screening assessments are presented in Table G-4.3-1. The HI is approximately 0.004, which is less than the NMED target HI of 1 (NMED 2014, 600115). These results do not change the HI and cancer risk calculated as a result of exposure to soil, as presented in section G-4.2.

G-4.3.2 AOC 57-007

There is no source for VOCs at AOC 57-007. The chemistry trailer was used until 1989 and was removed from the site in March 1994. In addition, no buildings are currently on or near the site, and the Laboratory,

DOE, or the Forest Service has no plans to put another trailer, structure, or building of any kind at this site.

VOCs were minimally detected at this AOC. Dichlorobenzene[1,4-] was detected in three samples, and methylene chloride and trichloroethene were each detected in two samples. Concentrations were below or slightly above the EQLs and decreased with depth at all locations. The screening of the bulk soil data using the Johnson and Ettinger model, as presented below, indicates the soil has not been impacted. The vapor-intrusion pathway is therefore potentially complete based on NMED guidance (NMED 2014, 600115) and no additional evaluation is necessary.

The results of the residential vapor-intrusion screening assessments are presented in Tables G-4.3-2 and G-4.3-3. The total excess cancer risk is approximately 2×10^{-8}, which is less than the NMED target cancer risk level of 1×10^{-5} (NMED 2014, 600115). The HI is approximately 0.004, which is less than the NMED target HI of 1 (NMED 2014, 600115). These results do not change the HI and cancer risk calculated as a result of exposure to soil, as presented in section G-4.2.

G-4.4 Uncertainty Analysis

The human health risk-screening evaluations are subject to varying degrees and types of uncertainty. Aspects of data evaluation and COPC identification, exposure evaluation, toxicity evaluation, and the additive approach all contribute to uncertainties in the risk-evaluation process.

G-4.4.1 Data-Evaluation and COPC-Identification Process

A primary uncertainty associated with the COPC-identification process is the possibility that a chemical may be inappropriately identified as a COPC when it is actually not a COPC or that a chemical may not be identified as a COPC when it actually should be identified as a COPC. All detected organic chemicals were retained for analysis. Inorganic chemicals were appropriately identified as COPCs because those either detected or with detection limits above background were retained for further analysis. However, background concentrations may not be representative of certain subunits of the Bandelier Tuff (e.g., fractured, clay-rich material) because such samples are not included in the background dataset.

Other uncertainties may include errors in sampling, laboratory analysis, and data analysis. However, because concentrations used in the risk-screening evaluations include those detected below EQLs and nondetects above BVs, data evaluation uncertainties are expected to have little effect on the risk-screening results.

G-4.4.2 Exposure Evaluation

The current and reasonably foreseeable future land use is industrial. To the degree actual activity patterns are not represented by those activities assumed by the industrial scenario, uncertainties are introduced in the assessment, and the evaluation presented in this assessment overestimates potential risk. An individual may be subject to exposures in a different manner than the exposure assumptions used to derive the industrial SSLs. For the sites evaluated, individuals might not be on-site at present or in the future for that frequency and duration. The industrial assumptions for the SSLs are that the potentially exposed individual is outside on-site for 8 h/d, 225 d/yr, and 25 yr (NMED 2014, 600115). The residential SSLs are based on exposure of 24 h/d, 350 d/yr, and 30 yr (NMED 2014, 600115). As a result, the industrial and residential scenarios evaluated at these sites likely overestimate the exposure and risk.

A number of assumptions are made relative to exposure pathways, including input parameters, completeness of a given pathway, the contaminated media to which an individual may be exposed, and intake rates for different routes of exposure. In the absence of site-specific data, the exposure assumptions used were consistent with default values (NMED 2014, 600115). When several upper-bound values (as are found in NMED 2014, 600115) are combined to estimate exposure for any one pathway, the resulting risk estimate can exceed the 99th percentile and, therefore, can exceed the range of risk that may be reasonably expected. Also, the assumption that residual concentrations of chemicals in the tuff are available and result in exposure in the same manner as if they were in soil overestimates the potential exposure and risk to receptors.

Uncertainty is introduced in the concentration aggregation of data for estimating the EPCs at a site. Risk from a single location or area with relatively high COPC concentrations may be underestimated by using a representative site-wide value. The use of a UCL is intended to provide a protective upper-bound (i.e., conservative) COPC concentration and is assumed to be representative of the average exposure to a COPC across the entire site. Potential risk and exposure from a single location or area with relatively high COPC concentrations may be overestimated if a representative site-wide value is used. The use of the maximum detected concentration for the EPC overestimates the exposure to contamination because receptors are not consistently exposed to the maximum detected concentration across the site. In addition, the maximum detection limit was used as the EPC for some inorganic COPCs with elevated detection limits above BVs.

G-4.4.3 Toxicity Evaluation

The primary uncertainty associated with the SSLs is related to the derivation of toxicity values used in their calculation. Toxicity values (reference doses [RfDs] and slope factors [SFs]) were used to derive the SSLs used in this risk-screening evaluation (NMED 2014, 600115). Uncertainties were identified in four areas with respect to the toxicity values: (1) extrapolation from other animals to humans, (2) interindividual variability in the human population, (3) the derivation of RfDs and SFs, and (4) the chemical form of the COPC. No surrogates were used to establish toxicity values in the risk assessments.

Extrapolation from Animals to Humans. The SFs and RfDs are often determined by extrapolation from animal data to humans, which may result in uncertainties in toxicity values because differences exist in chemical absorption, metabolism, excretion, and toxic responses between animals and humans. Differences in body weight, surface area, and pharmacokinetic relationships between animals and humans are taken into account to address these uncertainties in the dose-response relationship. However, conservatism is usually incorporated in each of these steps, resulting in the overestimation of potential risk.

Individual Variability in the Human Population. For noncarcinogenic effects, the degree of variability in human physical characteristics is important both in determining the risks that can be expected at low exposures and in defining the no observed adverse effect level (NOAEL). The NOAEL uncertainty factor approach incorporates a 10-fold factor to reflect individual variability within the human population that can contribute to uncertainty in the risk evaluation; this factor of 10 is generally considered to result in a conservative estimate of risk to noncarcinogenic COPCs.

Derivation of RfDs and SFs. The RfDs and SFs for different chemicals are derived from experiments conducted by different laboratories that may have different accuracy and precision that could lead to an over- or underestimation of the risk. The uncertainty associated with the toxicity factors for noncarcinogens is measured by the uncertainty factor, the modifying factor, and the confidence level. For

carcinogens, the weight of evidence classification indicates the likelihood that a contaminant is a human carcinogen. Toxicity values with high uncertainties may change as new information is evaluated.

Chemical Form of the COPC. COPCs may be bound to the environment matrix and not available for absorption into the human body. However, it is assumed that the COPCs are bioavailable. This assumption can lead to an overestimation of the total risk.

G-4.4.4 Additive Approach

For noncarcinogens, the effects of exposure to multiple chemicals are generally not known, and possible interactions could be synergistic or antagonistic, resulting in either an overestimation or underestimation of the potential risk. Additionally, RfDs used in the risk calculations typically are not based on the same endpoints with respect to severity, effects, or target organs. Therefore, the potential for noncarcinogenic effects may be overestimated for individual COPCs that act by different mechanisms and on different target organs but are addressed additively.

G-4.5 Interpretation of Human Health Risk Screening Results

G-4.5.1 AOC 57-006

Industrial Scenario

Samples were not collected from 0.0−1.0 ft bgs. Therefore, the industrial scenario was not evaluated.

Residential Scenario

The total excess cancer risk for the residential scenario is 6×10^{-6}, which is less than the NMED target risk level of 1×10^{-5}. The residential HI is 0.05, which is less than the NMED target HI of 1.

G-4.5.2 AOC 57-007

Industrial Scenario

No carcinogen COPCs were identified in the depth interval of 0.0−1.0 ft bgs. The HI for the industrial scenario is 0.001, which is less than the NMED target HI of 1.

Residential Scenario

The total excess cancer risk for the residential scenario is 7×10^{-6}, which is less than the NMED target risk level of 1×10^{-5}. The residential HI is 0.3, which is less than the NMED target HI of 1.

G-5.0 ECOLOGICAL RISK-SCREENING EVALUATIONS

G-5.1 Introduction

The approach for conducting ecological evaluations is described in the “Screening Level Ecological Risk Assessment Methods, Revision 3” (LANL 2012, 226715). The evaluation consists of four parts: a scoping evaluation, a screening evaluation, an uncertainty analysis, and an interpretation of the results.

G-5.2 Scoping Evaluation

The scoping evaluation establishes the breadth and focus of the screening evaluation. The ecological scoping checklist (Attachment G-3) is a useful tool for organizing existing ecological information. The information was used to determine whether ecological receptors might be affected, identify the types of receptors that might be present, and develop the ecological conceptual site model for the sites (Attachment G-3). Most of the area on the mesa top is developed and typically provides minimal potential habitat for ecological receptors. The quality of the habitat varies and, in some cases, includes native grasses, forbs, and trees that can be suitable habitat for ecological receptors.

The scoping evaluation indicated that terrestrial receptors were appropriate for evaluating the concentrations of COPCs in soil and tuff. Exposure is assessed across a site to a depth of 0.0–5.0 ft bgs. Aquatic receptors were not evaluated because no aquatic communities and no aquatic habitat or perennial source of water exist at any of the sites. The depth of the regional aquifer (greater than 1000 ft bgs) and the semiarid climate limit transport to groundwater. The potential exposure pathways for terrestrial receptors in soil and tuff are root uptake, inhalation, soil ingestion, dermal contact, and food web transport (Attachment G-3). The weathering of tuff is the only viable natural process that may result in the exposure of receptors to contaminants in tuff. Because of the slow rate of weathering expected for tuff, exposure in tuff is negligible, although it is included in the assessment. Plant exposure in tuff is largely limited to fractures near the surface, which does not produce sufficient biomass to support an herbivore population. Consequently, the contaminants in tuff are unavailable to receptors.

The potential risk was evaluated in the risk-screening assessments for the following ecological receptors representing several trophic levels:

- a plant
- soil dwelling invertebrates (represented by the earthworm)
- the deer mouse (mammalian omnivore)
- the montane shrew (mammalian insectivore)
- desert cottontail (mammalian herbivore)
- red fox (mammalian carnivore)
- American robin (avian insectivore, avian omnivore, and avian herbivore)
- American kestrel (avian insectivore and avian carnivore)

The rationale for using these receptors is presented in “Screening Level Ecological Risk Evaluation Methods, Revision 3” (LANL 2012, 226715). The Mexican spotted owl does not nest or forage in the Fenton Hill area. The Jemez Mountain salamander (JMS) is the only threatened and endangered [T&E] species known to occur in the Fenton Hill area (Attachment G-4). The entire footprint of TA-57 is comprised of either developed or undeveloped core habitat for the JMS as defined by the Laboratory’s Habitat Management Plan (ENV Division Resources Management Team 2014, 600084). The previously disturbed footprint at TA-57 is developed core habitat and the undeveloped tree covered areas are undeveloped core habitat. Both AOCs 57-006 and 57-007 and their sampling locations are within developed core habitat for JMS.

Surveys for the JMS at TA-57 have been conducted by Federal- and State-permitted Laboratory biologists in 2012, 2013, and 2014 during the monsoon season, and no JMSs were observed. Historical surveys were completed at the site on June 23, 1985, and no JMSs were found. The nearest JMS observation to TA-57 is 0.75 mi north-northeast in designated critical habitat on the east side of the

highway. In a 2-mi radius of TA-57, all of the positive observations of JMS occurred on undeveloped tree-covered slopes. The TA-57 complex is situated on a flat, open mesa top with very little change in elevation. The likelihood of JMS occurring on the sites is very low, and occurrence of a JMS in the developed core habitat areas would essentially be zero (Attachment G-4).

G-5.3 Assessment Endpoints

An assessment endpoint is an explicit expression of the environmental value to be protected. These endpoints are ecologically relevant and help sustain the natural structure, function, and biodiversity of an ecosystem or its components (EPA 1998, 062809). In a screening-level evaluation, assessment endpoints are any adverse effects on ecological receptors, where receptors are populations and communities (EPA 1997, 059370). The purpose of the ecological screening evaluation is to protect populations and communities of biota rather than individual organisms, except for listed or candidate T&E species or treaty-protected species (EPA 1999, 070086) because populations of protected species tend to be small and the loss of an individual adversely affects the species as a whole (EPA 1997, 059370).

In accordance with this guidance, the Laboratory developed generic assessment endpoints (LANL 1999, 064137) to ensure that values at all levels of ecological organization are considered in the ecological screening process. These general assessment endpoints can be measured using impacts on reproduction, growth, and survival to represent categories of effects that may adversely impact populations. In addition, specific receptor species were chosen to represent each functional group. The receptor species were chosen because of their presence at the site, their sensitivity to the COPCs, and their potential for exposure to those COPCs. These categories of effects and the chosen receptor species were used to select the types of effects seen in toxicity studies considered in the development of the toxicity reference values (TRVs). Toxicity studies used in the development of TRVs included only studies in which the adverse effect evaluated affected reproduction, survival, and/or growth.

The selection of receptors and assessment endpoints is designed to be protective of both the representative species used as screening receptors and the other species within their feeding guilds and the overall food web for the terrestrial and aquatic ecosystems. Focusing the assessment endpoints on the general characteristics of species that affect populations (rather than the biochemical and behavioral changes that may affect only the studied species) also ensures the applicability to the ecosystem of concern.

G-5.4 Ecological Risk Screening Evaluation

The ecological screening evaluation identifies chemicals of potential ecological concern (COPECs) and is based on the comparison of EPCs (95% UCLs, maximum detected concentrations, or maximum detection limits) to ecological screening levels (ESLs). The EPCs used in the assessments for the sites are presented in Tables G-2.3-1 through Table G-2.3-5.

The ESLs were obtained from the ECORISK Database, Version 3.2 (LANL 2014, 262559) and are presented in Table G-5.4-1. The ESLs are based on similar species and are derived from experimentally determined NOAELs, lowest observed adverse effect levels (LOAELs), or doses determined lethal to 50% of the test population. Information relevant to the calculation of ESLs, including concentration equations, dose equations, bioconcentration factors, transfer factors, and TRVs, are presented in the ECORISK Database, Version 3.2 (LANL 2014, 262559).

The analysis begins with a comparison of the minimum ESL for a given COPC to the EPC. The HQ is defined as the ratio of the EPC to the concentration that has been determined to be acceptable to a given

ecological receptor (i.e., the ESL). The higher the contaminant levels relative to the ESLs, the higher the potential risk to receptors; conversely, the higher the ESLs relative to the contaminant levels, the lower the potential risk to receptors. HQs greater than 0.3 are used to identify COPECs requiring additional evaluation (LANL 2012, 226715). Individual HQs for a receptor are summed to derive an HI; COPCs without ESLs are retained as COPECs and evaluated further in the uncertainty section. An HI greater than 1 indicates further assessment may be needed to ensure exposure to multiple COPECs at a site will not lead to potential adverse impacts to a given receptor population. The HQ and HI analysis is a conservative indication of potential adverse effects and is designed to minimize the potential of overlooking possible COPECs at the site.

G-5.4.1 AOC 57-006

The results of the minimum ESL comparisons are presented in Table G-5.4-2. Antimony and zinc are retained as COPECs because the HQs were greater than 0.3.

The HQs and HIs for each COPEC and receptor combination are presented in Table G-5.4-3. The HI analysis indicates that the robin (insectivore) and shrew have HIs equivalent to 1 (the shrew HI was 0.97). The COPECs and receptors are discussed in the uncertainty section.

G-5.4.2 AOC 57-007

The results of the minimum ESL comparisons are presented in Table G-5.4-4. Barium, chromium, copper, cyanide, lead, mercury, selenium, silver, zinc, benzoic acid, and bis(2-ethylhexyl)phthalate are retained as COPECs because the HQs were greater than 0.3.

Perchlorate does not have ESLs, is retained as a COPEC, and is discussed in the uncertainty section.

The HQs and HIs for each COPEC and receptor combination are presented in Table G-5.4-5. The HI analysis indicates that the kestel (both feeding guilds), robin (all feeding guilds), cottontail, shrew, deer mouse, earthworm, and plant have HIs greater than 1. The COPECs and receptors are discussed in the uncertainty section.

G-5.5 Uncertainty Analysis

The uncertainty analysis describes the key sources of uncertainty related to the screening evaluations. This analysis can result in either adding or removing chemicals from the list of COPECs for sites. The following narrative contains a qualitative uncertainty analysis of the issues relevant to evaluating the potential ecological risk at the sites.

G-5.5.1 Chemical Form

The assumptions used in the ESL derivations were conservative and not necessarily representative of actual conditions. These assumptions include maximum chemical bioavailability, maximum receptor ingestion rates, minimum bodyweight, and additive effects of multiple COPECs. Most of these factors tend to result in conservative estimates of the ESLs, which may lead to an overestimation of the potential risk. The assumption of additive effects for multiple COPECs may result in an over- or underestimation of the potential risk to receptors.

The chemical form of the individual COPCs was not determined as part of the investigation, largely a limitation on analytical quantitation of individual chemical species. Toxicological data are typically based

on the most toxic and bioavailable chemical species not likely found in the environment. The inorganic, organic, and radionuclide COPECs are generally not 100% bioavailable to receptors in the natural environment because of the adsorption of chemical constituents to matrix surfaces (e.g., soil) or rapid oxidation or reduction changes that render harmful chemical forms unavailable to biotic processes. The ESLs were calculated to ensure a conservative indication of potential risk (LANL 2012, 226715), and the values were biased toward overestimating the potential risk to receptors.

G-5.5.2 Exposure Assumptions

The EPCs used in the calculations of HQs were the 95% UCL, the maximum detected concentration, or the maximum detection limit to a depth of 5.0 ft, thereby conservatively estimating the exposure to each COPC. As a result, the exposure of individuals within a population was evaluated using this specific concentration, which was assumed constant throughout the exposure area. The sampling also focused on areas of known contamination, and receptors were assumed to ingest 100% of their food and spend 100% of their time at the site. The assumptions made regarding exposure for terrestrial receptors results in an overestimation of the potential exposure and risk because COPECs varied across the site and were infrequently detected.

G-5.5.3 Toxicity Values

The HQs were calculated using ESLs, which are based on NOAELs as threshold effect levels; actual risk for a given COPEC/receptor combination occurs at a higher level, somewhere between the NOAEL-based threshold and the threshold based on the LOAEL. The use of NOAELs leads to an overestimation of potential risk to ecological receptors. ESLs are based on laboratory studies requiring extrapolation to wildlife receptors. Laboratory studies are typically based on “artificial” and maintained populations with genetically similar individuals and are limited to single chemical exposures in isolated and controlled conditions using a single exposure pathway. Wild species are concomitantly exposed to a variety of chemical and environmental stressors, potentially rendering them more susceptible to chemical stress. On the other hand, wild populations are likely more genetically diverse than laboratory populations, making wild populations, as a whole, less sensitive to chemical exposure than laboratory populations. The uncertainties associated with the ESLs may result in an under- or overestimation of potential risk.

G-5.5.4 Population Area Use Factors

EPA guidance is to manage the ecological risk to populations rather than to individuals, with the exception of T&E species (EPA 1999, 070086). One approach to address the potential effects on populations at sites is to estimate the spatial extent of the area inhabited by the local population that overlaps with the contaminated area. The population area for a receptor is based on the individual receptor home range (HR) and its dispersal distance. Bowman et al. (2002, 073475) estimate that the median dispersal distance for mammals is 7 times the linear dimension of the HR (i.e., the square root of the HR area). If only the dispersal distances for the mammals with HRs within the range of the screening receptors are used (Bowman et al. 2002, 073475), the median dispersal distance becomes 3.6 times the square root of the HR (R^2=0.91). If it is assumed that the receptors can disperse the same distance in any direction, the population area is circular and the dispersal distance is the radius of the circle. Therefore, the population area can be derived by $\pi(3.6\sqrt{HR})^2$ or approximately 40HR.

AOC 57-006

The area of AOC 57-006 is approximately 0.001 ha. The population area use factors (PAUFs) are estimated by dividing the site area by the population area of each receptor population (Table G-5.5-1). The HQs and HIs are recalculated using the PAUFs. The HIs for the plant and earthworm are not adjusted by PAUFs because these receptors do not have HRs.

The adjusted HIs for AOC 57-006 are less than 1 for all receptors. The plant had an unadjusted HI of 0.4 and the earthworm had an unadjusted HI of 0.5 (Table G-5.5-2).

AOC 57-007

The area of AOC 57-007 is approximately 0.03 ha. The PAUFs are estimated by dividing the site area by the population area of each receptor population (Table G-5.5-3). The HQs and HIs are recalculated using the PAUFs. The HIs for the plant and earthworm are not adjusted by PAUFs because these receptors do not have HRs.

The adjusted HIs for AOC 57-007 are less than 1 for all receptors. The plant had an unadjusted HI of 4 and the earthworm had an unadjusted HI of 82 (Table G-5.5-4).

G-5.5.5 LOAEL Analysis

AOC 57-007 has HIs greater than 1 for one or more receptors. To address the HIs and reduce the associated uncertainty, analyses were conducted using ESLs calculated based on a LOAEL rather than a NOAEL. The LOAEL-based ESLs were calculated based on toxicity information in the ECORISK Database, Release 3.2 (LANL 2014, 262559) and are presented in Table G-5.4-5. The analyses address some of the uncertainties and conservativeness of the ESLs used in the initial screening assessments. HI analyses and adjusted HI analyses were conducted using the LOAEL-based ESLs.

G-5.5.6 Site Discussions

AOC 57-007

The HI for AOC 57-007 is greater than 1 for the plant, with barium, selenium, and zinc being the primary COPECs. The HI analysis using LOAEL-based ESLs resulted in an HI of 0.9 for the plant (Table G-5.5-6).

The HI for AOC 57-007 is greater than 1 for the earthworm, with barium, mercury, and zinc being the primary COPECs. The HI analysis using LOAEL-based ESLs resulted in an HI of approximately 8 for the earthworm primarily from mercury (Table G-5.5-6). The mercury EPC for the 0.0–5.0 ft interval is 4.04 mg/kg. However, only four samples at two locations have mercury concentrations greater than the BV of 0.1 mg/kg. The locations are within the leach field and are in close proximity (less than 5 ft apart). In addition, two of the four samples in which mercury concentrations were above the BV were collected from Qbt3, which is a less bioavailable matrix compared with soil. The EPC without the two largest concentrations from soil (20.6 mg/kg and 4.2 mg/kg) is 0.21 mg/kg, which is less than the LOAEL-based-ESL and results in an HQ of 0.4. Thus, most of the site poses no potential risk to the earthworm, and the HI does not indicate potential risk to the soil invertebrate population beyond the small area and limited depth of the elevated mercury concentrations. In addition, field observations made during the site visit found no indication of adverse effects from COPECs on the terrestrial community (Attachment G-3). Field observations indicated the area in and around the site has moderate-to-high vegetative cover, which is evidence of recolonzation of these sites after their active use as industrial sites. Therefore, the HI does not indicate potential risk to the plants or soil invertebrates.

G-5.5.7 Chemicals without ESLs

One COPEC does not have ESLs for any receptor in version 3.2 of the ECORISK Database (LANL 2014, 262559). In an effort to address this uncertainty and to provide a quantitative assessment of potential ecological risk, several online toxicity databases searches were conducted to determine if any relevant toxicity information is available. The online searches of the following databases were conducted: EPA Ecotox Database, EPA Office of Pesticide Programs Aquatic Life Benchmarks, U.S. Army Corps of Engineers/EPA Environmental Residue-Effects, California Cal/Ecotox Database, Pesticide Action Network Pesticide Database, U.S. Army Wildlife Toxicity Assessment Program, U.S. Department of Agriculture Integrated Pesticide Management Database, American Bird Conservancy Pesticide Toxicity Database, and Oak Ridge National Laboratory Risk Assessment Information System. Some COPECs without ESLs do not have chemical-specific toxicity data or surrogate chemicals to be used in the screening assessments and cannot be assessed quantitatively for potential ecological risk. The COPEC in question was not detected at one site and infrequently detected at the other site.

Toxicity data are not available for perchlorate. For perchlorate, no surrogate or other toxicity information is available.

Perchlorate was not detected at AOC 57-006 and was detected in seven samples at AOC 57-007 from 0.0−5.0 ft with concentrations ranging from 0.000582 mg/kg to 0.00159 mg/kg. The NMED residential SSL for perchlorate is 54.8 mg/kg, indicating that potential toxicity is low. Because of the potential low toxicity and infrequent detection of perchlorate, it is eliminated as a COPEC.

G-5.6 Interpretation of Ecological Risk Screening Results

G-5.6.1 Receptor Lines of Evidence

Based on the ecological risk-screening assessments, several COPECs (including COPECs without an ESL) were identified for the sites. Receptors were evaluated using several lines of evidence: minimum ESL comparisons, HI analyses, potential effects to populations, and LOAEL analyses.

Plant

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the plant, were less than 0.3.
- The HI was less than 1 for the plant at AOC 57-006, and the HI was greater than 1 for the plant at AOC 57-007.
- The HI analysis using the LOAEL-based ESL resulted in an HI less than 1 for AOC 57-007.
- Field observations made during the site visit found no indication of adverse effects on the plant community from COPECs. In addition, these sites have moderate-to-high vegetative cover, which is evidence of recolonization of these sites since their active use as industrial sites.

These lines of evidence support the conclusion that no potential ecological risk to the plants exists at theTA-57 Aggregate Area sites.

Earthworm (Invertebrate)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the earthworm, were less than 0.3.
- The HI was less than 1 for the earthworm at AOC 57-006, and the HI was greater than 1 for the earthworm at AOC 57-007.
- The HI analysis using the LOAEL-based ESL resulted in an HI greater than 1 for AOC 57-007.
- As discussed in section G-5.5.6, the potential risks to the earthworm are overestimated and/or are not representative of the site.

These lines of evidence support the conclusion that no potential ecological risk to the earthworm (soil invertebrate population) exists at the TA-57 Aggregate Area sites.

Montane Shrew (Insectivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the shrew, were less than 0.3.
- The HI was less than 1 for the shrew at AOC 57-006, and the HI was greater than 1 for the shrew at AOC 57-007.
- The HI for AOC 57-007 was adjusted by the PAUF, which is the ratio of the site area to the shrew's population area. The adjusted HI was less than 1.

These lines of evidence support the conclusion that no potential ecological risk to the montane shrew exists at the TA-57 Aggregate Area sites.

Deer Mouse (Omnivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the deer mouse, were less than 0.3.
- The HI was less than 1 for the deer mouse at AOC 57-006, and the HI was greater than 1 for the deer mouse at AOC 57-007.
- The HI for AOC 57-007 was adjusted by the PAUF, which is the ratio of the site area to the deer mouse's population area. The adjusted HI was less than 1.

These lines of evidence support the conclusion that no potential ecological risk to the deer mouse exists at the TA-57 Aggregate Area sites.

Desert Cottontail (Herbivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the cottontail, were less than 0.3.
- The HI was less than 1 for the cottontail at AOC 57-006, and the HI was greater than 1 for the cottontail at AOC 57-007.
- The HI for AOC 57-007 was adjusted by the PAUF, which is the ratio of the site area to the cottontail's population area. The adjusted HI was less than 1.

These lines of evidence support the conclusion that no potential ecological risk to the cottontail exists at the TA-57 Aggregate Area sites.

Red Fox (Carnivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the fox, were less than 0.3.
- The HIs were less than 1 for the red fox at both sites.

These lines of evidence support the conclusion that no potential ecological risk to the fox exists at the TA-57 Aggregate Area sites.

Robin (All Feeding Guilds)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the robin, were less than 0.3.
- The HI was less than 1 for the robin (herbivore and omnivore) and equivalent to 1 for the robin (insectivore) at AOC 57-006, and the HIs were greater than 1 for the robin (all feeding guilds) at AOC 57-007.
- The HIs were adjusted by the PAUF, which is the ratio of the site area to the robin's population area. The adjusted HIs were less than 1 at both sites.

These lines of evidence support the conclusion that no potential ecological risk to the robin (all feeding guilds) exists at the TA-57 Aggregate Area sites.

Kestrel (Intermediate Carnivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the kestrel (intermediate carnivore), were less than 0.3.
- The HI was less than 1 for the kestrel (intermediate carnivore) at AOC 57-006, and the HI was greater than 1 for the kestrel (intermediate carnivore) at AOC 57-007.
- The HI at AOC 57-007 was adjusted by the PAUF, which is the ratio of the site area to the kestrel's population area. The adjusted HI was less than 1.

These lines of evidence support the conclusion that no potential ecological risk to the kestrel (intermediate carnivore) exists at the TA-57 Aggregate Area sites.

Kestrel (Top Carnivore)

- Initial screening using the minimum ESLs eliminated a number of COPECs because the HQs for all of the receptors, including the kestrel (top carnivore), were less than 0.3.
- The HI was less than 1 for the kestrel (top carnivore) at AOC 57-006, and the HI was greater than 1 for the kestrel (top carnivore) at AOC 57-007.
- The HI at AOC 57-007 was adjusted by the PAUF, which is the ratio of the site area to the kestrel's population area. The adjusted HI was less than 1.

These lines of evidence support the conclusion that no potential ecological risks to the kestrel (top carnivore) exist at the TA-57 Aggregate Area sites.

G-5.6.2 COPECs with No ESLs

The COPEC without ESLs was eliminated based on comparisons to human health SSLs and the frequency of detection.

G-5.6.3 Summary

Based on evaluations of the minimum ESLs, HI analyses, potential effects to populations, LOAEL analyses, and COPECs without ESLs no potential ecological risks to the ecological receptors exist at the TA-57 Aggregate Area sites.

G-6.0 CONCLUSIONS

G-6.1 Human Health Risk

AOC 57-006 was not evaluated for the industrial scenario because no samples were collected from the 0.0–1.0-ft depth interval. For AOC 57-007, no carcinogen COPCs were identified in the 0.0–1.0-ft depth interval and the industrial HI was less than 1. Therefore, the exposure and risk are not issues for a Laboratory worker. For the residential scenario, both sites had total excess cancer risks less than the 1×10^{-5} target risk level and had HIs less than 1.

G-6.2 Ecological Risk

Based on evaluations of the minimum ESLs, HI analyses, potential effects to populations, LOAEL analyses, and COPECs without ESLs, no potential ecological risks to the earthworm, plant, American robin, American kestrel, deer mouse, montane shrew, desert cottontail, and red fox exist for the TA-57 Aggregate Area sites.

G-7.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID or ESH ID. This information is also included in text citations. ER IDs were assigned by the Environmental Programs Directorate's Records Processing Facility (IDs through 599999), and ESH IDs are assigned by the Environment, Safety, and Health (ESH) Directorate (IDs 600000 and above). IDs are used to locate documents in the Laboratory's Electronic Document Management System and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the New Mexico Environment Department Hazardous Waste Bureau and the ESH Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

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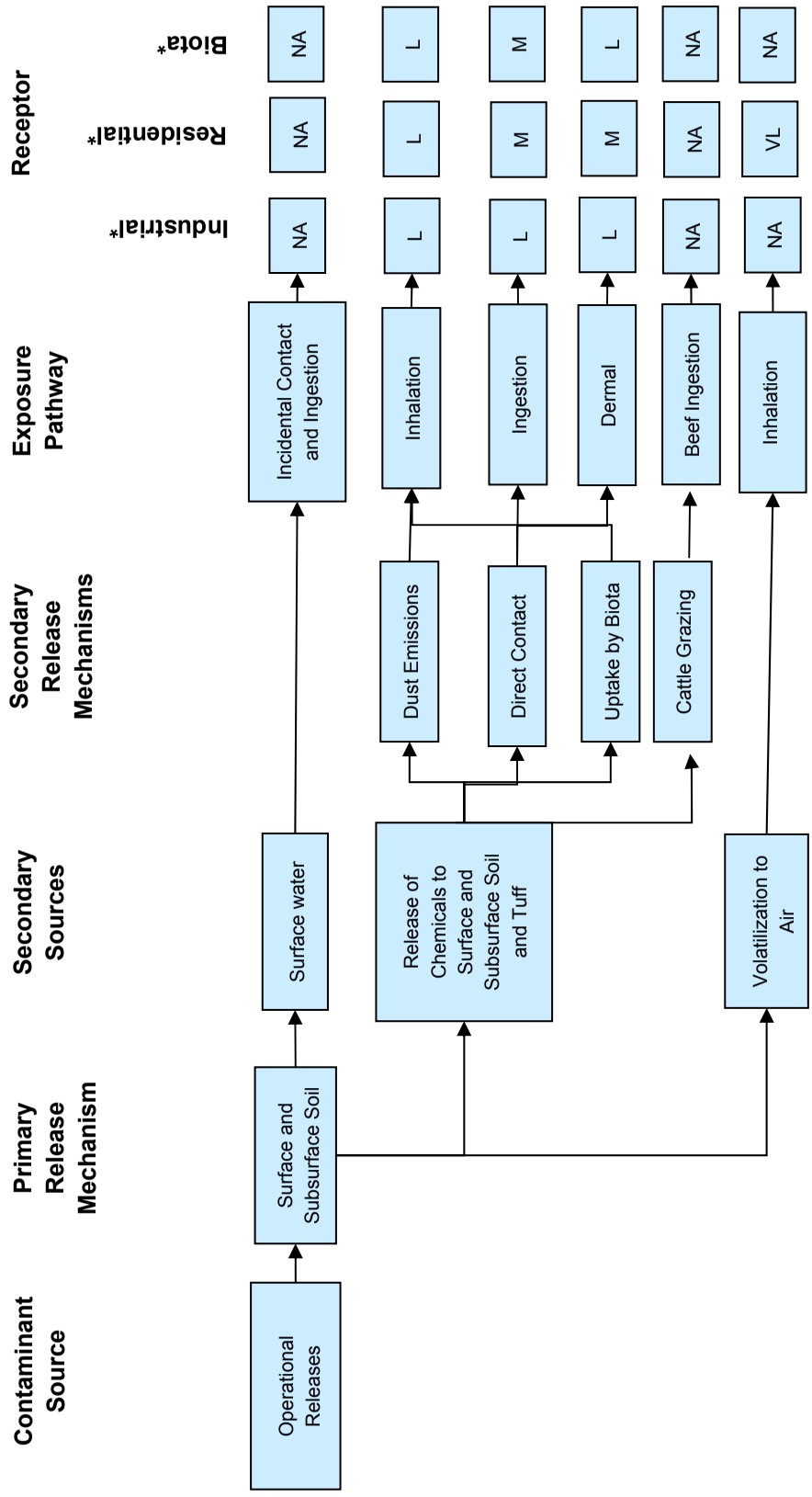

*VL = Very low, L = low, and M = moderate. Designations indicate the pathway is a potentially complete pathway and is evaluated in the risk assessments.
NA = Not applicable and indicates the pathway is incomplete and is not evaluated in the risk assessments.

Figure G-3.1-1 Conceptual site model for the TA-57 Aggregate Area AOCs

Table G-2.3-1
EPCs at AOC 57-006 for the Residential Scenario

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Antimony	12	0	0.946(U)	1.12(U)	n/a*	1.12(U)	Maximum detection limit
Barium	12	12	42.6	136	Normal	99.9	95% Student's-t
Chromium	12	12	3.37	113	Gamma	58.6	95% Adjusted Gamma
Copper	12	12	2.22	26	Nonparametric	13.5	95% Chebyshev (Mean, Sd)
Selenium	12	2	0.347	1.11(U)	n/a	0.358	Maximum detected concentration
Zinc	12	12	44.5	75.1	Normal	64	95% Student's-t
Organic Chemicals (mg/kg)							
Bis(2-ethylhexyl)phthalate	12	1	0.269	0.384(U)	n/a	0.269	Maximum detected concentration
Methylene Chloride	12	2	0.00248	0.00576(U)	n/a	0.0028	Maximum detected concentration
Trichloroethene	12	2	0.000539	0.00115(U)	n/a	0.000726	Maximum detected concentration

Note: Data qualifiers are defined in Appendix A.
*n/a = Not applicable.

Table G-2.3-2
EPCs at AOC 57-006 for Ecological Risk

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Antimony	4	0	1.06(U)	1.1(U)	n/a*	1.1(U)	Maximum detection limit
Zinc	4	4	45.5	53.6	n/a	53.6	Maximum detected concentration
Organic Chemicals (mg/kg)							
Methylene Chloride	4	1	0.00248	0.00565(U)	n/a	0.00248	Maximum detected concentration
Trichloroethene	4	1	0.000539	0.00113(U)	n/a	0.000539	Maximum detected concentration

Note: Data qualifiers are defined in Appendix A.
*n/a = Not applicable.

Table G-2.3-3
EPCs at AOC 57-007 for the Industrial Scenario

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Antimony	7	2	0.361	1.06(U)	n/a*	0.488	Maximum detected concentration
Perchlorate	7	2	0.000786	0.00225(U)	n/a	0.000841	Maximum detected concentration
Zinc	7	7	41.1	55.7	n/a	55.7	Maximum detected concentration
Organic Chemicals (mg/kg)							
Fluoranthene	7	1	0.0145	0.0373(U)	n/a	0.0145	Maximum detected concentration
Methylene Chloride	7	1	0.00277	0.00561(U)	n/a	0.00277	Maximum detected concentration
Phenanthrene	7	1	0.0134	0.0373(U)	n/a	0.0134	Maximum detected concentration
Trichloroethene	7	2	0.00105(U)	0.00294	n/a	0.00294	Maximum detected concentration

Note: Data qualifiers are defined in Appendix A.
*n/a = Not applicable.

Table G-2.3-4
EPCs at AOC 57-007 for the Residential Scenario

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Antimony	33	7	0.361	1.15(U)	Normal	0.474	95% KM (t)
Arsenic	37	37	0.527	5.12	Gamma	1.95	95% Adjusted Gamma
Barium	33	33	19.6	384	Gamma	102	95% Adjusted Gamma
Chromium	33	33	2.92	68.3	Nonparametric	25.4	95% Chebyshev (Mean, Sd)
Copper	33	33	1.28	65.1	Nonparametric	14.2	95% Chebyshev (Mean, Sd)
Cyanide (Total)	33	4	0.085	0.73	n/a*	0.73	Maximum detected concentration
Lead	33	33	7.74	33.6	Gamma	13.5	95% Adjusted Gamma
Mercury	33	33	0.00703	20.6	Nonparametric	3.56	95% Chebyshev (Mean, Sd)
Perchlorate	33	8	0.000582	0.00225(U)	Normal	0.00112	95% KM (t)
Selenium	33	0	0.917(U)	1.11(U)	n/a	1.11	Maximum detection limit
Silver	33	16	0.105	15.2	Nonparametric	1.62	95% KM (BCA)
Zinc	33	33	39	113	Gamma	58.6	95% Adjusted Gamma
Organic Chemicals (mg/kg)							
Benzoic Acid	33	3	0.324	2.83	n/a	2.83	Maximum detected concentration
Bis(2-ethylhexyl)phthalate	33	1	0.13	0.385(U)	n/a	0.13	Maximum detected concentration
Butylbenzylphthalate	33	1	0.339	0.385(U)	n/a	0.339	Maximum detected concentration
Dichlorobenzene[1,4-]	33	3	0.000357	0.00116(U)	n/a	0.00043	Maximum detected concentration
Fluoranthene	33	2	0.013	0.0385(U)	n/a	0.0145	Maximum detected concentration
Methylene Chloride	33	2	0.00277	0.00578(U)	n/a	0.00299	Maximum detected concentration
Phenanthrene	33	1	0.0134	0.0385(U)	n/a	0.0134	Maximum detected concentration
Trichloroethene	33	2	0.00103(U)	0.00294	n/a	0.00294	Maximum detected concentration

Note: Data qualifiers are defined in Appendix A.
*n/a = Not applicable.

Table G-2.3-5
EPCs at AOC 57-007 for Ecological Risk

COPC	Number of Analyses	Number of Detects	Minimum Concentration	Maximum Concentration	Distribution	EPC	EPC Method
Inorganic Chemicals (mg/kg)							
Antimony	29	6	0.361	1.15(U)	Normal	0.475	95% KM (t)
Arsenic	31	31	0.527	3.85	Normal	1.80	95% Student's-t
Barium	29	29	19.6	384	Normal	109.6	95% Student's-t
Chromium	29	29	2.92	68.3	Nonparametric	23.1	95% Chebyshev (Mean, Sd)
Copper	29	29	1.28	65.1	Nonparametric	15.7	95% Chebyshev (Mean, Sd)
Cyanide (Total)	29	4	0.085	0.73	n/a*	0.73	Maximum detected concentration
Lead	29	29	7.74	33.6	Gamma	13.8	95% Adjusted Gamma
Mercury	29	29	0.00703	20.6	Nonparametric	4.04	95% Chebyshev (Mean, Sd)
Selenium	29	0	0.917(U)	1.11(U)	n/a	1.11(U)	Maximum detection limit
Silver	29	16	0.105	15.2	Nonparametric	3.08	95% KM Chebyshev
Zinc	29	29	39	113	Normal	59.5	95% Student's-t
Organic Chemicals (mg/kg)							
Benzoic Acid	29	3	0.324	2.83	n/a	2.83	Maximum detected concentration
Bis(2-ethylhexyl)phthalate	29	1	0.13	0.385(U)	n/a	0.13	Maximum detected concentration
Butylbenzylphthalate	29	1	0.339	0.385(U)	n/a	0.339	Maximum detected concentration
Dichlorobenzene[1,4-]	29	3	0.000357	0.00116(U)	n/a	0.00043	Maximum detected concentration
Fluoranthene	29	2	0.013	0.0385(U)	n/a	0.0145	Maximum detected concentration
Methylene Chloride	29	2	0.00277	0.00578(U)	n/a	0.00299	Maximum detected concentration
Phenanthrene	29	1	0.0134	0.0385(U)	n/a	0.0134	Maximum detected concentration
Trichloroethene	29	2	0.00103(U)	0.00294	n/a	0.00294	Maximum detected concentration

Note: Data qualifiers are defined in Appendix A.
*n/a = Not applicable.

Table G-3.2-1
Physical and Chemical Properties of
Inorganic COPCs for the TA-57 Aggregate Area

COPC	K_d[a] (cm^3/g)	Water Solubility[a,b] (g/L)
Antimony	45	Insoluble
Arsenic	29	Insoluble
Barium	41	Insoluble
Chromium	850	Insoluble
Copper	35	Insoluble
Cyanide (Total)	9.9	na[c]
Lead	900	Insoluble
Mercury	52	Insoluble
Perchlorate	na	2.45E+05
Selenium	5	Insoluble
Silver	8.3	Insoluble
Zinc	62	Insoluble

[a] Information from http://rais.ornl.gov/cgi-bin/tox/TOX_select?select=nrad.

[b] Information from http://www.epa.gov/superfund/sites/npl/hrsres/tools/scdm.htm.

[c] na = Not available.

Table G-3.2-2
Physical and Chemical Properties of Organic COPCs for the TA-57 Aggregate Area

COPC	Water Solubility[a] (mg/L)	Organic Carbon Coefficient K_{oc}[a] (L/kg)	Log Octanol-Water Partition Coefficient K_{ow}[a]	Vapor Pressure[a] (mm Hg at 25°C)
Benzoic acid	3.40E+03[b]	1.45E+01	1.87E+00[b]	7.00E-04[b]
Bis(2-ethylhexyl)phthalate	2.70E-01[b]	1.65E+05	7.60E+00[b]	1.42E-07[b]
Butylbenzylphthalate	2.69E+00	9.36E+03	4.73E+00	8.25E-06
Dichlorobenzene[1,4-]	8.13E+01	3.75E+02	3.44E+00	1.74E+00
Fluoranthene	2.60E-01[c]	5.55E+04[c]	5.16E+00	9.22E-06
Methylene chloride	1.30E+04[b]	2.37E+01	1.30E+00[b]	4.30E+02[b]
Phenanthrene	1.15E+00[b]	2.08E+04	4.46E+00[b]	1.12E-04[b]
Trichloroethene	1.28E+03	6.07E+01	2.42E+00	6.90E+01

[a] Information from http://rais.ornl.gov/cgi-bin/tox/TOX_search, unless noted otherwise.

[b] Information from http://www.epa.gov/superfund/sites/npl/hrsres/tools/scdm.htm.

[c] Information from NMED (2014, 600115).

Table G-4.1-1
Exposure Parameter Values Used to Calculate
Chemical SSLs for the Industrial and Residential Scenarios

Parameters	Residential Values	Industrial Values
Target HQ	1	1
Target cancer risk	10^{-5}	10^{-5}
Averaging time (carcinogen/mutagen)	70 yr × 365 d	70 yr × 365 d
Averaging time (noncarcinogen)	Exposure duration × 365 d	Exposure duration × 365 d
Skin absorption factor	Semivolatile organic compound (SVOC) = 0.1	SVOC = 0.1
	Chemical-specific	Chemical-specific
Adherence factor–child	0.2 mg/cm^2	n/a[a]
Body weight–child	15 kg (0–6 yr of age)	n/a
Cancer slope factor–oral (chemical-specific)	(mg/kg-d)$^{-1}$	(mg/kg-d)$^{-1}$
Inhalation unit risk (chemical-specific)	(µg/m^3)	(µg/m^3)
Exposure frequency	350 d/yr	225 d/yr
Exposure time	24 h/d	8 h/day
Exposure duration–child	6 yr[b]	n/a
Age-adjusted ingestion factor for carcinogens	36,750 mg/kg	n/a
Age-adjusted ingestion factor for mutagens	25,550 mg/kg	n/a
Soil ingestion rate–child	200 mg/d	n/a
Particulate emission factor	6.61 × 10^9 m^3/kg	6.61 × 10^9 m^3/kg
Reference dose–oral (chemical-specific)	(mg/kg-d)	(mg/kg-d)
Reference dose–inhalation (chemical-specific)	(mg/kg-d)	(mg/kg-d)
Exposed surface area–child	2690 cm^2/d	n/a
Age-adjusted skin contact factor for carcinogens	112266 mg/kg	n/a
Age-adjusted skin contact factor for mutagens	166833 mg/kg	n/a
Volatilization factor for soil (chemical-specific)	(m^3/kg)	(m^3/kg)
Body weight–adult	80 kg	80 kg
Exposure duration[c]	30 yr[d]	25 yr
Adherence factor–adult	0.07 mg/cm^2	0.12 mg/cm^2
Soil ingestion rate–adult	100 mg/d	100 mg/d
Exposed surface area–adult	6032 cm^2/d	3470 cm^2/d

Note: Parameter values from NMED (2014, 600115).

[a] n/a = Not applicable.

[b] The child exposure duration for mutagens is subdivided into 0–2 yr and 2–6 yr.

[c] Exposure duration for lifetime resident is 26 yr. For carcinogens, the exposures are combined for child (6 yr) and adult (20 yr).

[d] The adult exposure duration for mutagens is subdivided into 6–16 yr and 16–30 yr.

Table G-4.2-1
Residential Carcinogenic
Screening Evaluation for AOC 57-006

COPC	EPC (mg/kg)	Residential SSL* (mg/kg)	Excess Cancer Risk
Chromium	58.6	96.6	6.07E-06
Bis(2-ethylhexyl)phthalate	0.269	380	7.08E-09
Total Excess Cancer Risk			**6E-06**

*SSLs from NMED (2014, 600115).

Table G-4.2-2
Residential Noncarcinogenic
Screening Evaluation for AOC 57-006

COPC	EPC (mg/kg)	Residential SSL* (mg/kg)	HQ
Antimony	1.12(U)	31.3	3.58E-02
Barium	99.9	15,600	6.40E-03
Copper	13.5	3130	4.33E-03
Selenium	0.358	391	9.16E-04
Zinc	64	23,500	2.72E-03
Methylene Chloride	0.0028	409	6.85E-06
Trichloroethene	0.000726	6.77	1.07E-04
HI			**0.05**

*SSLs from NMED (2014, 600115).

Table G-4.2-3
Industrial Noncarcinogenic
Screening Evaluation for AOC 57-007

COPC	EPC (mg/kg)	Industrial SSL* (mg/kg)	HQ
Antimony	0.488	519	9.40E-04
Perchlorate	0.000841	908	9.26E-07
Zinc	55.7	389,000	1.43E-04
Fluoranthene	0.0145	33,700	4.30E-07
Methylene Chloride	0.00277	5130	5.40E-07
Phenanthrene	0.0134	25,300	5.30E-07
Trichloroethene	0.00294	36.5	8.05E-05
HI			**0.001**

*SSLs from NMED (2014, 600115).

Table G-4.2-4
Residential Carcinogenic
Screening Evaluation for AOC 57-007

COPC	EPC (mg/kg)	Residential SSL[a] (mg/kg)	Excess Cancer Risk
Arsenic	1.95	4.25	4.59E-06
Chromium	25.4	96.6	2.63E-06
Bis(2-ethylhexyl)phthalate	0.13	380	3.42E-09
Butylbenzylphthalate	0.339	2800[b]	1.21E-09
Dichlorobenzene[1,4-]	0.00043	32.8	1.31E-10
Total Excess Cancer Risk			**7E-06**

[a] SSLs from NMED (2014, 600115) unless otherwise noted.

[b] EPA regional screening level (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

Table G-4.2-5
Residential Noncarcinogenic
Screening Evaluation for AOC 57-007

COPC	EPC (mg/kg)	Residential SSL[a] (mg/kg)	HQ
Antimony	0.474	31.3	1.51E-02
Barium	102	15,600	6.54E-03
Copper	14.2	3130	4.54E-03
Cyanide (Total)	0.73	11.2	6.52E-02
Lead	13.5	400	3.37E-02
Mercury	3.56	23.5	1.51E-01
Perchlorate	0.00112	54.8	2.04E-05
Selenium	1.11(U)	391	2.84E-03
Silver	1.62	391	4.13E-03
Zinc	58.6	23,500	2.49E-03
Benzoic Acid	2.83	250,000[b]	1.13E-05
Fluoranthene	0.0145	2320	6.25E-06
Methylene Chloride	0.00299	409	7.31E-06
Phenanthrene	0.0134	1740	7.70E-06
Trichloroethene	0.00294	6.77	4.34E-04
HI			**0.3**

[a] SSLs from NMED (2014, 600115) unless otherwise noted.

[b] EPA regional screening level (http://www.epa.gov/region06/6pd/rcra_c/pd-n/screen.htm).

Table G-4.3-1
Residential Noncarcinogenic Screening of Vapor Intrusion for AOC 57-006

COPC	EPC[a] (mg/kg)	Vapor-Intrusion Risk-Based Concentration[b] (mg/kg)	HQ
Methylene chloride	0.0028	62.7	4.47E-05
Tricloroethene	0.000726	0.209	3.47E-03
		HI	**0.004**

[a] Maximum detected concentration.
[b] Vapor-intrusion risk values generated by the Johnson and Ettinger advanced soil model.

Table G-4.3-2
Residential Carcinogenic Screening of Vapor Intrusion for AOC 57-007

COPC	EPC[a] (mg/kg)	Vapor-Intrusion Risk-Based Concentration[b] (mg/kg)	Cancer Risk
Dichlorobenzene[1,4-]	0.00043	0.27	1.62E-08
		Total Excess Cancer Risk	**2E-08**

[a] Maximum detected concentration.
[b] Vapor-intrusion risk values generated by the Johnson and Ettinger advanced soil model.

Table G-4.3-3
Residential Noncarcinogenic Screening of Vapor Intrusion for AOC 57-007

COPC	EPC[a] (mg/kg)	Vapor-Intrusion Risk-Based Concentration[b] (mg/kg)	HQ
Methylene chloride	0.00299	89.9	3.32E-05
Trichloroethene	0.00294	0.687	4.28E-03
		HI	**0.004**

[a] Maximum detected concentration.
[b] Vapor-intrusion risk values generated by the Johnson and Ettinger advanced soil model.

Table G-5.4-1
ESLs for Terrestrial Receptors

COPC	Red Fox (mammalian top carnivore)	American Kestrel (avian top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Desert Cottontail (mammalian herbivore)	Montane Shrew (mammalian	Deer Mouse (mammalian omnivore)	Earthworm (soil dwelling invertebrate insectivore)	Plant (terrestrial autotroph-producer)
Inorganic Chemicals (mg/kg)											
Antimony	46	na*	na	na	na	na	2.6	2.6	2.4	78	11
Arsenic	820	850	120	42	26	18	140	15	32	6.8	18
Barium	41000	28000	8600	820	930	1000	2900	1300	1800	330	110
Chromium	1800	1000	200	68	40	28	750	45	110	na	na
Copper	4000	1300	92	38	22	15	240	38	64	80	70
Cyanide	2800	0.59	0.4	0.1	0.1	0.1	660	310	340	na	na
Lead	3700	630	95	21	16	14	330	72	120	1700	120
Mercury	61	0.29	0.066	0.07	0.022	0.013	20	1.7	3	0.05	34
Selenium	90	81	4.3	1	0.87	0.75	1.9	0.66	0.83	4.1	0.52
Silver	4300	670	14	11	4.3	2.6	140	14	24	na	560
Zinc	7800	2400	250	350	85	48	1600	98	170	120	160
Organic Chemicals (mg/kg)											
Benzoic acid	1800	na	na	na	na	na	3.7	1	1.3	na	na
Bis(2-ethylhexyl)phthalate	380	8.1	0.1	20	0.04	0.02	2400	0.59	1.1	na	na
Butylbenzylphthalate	18000	na	na	na	na	na	2000	90	160	na	na
Dichlorobenzene[1,4-]	380	na	na	na	na	na	10	0.88	1.5	1.2	na
Fluoranthene	3300	na	na	na	na	na	230	22	38	10	na
Methylene Chloride	4200	na	na	na	na	na	3	9	2.6	na	1600
Phenanthrene	1700	na	na	na	na	na	52	10	15	5.5	na
Trichloroethene	37000	na	na	na	na	na	150	42	55	na	na

Note: ESLs from ECORISK Database, Version 3.2 (LANL 2014, 262559).
*na = Not available.

Table G-5.4-2
Minimum ESL Comparison for AOC 57-006

COPC	EPC (mg/kg)	ESL (mg/kg)	Receptor	HQ
Inorganic Chemicals (mg/kg)				
Antimony	1.1(U)	2.4	Deer mouse	**0.46**
Zinc	53.6	48	American Robin (insectivore)	**1.12**
Organic Chemicals (mg/kg)				
Methylene Chloride	0.00248	2.6	Deer mouse	0.001
Trichloroethene	0.000539	42	Montane Shrew	0.00001

Note: Bolded values indicate HQs greater than 0.3. Data qualifiers are defined in Appendix A.

Table G-5.4-3
HI Analysis for AOC 57-006

COPEC	EPC (mg/kg)	Red Fox (mammalian top carnivore)	American Kestrel (avian top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Desert Cottontail (mammalian herbivore)	Montane Shrew (mammalian	Deer Mouse (mammalian omnivore)	Earthworm (soil dwelling invertebrate insectivore)	Plant (terrestrial autotroph-producer)
Antimony	1.1(U)	0.024	na*	na	na	na	na	**0.42**	**0.42**	**0.46**	0.014	0.1
Zinc	53.6	0.007	0.022	0.21	0.15	**0.63**	**1.12**	0.034	**0.55**	**0.32**	**0.45**	0.34
HI		0.03	0.02	0.2	0.2	0.6	1	0.5	1	0.8	0.5	0.4

Note: Bolded values indicate HQs greater than 0.3 or HI greater than 1.0. Data qualifiers are defined in Appendix A.
*na = Not available.

Table G-5.4-4
Minimum ESL Comparison for AOC 57-007

COPC	EPC (mg/kg)	ESL (mg/kg)	Receptor	HQ
Inorganic Chemicals (mg/kg)				
Antimony	0.475	2.4	Deer mouse	0.2
Arsenic	1.80	6.8	Earthworm	0.27
Barium	109.6	110	Plant	**1**
Chromium	23.1	28	American Robin (insectivore)	**0.82**
Copper	15.7	15	American Robin (insectivore)	**1.05**
Cyanide (Total)	0.73	0.1	American Robin (all diets)	**7.3**
Lead	13.8	14	American Robin (insectivore)	**0.99**
Mercury	4.04	0.013	American Robin (insectivore)	**311**
Selenium	1.11(U)	0.52	Plant	**2.13**
Silver	3.08	2.6	American Robin (insectivore)	**1.18**
Zinc	59.5	48	American Robin (insectivore)	**1.24**
Organic Chemicals (mg/kg)				
Benzoic Acid	2.83	1	Montane Shrew	**2.83**
Bis(2-ethylhexyl)phthalate	0.13	0.02	American Robin (insectivore)	**6.5**
Butylbenzylphthalate	0.339	90	Montane Shrew	0.0038
Dichlorobenzene[1,4-]	0.00043	0.88	Montane Shrew	0.00049
Fluoranthene	0.0145	10	Earthworm	0.0015
Methylene Chloride	0.00299	2.6	Deer mouse	0.0012
Phenanthrene	0.0134	5.5	Earthworm	0.0024
Trichloroethene	0.00294	42	Montane Shrew	0.00007

Note: Bolded values indicate HQs greater than 0.3. Data qualifiers are defined in Appendix A.

Table G-5.4-5
HI Analysis for AOC 57-007

COPEC	EPC (mg/kg)	Red Fox (mammalian top carnivore)	American Kestrel (avian top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Desert Cottontail (mammalian herbivore)	Montane Shrew (mammalian	Deer Mouse (mammalian omnivore)	Earthworm (soil dwelling invertebrate insectivore)	Plant (terrestrial autotroph-producer)
Barium	109.6	0.0027	0.0039	0.013	0.13	0.12	0.11	0.038	0.084	0.061	**0.33**	**1**
Chromium	23.1	0.013	0.023	0.12	**0.34**	**0.58**	**0.82**	0.031	**0.51**	0.21	na*	na
Copper	15.7	0.0039	0.012	0.17	**0.41**	**0.71**	**1.05**	0.066	**0.41**	0.25	0.2	0.22
Cyanide (Total)	0.73	0.0003	**1.24**	**1.83**	**7.3**	**7.3**	**7.3**	0.0011	0.0024	0.0021	na	na
Lead	13.8	0.0037	0.022	0.15	**0.66**	**0.86**	**0.99**	0.042	0.19	0.12	0.0081	0.12
Mercury	4.04	0.066	**13.9**	**61**	**57.7**	**184**	**311**	0.2	**2.38**	**1.35**	**80.8**	0.12
Selenium	1.11(U)	0.012	0.014	0.26	**1.11**	**1.28**	**1.48**	**0.58**	**1.68**	**1.34**	0.27	**2.13**
Silver	3.08	0.0007	0.0046	0.22	0.28	**0.72**	**1.18**	0.022	0.22	0.13	na	0.0055
Zinc	59.5	0.0076	0.025	0.24	0.17	**0.7**	**1.24**	0.037	**0.61**	**0.35**	**0.5**	**0.37**
Benzoic Acid	2.83	0.0016	na	na	na	na	na	**0.76**	**2.83**	**2.18**	na	na
Bis(2-ethylhexyl)phthalate	0.13	0.0003	0.016	**1.3**	0.0065	**3.25**	**6.5**	0.0001	0.22	0.12	na	na
HI		0.1	**15**	**66**	**68**	**199**	**332**	**2**	**9**	**6**	**82**	**4**

Note: Bolded values indicate HQs greater than 0.3 or HI greater than 1. Data qualifiers are defined in Appendix A.
*na = Not available.

Table G-5.5-1
PAUFs for Ecological Receptors for AOC 57-006

Receptor	HR (ha)[a]	Population Area (ha)	PAUF[b]
American Kestrel	106	4240	0.000000236
American Robin	0.42	16.8	0.0000595
Deer Mouse	0.077	3	0.000333
Desert Cottontail	3.1	124	0.00000806
Montane Shrew	0.39	15.6	0.0000641
Red Fox	1038	41,520	0.0000000241

[a] Values from EPA (1993, 059384).

[b] PAUF is calculated as the area of the site (0.001 ha) divided by the population area.

Table G-5.5-2
Adjusted HIs at AOC 57-006

COPECs	EPC (mg/kg)	Red Fox (mammalian top carnivore)	American Kestrel (avian top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Desert Cottontail (mammalian herbivore)	Montane Shrew (mammalian	Deer Mouse (mammalian omnivore)	Earthworm (soil dwelling invertebrate insectivore)	Plant (terrestrial autotroph-producer)
Antimony	1.1(U)	5.8E-10	na*	na	na	na	na	3.4E-06	2.7E-05	0.00015	0.014	0.1
Zinc	53.6	1.7E-10	5.3E-09	5.1E-08	9.1E-06	3.7E-05	6.6E-05	2.7E-07	3.5E-05	0.00011	**0.45**	**0.34**
Adjusted HI		8E-10	5E-09	5E-08	9E-06	4E-05	7E-05	4E-06	6E-05	0.0003	0.5	0.4

Notes: Bolded values indicate HQ greater than 0.3 or HI greater than 1. Data qualifiers are defined in Appendix A.
*na = Not available.

Table G-5.5-3
PAUFs for Ecological Receptors for AOC 57-007

Receptor	HR (ha)[a]	Population Area (ha)	PAUF[b]
American Kestrel	106	4240	0.0000071
American Robin	0.42	16.8	0.00179
Deer Mouse	0.077	3	0.01
Desert Cottontail	3.1	124	0.000242
Montane Shrew	0.39	15.6	0.00192
Red Fox	1038	41,520	0.00000072

[a] Values from EPA (1993, 059384).

[b] PAUF is calculated as the area of the site (0.03 ha) divided by the population area.

Table G-5.5-4
Adjusted HIs for AOC 57-007

COPECs	EPC (mg/kg)	Red Fox (mammalian top carnivore)	American Kestrel (avian top carnivore)	American Kestrel (avian intermediate carnivore)	American Robin (avian herbivore)	American Robin (avian omnivore)	American Robin (avian insectivore)	Desert Cottontail (mammalian herbivore)	Montane Shrew (mammalian	Deer Mouse (mammalian omnivore)	Earthworm (soil dwelling invertebrate insectivore)	Plant (terrestrial autotroph-producer)
Barium	109.6	1.9E-09	2.8E-08	9.0E-08	0.00024	0.00021	0.0002	9.1E-06	1.6E-04	6.1E-04	**0.33**	**1**
Chromium	23.1	9.3E-09	1.6E-07	8.2E-07	0.00061	0.001	0.0015	7.4E-06	0.00099	0.0021	na*	na
Copper	15.7	2.8E-09	8.6E-08	1.2E-06	0.00074	0.0013	0.0019	1.6E-05	0.0008	0.0025	0.2	0.22
Cyanide (Total)	0.73	1.9E-10	8.8E-06	1.3E-05	0.013	0.013	0.013	2.7E-07	4.5E-06	2.2E-05	na	na
Lead	13.8	2.7E-09	1.6E-07	1.0E-06	0.0012	0.0015	0.0018	1.0E-05	0.00037	0.0012	0.0081	0.12
Mercury	4.04	4.8E-08	9.9E-05	0.00043	0.1	**0.33**	**0.56**	4.9E-05	0.0046	0.014	**80.8**	0.12
Selenium	1.11(U)	8.9E-09	9.7E-08	1.8E-06	0.002	0.0023	0.0026	0.00014	0.0032	0.013	0.27	**2.13**
Silver	3.08	5.2E-10	3.3E-08	1.6E-06	0.0005	0.0013	0.0021	5.3E-06	0.00042	0.0013	na	0.0055
Zinc	59.5	5.5E-09	1.8E-07	1.7E-06	0.0003	0.0013	0.0022	9.0E-06	0.0012	0.0035	**0.5**	**0.37**
Benzoic Acid	2.83	1.1E-09	na	na	na	na	na	0.00019	0.0054	0.022	na	na
Bis(2-ethylhexyl)phthalate	0.13	2.5E-10	1.1E-07	9.2E-06	1.2E-05	0.0058	0.012	1.3E-08	0.00042	0.0012	na	na
Adjusted HI		8E-08	0.0001	0.0005	0.1	0.4	0.6	0.0004	0.02	0.06	**82**	**4**

Notes: Bolded values indicate HQ greater than 0.3 or HI greater than 1. Data qualifiers are defined in Appendix A.
*na = Not available.

Table G-5.5-5
LOAEL-Based ESLs for Terrestrial Receptors

COPEC	Receptor	LOAEL–Based ESL* (mg/kg)
Barium	Earthworm	3200
	Plant	260
Mercury	Earthworm	0.5
Selenium	Plant	3
Zinc	Earthworm	930
	Plant	810

*LOAEL-based ESLs from ECORISK Database, Version 3.2 (LANL 2014, 262559).

Table G-5.5-6
HI Analysis Using LOAEL-Based ESLs at AOC 57-007

COPEC	EPC (mg/kg)	Earthworm	Plant
Barium	109.6	0.03	**0.42**
Mercury	4.04	**8.08**	n/a*
Selenium	1.11(U)	n/a	**0.37**
Zinc	59.5	0.06	0.07
HI		**8**	0.9

Notes: Bolded values indicate HQ greater than 0.3 or HI greater than 1.
*n/a = Not applicable.