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*Date:* March 30, 2007
*Refer To:* EP2007-0175

Mr. James Bearzi
Bureau Chief
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Building 1
Santa Fe, NM 87505-6303

**Subject: Submittal of the Response to Comments on Section 8 in Approval with Direction, Mortandad Canyon Investigation Report**

Dear Mr. Bearzi:

Enclosed please find two hard copies with electronic files of the "Response to Comments on Section 8 in Approval with Direction, Mortandad Canyon Investigation Report, EPA ID# NM0890010515, HWB-LANL-06-022." This deliverable meets the required action in New Mexico Environment Department's (NMED's) Approval with Direction to provide the information requested for comments related to Section 8 within 30 days of receipt of the approval. Included with the Laboratory's response are two red-line copies of Section 8 of the Mortandad Canyon investigation report and accompanying tables, including the Laboratory's proposed revisions to address NMED's comments. Upon approval of the proposed revisions, the Laboratory will issue a report titled "Revised Risk Assessment for Mortandad Canyon" that includes these changes to Section 8, renumbering sections and tables and referencing the Mortandad Canyon investigation report for supporting information.

If you have questions, please contact Danny Katzman (505) 667-6333 (katzman@lanl.gov) or Mat Johansen (505) 665-5046 (mjohansen@doeal.gov).

Sincerely,

Carolyn A. Mangeng, Acting Associate Director
Environmental Programs
Los Alamos National Laboratory

Sincerely,

George J. Rael, Assistant Manager
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Enclosure: Two hard copies with electronic files – "Response to Comments on Section 8 in Approval with Direction, Mortandad Canyon Investigation Report" (EP2007-0179)

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**Response to Comments on Section 8 in "Approval with Direction, Mortandad Canyon Investigation Report, EPA ID# NM0890010515, HWB-LANL-06-022" Dated February 23, 2007**

## INTRODUCTION

This is Los Alamos National Laboratory's (the Laboratory's or LANL's) response to the part of the Approval with Direction issued by the New Mexico Environment Department (NMED) (NMED 2007, 095109) for the "Mortandad Canyon Investigation Report" (MCIR) (LANL 2006, 094161) that pertains to Section 8, "Risk Assessments." To facilitate review of this response, NMED's comments on this section are included verbatim. The Laboratory's responses follow each NMED comment, and proposed revisions to text and tables in Section 8 are provided in the accompanying attachment in red-line strike-out mode. New tables have the suffix "AWD" in this response. Pending agreement from NMED on the responses and revisions, the Laboratory proposes to incorporate these changes into a revised risk assessment report for Mortandad Canyon, adjusting numbering for sections and tables and referencing MCIR as appropriate for supporting information.

## COMMENTS

### Section 8.1.1 Problem Formulation, p. 96:

**NMED Comment**

13. *This subsection describes the process for evaluation of chemicals of potential concern (COPCs) and identification of chemicals of potential ecological concern (COPECs). It is recognized that the various ecological effects provide a compelling weight-of-evidence risk conclusion. An important line of evidence in identifying COPECs is understanding the fate of each COPEC; however, this has not been included in this section. To provide a clear justification of COPEC selection, the Permittees must summarize, in a table format, the list of COPECs by exposure media and the various lines of evidence used to describe the risk as well as the uncertainties associated with these lines of evidence for each chemical.*

**LANL Response**

13. The Laboratory has revised Section 8.1.1.1, "Refinement of COPEC List," in the red-line strike-out version to include a new table (Table 8.1-1-AWD) that provides the requested information for all study design COPECs. The revised text references the "Mortandad Canyon Biota Investigation Work Plan" (LANL 2005, 089308), the original source of this information.

### Section 8.1.1.3 Conceptual Exposure Model, p. 101:

**NMED Comment**

14. *This section describes the conceptual pathways associated with the baseline ecological risk assessment (BERA). It appears that the Mortandad Canyon watershed would have minimal connectivity to the down-gradient Rio Grande receiving system. However, this is not clearly described. The Permittees must update the information within the conceptual model to include the*

*potential down-gradient connectivity to the Rio Grande (if it exists) and how this pathway was addressed as part of the BERA.*

**LANL Response**

The Laboratory has added text to Section 8.1.1.3 in the red-line strike-out version to mention specifically the absence of connectivity with the Rio Grande and, therefore, the restriction of the ecological risk assessment to the part of the Mortandad watershed west of State Road 4 with contaminants originating from Laboratory operations.

**Section 8.1.2.4 Nest Box Studies, p. 106:**

**NMED Comment**

15. *The second paragraph of this section introduces the 'occult little brown myotis bat' receptor as a line of evidence for an avian insectivore pathway analysis. This approach is useful and provides substantial information for the BERA. As such, the Permittees must integrate it into the appropriate endpoints for the BERA and present it consistently throughout the assessment (rather than introducing it only in this subsection).*

**LANL Response**

15. The Laboratory has revised the text in the red-line strike-out version to incorporate more fully the occult little brown myotis bat as a receptor for the aerial insectivore feeding guild. Section 8.1.1.2 already lists COPECs for this receptor as the mammalian sediment pathway receptor. The bullet describing assessment endpoint 6 (AE6) in Section 8.1.1.4 has been changed from "Survival and reproduction of the southwestern willow flycatcher" to "Survival and reproduction of aerial insectivores." Text in Section 8.1.2.4 has been modified to indicate that AE6 applies to both the flycatcher and the bat. Section 8.1.3.2 has been modified to refer to both of these aerial insectivores, and the information on the measure of the bat (dose calculations based on insect concentrations) has been moved from Section 8.1.3.7 and Table 8.1-12 to Section 8.1.3.2 and Table 8.1-5-AWD. Table 8.1-15 already lists the lines of evidence associated with the bat. The text in Section 8.1.4.1, "Risk Estimation," has been modified to include a summary of the results of the bat measure.

**Section 8.1.2.10 Rapid Bioassessment Characterization, page 108, and Section 8.1.3.7 Aquatic Community, p. 118:**

**NMED Comment**

16. *These sections describe the results of the rapid bioassessment characterization efforts completed throughout the watershed. It is not clear if any information gathered from these efforts was found useful for the purposes of the BERA. If the EPA Rapid Bioassessemnt Protocol (RBP) was followed, the measures of 'habitat characterization' taken, and/or in-field benthic macroinvertebrate biometrics, should be documented and explained. The Permittees must provide additional detail in this section to indicate if any information was gained from this effort and how was it applied as a line of evidence to the BERA.*

**LANL Response**

16. The Laboratory has provided additional text and tables summarizing the results of the characterization in Section 8.1.3.7 in the red-line strike-out version. Tables of habitat assessment scores by parameter (Table 8.1-10-AWD), physical and chemical surface water parameters (Table 8.1-10-AWD2), and macroinvertebrate sample abundance and number of taxa (Table 8.1-10-AWD3) have been added to this section to support the text.

**Section 8.1.3 Baseline Ecological Risk Assessment, p. 109:**

**NMED Comment**

*17. This section states that "screening of concentrations of COPCs in sediment and water samples collected in 2005 is also a line of evidence supporting the evaluation of potential ecological risk in Mortandad Canyon watershed." A summary of sample collection activities is also provided in Table 4.2-1. However, the findings from this screening are not presented in any of the risk conclusions. The Permittees must include a summary of this line of evidence in the Report in Section 8.1.3.7 (Pages 118 – 119).*

**LANL Response**

17. The Laboratory has added a summary discussion of the results of the new screening, currently presented in Section 8.1.1.1 ("Screening Against ESLs and BCGs for 2005 Sediment and Water Data"), to Section 8.1.3.7 in the red-line strike-out version.

**Section 8.1.3.1 Mexican Spotted Owl, p. 110:**

**NMED Comment**

*18. The first paragraph on Page 110 provides compelling information from the pellet analysis for incorporation into the diet modeling approaches. However, the results of the pellet analysis are not presented. It is useful to have the data results from the pellet analysis in order to understand portion of diet comprised by individual species. The Permittees must provide the pellet analysis results in a tabular format.*

**LANL Response**

18. The Laboratory has provided the results of the owl pellet analysis in a new table, Table 8.1-3-AWD, in the red-line strike-out version. A reference to Table 8.1-3-AWD has been added to Section 8.1.3.1.

**Section 8.1.3.1 Mexican Spotted Owl, p. 110:**

**NMED Comment**

*19. The last paragraph on Page 110 indicates that conservative assumptions regarding methyl mercury content were applied for the tissue (diet) evaluation. It is not clear if it was assumed whether the methyl mercury content was equivalent to the inorganic mercury content. The Permittees must clarify in all appropriate sections (e.g. page 113, COPEC Concentration in Worms and Table 8.1-5) and tables what conservative assumptions regarding methyl mercury content were applied.*

**LANL Response**

19. The Laboratory has revised text and tables as requested in the red-line strike-out version. The text in Sections 8.1.3.1 and 8.1.3.3 and the associated footnotes for Tables 8.1-4, 8.1-5, and 8.1-6 referring to mercury in the tissues of both earthworms and small mammals have been revised to clarify that the estimated risk from methyl mercury includes the upper-bound assumption that the detected mercury was 100% methyl mercury.

**Section 8.1.3.4 Mammalian Invertevore Feeding Guild, pp. 114 and 115:**

**NMED Comment**

20. *The last paragraph on page 114 and the first four paragraphs on page 115 describe the 'statistical significance' of pelt and/or carcass tissue content as compared to sediment COPEC concentrations. However, statistical significance is not clearly defined for each comparison ($p = 0.07$ for regression for selenium, but is not described for the other COPECs demonstrating a trend in the data). The Permittees must update this section to define the level of significance for each parameter.*

**LANL Response**

20. The Laboratory has revised the section in the red-line strike-out version to indicate that the basis for statistical significance of the regressions of tissue versus sediment concentrations was $p<0.05$. The regression for selenium did not meet the criterion for statistical significance, but selenium was included based on direction from NMED.

**Section 8.2.1 Problem Formulation, page 126:**

**NMED Comment**

21. *This section indicates that a residential exposure scenario was evaluated as a supplemental exposure scenario for comparison purposes only. Similar statements are made throughout the human health risk assessment. The reason a residential scenario is included as a hypothetical future land use is to determine the need for land use controls or other types of institutional controls, in the event land use were to change from current uses. The Permittees must clarify that the residential scenario is evaluated to determine the need for land use controls or institutional controls for preventing unrestricted use of the property.*

**LANL Response**

21. The residential exposure scenario is included because Section XI.E of the March 1, 2005, Compliance Order on Consent (Consent Order) states that residential land use shall be included even if it is not the current and reasonably foreseeable future land use. The residential scenario is not included to determine the need for land-use controls or other types of institutional controls. The need for controls is inherent in using other scenarios (recreational) to evaluate potential risk. Therefore, the Laboratory proposes to make no changes to the text in regard to evaluation of the residential scenario other than adding reference to the Consent Order.

**Section 8.2.2 Data Collection and Evaluation, page 126:**

**NMED Comment**

22. *This section refers the reader to Section 6 for a description on how sediment data were separated into reaches and how sediment data within reaches were combined for the comparison of contaminant data maxima with background values. However, this information could not be located in this section. The Permittees must include a reference to the appropriate locations in the Report that describe how the sediment data were separated into reaches as well as combined within reaches as a basis for selecting COPCs.*

**LANL Response**

22. Reference to Section 6 for the separation of sediment data into reaches was incorrect, and the Laboratory has revised Section 8.2.2 in the red-line strike-out version to correct this error.

**Section 8.2.5 Risk Characterization, pages 131-132:**

**NMED Comment**

23. *Sections 8.2.5.1 Noncarcinogenic Effects, 8.2.5.2 Carcinogenic Effects, and 8.2.5.3 Radiation Dose do not include a discussion of the noncarcinogenic effects, carcinogenic effects, or radiation dose associated with the residential scenario that was evaluated throughout the human health risk assessment in Appendix E. It is understood that the residential scenario is not a decision scenario for the determination of further investigation or corrective action. However, this scenario is evaluated to determine the need for land use restrictions. Based on a review of Appendix E, the cumulative cancer risks are at or below the NMED target risk level of* $10^{-5}$ *and the cumulative noncancer hazard indices (HIs) are close to the NMED target of 1.0. However, the radionuclide dose in eight of the reaches exceeds the target dose limit of 15 mrem/yr. In addition, the doses ranged from 16 to 1017 mrem/yr, with seven of the eight reaches significantly above the target dose limit. Based on these results, the reaches present an unacceptable risk under an unrestricted land use scenario. The unacceptable risk justifies the need for land use controls at these areas. The Permittees must summarize the results of the residential scenario to accurately reflect the results of the risk assessment presented in Appendix E.*

**LANL Response**

23. The residential scenario is not summarized in the sections listed above because it is not a decision scenario, and Section 8.2.5 of MCIR references Appendix E for the results of the residential scenario. Therefore, the Laboratory proposes to make no changes to the text in regard to evaluation of the residential scenario.

**Table 8.1-2 Number of Each Species Collected for Analysis in Each Reach in the Mortandad Watershed, page 287, Figure 8.1-15 Mean Percent Daily Capture Rate for Small Mammals and Figure 8.1-16 Small Mammals Species Diversity, page 220:**

**NMED Comment**

24. *The information provided in Table 8.1-2 appears to conflict with the bar graphs provided in Figures 8.1-15 and 8.1-16. It stands to reason that the diversity for reach E-1W would yield the*

*highest value having 22 individuals and 5 species. However, the diversity for the LA-BKG reach should be comparable with 31 individuals and 4 species (as compared to M-2W and M-3E with 31 individuals and 3 species, and 37 individuals and 3 species respectively). Yet the diversity measure for the background reach is shown to be much less than E-1W. The Permittees must revisit the Shannon-Weaver diversity calculations to determine if there is an error in the values presented and ensure the text, tables, and figures are consistent.*

**LANL Response**

24. The Laboratory has revisited the calculations and has concluded that there is no error. Table 8.1-2 provides the number of animals of each species collected for laboratory analysis, which is different from the total number of animals trapped. The latter number is presented in Figures 8.1-15 and 8.1-16. The numbers are different because some small mammals were released after trapping when sufficient mass for analytical analysis for that species in that reach had been obtained; species with an insufficient number captured to produce sufficient analytical mass also were not submitted for analysis. The total number of each species trapped in each reach is provided in Figures 6 through 8 of "Small Mammal Sampling in Mortandad and Los Alamos Canyons, 2005" (Bennett et al. 2006, 093701).

    The values for the Shannon-Weaver Index were calculated using the on-line calculator available at http://math.hws.edu/javamath/ryan/DiversityTest.html. These calculations have been independently verified; the existing tables, text, and figures are correct and consistent. The index for LA-BKG is lower because it measures species evenness as well as species richness. (The website referenced above provides an example of the effect of evenness on the index.) The species evenness was low in reach LA-BKG: 70.4% of the animals captured in the reach were deer mice, and 18.5% were voles. The result was a low index.

    To document the basis of the Shannon-Weaver calculations better, the Laboratory has added a new table, Table 8.1-6-AWD, and accompanying text to Section 8.1.3.4 in the red-line strike-out version. Table 8.1-6-AWD provides the total number of each species trapped in each reach and the calculated value of the first order Shannon-Weaver Index for each reach. The text has been modified to include a reference for the on-line calculator web page.

**NMED Comment**

25. *This table indicates that the radionuclide dose associated with sediment and surface water at reach E1-1 is 43.7 mrem/yr and 0.25 mrem/yr, respectively, for a total dose of 44 mrem/yr for the reach. The text in Section 8.2.5.3 Radiation Dose also cites 44 mrem/yr for the reach as a total dose. However, Table 8.2-12 indicates that the radionuclide dose associated with sediment at reach E1-1 is 51.2 mrem/year. The Executive Summary and Section 9.0 Conclusions and Recommendations (second paragraph on page 137) indicates the calculated dose for reach E-1E is 52 mrem/yr (corresponding to a radiological risk of approximately $2 \times 10^{-4}$). The Permittees must correct the tables and/or text to ensure consistency throughout the Report with respect to communicating the total dose calculations for reach E1-1.*

**LANL Response**

25. This is a duplicate of comment 26. See response below.

**Table 8.2-11 Summary of Trail User Risk Assessment Results, page 311:**

**NMED Comment**

26. *This table indicates that the radionuclide dose associated with sediment and surface water at reach E1-1 is 43.7 mrem/yr and 0.25 mrem/yr, respectively, for a total dose of 44 mrem/yr for the reach. The text in Section 8.2.5.3 Radiation Dose also cites 44 mrem/yr for the reach as a total dose. However, Table 8.2-12 indicates that the radionuclide dose associated with sediment at reach E1-1 is 51.2 mrem/year. The Executive Summary and Section 9.0 Conclusions and Recommendations (second paragraph on page 137) indicates the calculated dose for reach E-1E is 52 mrem/yr (corresponding to a radiological risk of approximately $2 \times 10^{-4}$). The Permittees must correct the tables and/or text to ensure consistency throughout the Report with respect to communicating the total dose calculations for reach E1-1.*

**LANL Response**

26. The correct total dose for reach E-1E is 44 mrem/yr for sediment and water combined, and the Executive Summary and Section 9.0 are in error. Values in Tables 8.2-12 and 8.2-14 are also in error, and significant figures are not presented accurately in Tables 8.2-12, 8.2-14, and 8.2-15. The Laboratory has corrected the values in Tables 8.2-12, 8.2-14, and 8.2-15 in the red-line strike-out version, and will present the correct values in summary sections of a revised risk assessment report.

## REFERENCES

Bennett, K., S. Sherwood, and R. Robinson, August 2006. "Small Mammal Sampling in Mortandad and Los Alamos Canyons, 2005," Los Alamos National Laboratory report LA-14301, Los Alamos, New Mexico. (Bennett et al. 2006, 093701)

LANL (Los Alamos National Laboratory), May 2005. "Mortandad Canyon Biota Investigation Work Plan," Los Alamos National Laboratory document LA-UR-05-2231, Los Alamos, New Mexico. (LANL 2005, 089308)

LANL (Los Alamos National Laboratory), October 2006. "Mortandad Canyon Investigation Report," Los Alamos National Laboratory document LA-UR-06-6752, Los Alamos, New Mexico. (LANL 2006, 094161)

NMED (New Mexico Environment Department), February 23, 2007. "Approval with Direction, Mortandad Canyon Investigation Report, EPA ID# NM0890010515, HWB-LANL-06-022," New Mexico Environment Department letter to David Gregory (Federal Project Director, Department of Energy/Los Alamos Site Office) and David McInroy (Project Director, LANL) from James Bearzi (Chief, NMED-Hazardous Waste Bureau), Santa Fe, New Mexico. (NMED 2007, 095109)

**Attachment 1**

**Revised MCIR Section 8 text and tables**

## 8.0 RISK ASSESSMENTS

This section presents the methods used to evaluate the potential for adverse ecological and human health risks from COPCs in sediment and surface water. Risk characterization results, uncertainty analysis, and risk assessment summary are also provided for each assessment.

### 8.1 Baseline Ecological Risk Assessment

Biological data were collected in the Mortandad watershed to evaluate the potential for adverse ecological effects from contaminants in sediment and persistent surface water. A biological investigation work plan was developed based on the application of the eight-step EPA ecological risk assessment guidance for Superfund (ERAGS) (EPA 1997, 59370) to COPECs in sediment and persistent surface water (LANL 2005, 89308).

Steps 1 and 2 of ERAGS include the screening-level ecological risk assessment (SLERA) (LANL 2004, 87630), which identifies COPECs and ecological receptors potentially at risk. Ecological screening results based on the comparison of ecological screening levels (ESLs) with available sediment and water data are provided in the "Mortandad Canyon Biota Investigation Work Plan" (LANL 2005, 89308) and in Appendix E-1. Also presented in the biota investigation work plan is a comparison of available data with DOE biota concentration guidelines (BCGs) for radionuclides (DOE 2002, 85637; DOE 2004, 85639). These screening-level assessments identified COPECs and formed the basis for proceeding to the baseline ecological risk assessment (ERAGS Steps 3 to 8).

Steps 3 and 4 of ERAGS comprise problem formulation and study design, which include refining the list of COPECs, developing a conceptual exposure model, selecting assessment endpoints, and selecting associated measures of effect and exposure. The study design required for these measures was included in the biota investigation work plan (LANL 2005, 89308). Aspects of study design were modified based on field verification of the design (ERAGS Step 5) and on comments received from NMED (NMED 2005, 92084). Deviations to the original biota work plan are discussed in Section 8.1.2. ERAGS Steps 6 and 7 comprise the implementation of the study design, analysis of ecological exposure and effects, and risk characterization. ERAGS Step 8 is risk management and the conclusions that may lead to risk management activities are documented in Section 9.

#### 8.1.1 Problem Formulation

This section addresses the baseline ecological risk assessment problem formulation, which is Step 3 of ERAGS. A problem formulation was presented in Appendix D of the "Mortandad Canyon Biota Investigation Work Plan" (LANL 2005, 89308, pp. D-1–D-3). Problem formulation includes refinement of the list of COPECs, a literature search on known ecological effects, the conceptual exposure model, and the selection of assessment endpoints. Additional samples have been collected since the initial problem formulation in the biota investigation work plan, and new COPECs have been identified; therefore the problem formulation elements are updated and presented in the following sections.

##### 8.1.1.1 Refinement of COPEC list

The third step of the ERAGS process involves refinement of the COPEC list from the screening to focus on those COPECs that have the largest impact on the potential ecological risk. As explained in the SLERA methods document (LANL 2004, 87630, p. 31), the criterion for retaining a COPC as a COPEC is a HQ greater than 0.3. The ESL screening excludes only COPCs with an HQ less than or equal to 0.3, which are COPCs for which no potential for ecological risk exists. To determine whether areas of the canyon may pose a risk to ecological receptors, and therefore what areas should be included within the scope of the biota investigation, the criterion of an HQ greater than 3 was used. An HQ greater than 3 represents levels that may impact receptors and is therefore appropriate for determining which COPECs should be included in site-specific biota studies in the Mortandad watershed. This criterion of 3 is based on the geometric mean of the ratio between the no observed adverse effect level (NOAEL) and the lowest observed adverse effect level (LOAEL) (Dourson and Stara 1983, 73474). Concentrations corresponding to LOAELs represent levels where impacts to individuals or populations may occur, and these levels represent a more appropriate criterion for determining which COPECs should be included in site-specific biota analyses to assess if impacts to ecological receptors have actually occurred. The same criterion of an HQ greater than 3 was used to refine the list of COPECs for the baseline studies conducted in Los Alamos and Pueblo Canyons (LANL 2004, 87390, p. 8-2). Receptors representing threatened and endangered (T&E) species are evaluated versus an HQ greater than 1 to ensure protection of each individual within the population.

Selection of study design COPECs for soil was based on comparison of the maximum detected concentrations in all geomorphic units within a reach with the minimum soil ESL. Active channel sediments may be exposed due to the transient nature of water flow in the channels in this watershed; therefore concentrations in the active channel geomorphic unit (c1) were included in the screening for terrestrial receptors. The COPECs for soil identified in the biota investigation work plan are: arsenic, barium, cadmium, chromium, copper, total cyanide, lead, manganese, mercury, selenium, silver, thallium, vanadium, zinc, americium-241, cesium-137, plutonium-238, plutonium-239, strontium-90, Aroclor-1254, Aroclor-1260, acenaphthene, chrysene, naphthalene, di-n-butyl phthalate, and endrin aldehyde (LANL 2005, 89308). Study design COPECs for sediment were chosen based on a comparison of maximum detected concentrations in geomorphic unit c1 (the active channel sediments) with the ESLs for sediment. The study design COPECs in sediment identified in the biota investigation work plan include: aluminum, arsenic, barium, copper, mercury, silver, vanadium, acenaphthene, acetone, anthracene, Aroclor-1260, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, alpha-chlordane, gamma-chlordane, chrysene, 4,4-DDT, di-n-butylphthalate, dibenz(a,h) anthracene, fluoranthene, fluorene, indeno(1,2,3-c,d)pyrene, 4,4'-methoxychlor, 2-methylnaphthalene, naphthalene, phenanthrene, and pyrene. Study design COPECs for water were based on the comparison to ESLs and DOE BCGs. Study design COPECs for water identified in the biota investigation work plan are: aluminum, barium, cadmium, copper, cyanide (total), lead, manganese, silver, zinc, americium-241, and radium-226.

After its review of the biota investigation work plan, NMED requested considering gross alpha and selenium as COPECs in all evaluations (NMED 2005, 92084). There is no ESL for gross alpha, but gross alpha has an NMED surface water standard in 20.6.4 NMAC. Therefore, gross alpha was evaluated through screening of surface water against this standard. Individual alpha-emitting radionuclides were screened against the ESLs and DOE BCGs for each individual radionuclide. In the screening conducted for the biota investigation work plan (LANL 2005, 89308), selenium was designated as a study design COPEC only for plants. In response to NMED’s concerns the evaluation of the results of each field study and the modeling of COPEC ingestion through the food chain to avian and mammalian receptors includes selenium.

Subsequent to the screening against minimum ESLs, the study design COPECs were screened against the ESLs for individual receptors to determine which COPECs should be addressed by each of the field measures. Table D-6.0-1 of the biota investigation work plan (LANL 2005, 89308) lists the COPECs for individual receptors; these subsets of COPECs were used to determine the appropriate analytical suites and locations for each measure. **The lines of evidence for investigating potential effects of COPECs, by media, and uncertainties relating to the lines of evidence are presented in the biota**

**investigation work plan and are summarized in Table 8.1-1-AWD.** The COPECs and analytical suites associated with each measure are described in the discussion of each individual field measure in Section 8.1.2. The receptors potentially at risk from exposure to soil COPECs include plants, soil invertebrates (earthworms), small mammals, mammalian carnivores, omnivorous birds, and carnivorous birds representing a T&E species, the Mexican spotted owl (*Strix occidentalis lucida*). Receptors at potential risk from exposure to sediment include the swallow (which also represents a T&E species, the southwestern willow flycatcher [*Empidonax traillii extimus*]), the bat, and the aquatic community (which represents a number of aquatic species). Receptors at potential risk from exposure to COPCs in water also included representatives of the aquatic community (aquatic invertebrates and algae).

**Screening Against ESLs and BCGs for 2005 Sediment and Water Data**

Sediment samples were collected in 20 of the investigation reaches in the Mortandad watershed and in the background reach in Los Alamos Canyon in 2005 after preparation of the biota investigation work plan. The concentrations of COPCs in these samples were screened against ESLs and BCGs to determine if any new study design COPECs (COPECs with an HQ >3) were identified by the additional sampling. Screening the data from 2005 samples was conducted with ECORISK Database Version 2.2 (LANL 2005, 90032); the screening documented in the “Mortandad Canyon Biota Investigation Work Plan” (LANL 2005, 89308) used the version of the ESL database that was current at the time that the report was written, ECORISK Database Version 2.1 (LANL 2004, 87386). The tables for this screening are presented in Section E-1.2 of Appendix E. The section below includes a discussion of the results of the screening and whether new COPECs were identified based on higher detected maximum concentrations or a decrease in the ESL between the versions of the database.

**Additional COPECs for Soil**

Tables E-1.2-1 to E-1.2-3 in Appendix E show the HQs for soil COPECs based on the screening of the 2005 samples. The maximum detected concentrations of analytes in soil for these samples are available in the data files in Appendix C.

Soil samples from two reaches with the highest concentrations of chromium were analyzed for hexavalent chromium in 2005. In reach E-1FW, the HQ for both the earthworm and the plant for hexavalent chromium was 5.8. Based on other study design COPECs, reach E-1FW was already included in the plant and earthworm toxicity studies that includes metals; therefore, no additional studies are necessary based on the designation of hexavalent chromium as a study design COPEC.

The SVOC bis (2-ethylhexyl) phthalate is also a new COPEC for soil based on the screening of the data from the 2005 samples; bis (2-ethylhexyl) phthalate is a COPEC in soil for reach TS-1C. The ESL for bis (2-ethylhexyl) phthalate in the ECORISK Database Version 2.2 (LANL 2005, 90032) is lower for terrestrial avian receptors than in the previous version of the database (LANL 2004, 87386) due to a revision to the transfer factor EPA recommended for calculating the dose to avian receptors (LANL 2005, 90032). Bis (2-ethylhexyl) phthalate is a COPEC in sediment only for reach TS-1C. Additional nest boxes were added to reach TS-1C in 2005 as part of the field studies. Therefore the existing studies for the Mortandad watershed include the potential effects of this and other COPECs on avian receptors.

Existing study design COPECs for soil, particularly inorganic COPECs, were designated as study design COPECs for additional reaches as a result of the screening of data from the 2005 samples: cadmium and lead in E-1FW, chromium and copper in TS-2E, manganese in TS-1E, vanadium in TS-1W, and Aroclor-1254 in E-1E. Mercury is now a study design COPEC in a number of additional reaches because of an updated transfer factor EPA recommended for calculating the ESL for avian species (LANL 2005, 90032), and the current ESL is one-fourth of the ESL used for the original screening in the biota investigation work plan. The additional reaches for which mercury is a COPEC are M-1E, M-2W, M-2E, and M-3. Some existing study design COPECs were also detected at higher concentrations in reaches in which they were already study design COPECs. These COPECs were already considered in the study designs for other reaches and were not detected at concentrations greatly exceeding the concentrations detected in earlier samples. Therefore, no additional studies are indicated for these COPECs based on the screening of the new data.

**Additional COPECs for Sediment**

Tables E-1.2-4 to E-1.2-6 in Appendix E show the HQs for sediment COPECs based on the screening of the 2005 samples. The maximum detected concentrations of COPCs in sediment for these samples are available in the data files in Appendix C.

Based on the screening of 2005 samples iron is a study design COPEC in active channel sediments. No iron ESL for sediment was available at the time of the screening against ESLs in the biota investigation work plan; the new ESL is based on exposure to aquatic community organisms (LANL 2005, 90032). Based on the screening of the 2005 sediment data, iron would be a study design COPEC in reaches E-1W, M-1E, and M-4. The HQs for all three reaches are similar, and reach E-1W was already included in the study for ecological risk to the aquatic community (the *Chironomus tentans* laboratory toxicity assay). Therefore the existing field studies for the Mortandad watershed address this additional COPEC.

The SVOC bis (2-ethylhexyl) phthalate is also a new COPEC based on the screening of the 2005 sediment data, combined with revisions to ESLs. The ESL for bis(2-ethylhexyl) phthalate in the ECORISK Database Version 2.2 (LANL 2005, 90032) is lower for the avian receptor (the violet green swallow) exposed to sediment than the ESL in the previous version of the database due to a revision in the transfer factor EPA recommended for calculating the dose to avian receptors. Bis(2-ethylhexyl)phthalate is a COPEC in sediment only for reach TS-1C. Additional nest boxes were added to reach TS-1C in 2005 as part of the field studies. Therefore, the existing studies for the Mortandad watershed include the potential effects of this and other COPECs on avian receptors.

Several existing study design COPECs for sediment are designated as study design COPECs for additional reaches based on the screening of the 2005 sediment data. Anthracene is now a study design COPEC for aquatic community organisms in sediment in two additional reaches, E-1E and M-2W. Mercury is now a study design COPEC for avian receptors in reach M-1E in addition to the existing reaches for which it was already a study design COPEC. These COPECs were considered in the study designs for aquatic community and avian species in other reaches and were not detected at concentrations greatly exceeding the concentrations in earlier samples. Therefore, no additional studies are indicated for these COPECs based on the screening of data from the 2005 sediment samples.

**Additional COPECs in Surface Water**

Samples of nonfiltered nonstormwater (nonstormwater includes base flow, snowmelt, and persistent pools), filtered nonstormwater, and filtered stormwater were collected from individual water locations within the Mortandad watershed in 2005. Tables E-1.2-7 to E-1.2-12 in Appendix E show the HQs for surface water COPECs based on the screening of the 2005 samples. The maximum detected concentrations of analytes in surface water for these samples are available in the data files in Appendix C.

In the filtered nonstormwater samples (see Tables E-1.2-7 and E-1.2-8 [Appendix E]), two additional surface water COPECs were designated. Cobalt had an HQ of 4.7 for the maximum detected concentration in reach E-1FW. E-1FW was not included in the aquatic studies, but these surface water screening results are unlikely to indicate a widespread ecological risk within the watershed as the HQ in only one reach exceeded 3. Iron, which did not have an ESL for water at the time of the screening presented in the biota investigation work plan, is designated as a study design COPEC for reaches E-1FW, E-1W, and M-1W. Reaches E-1W and M-1W were already included in studies both for toxicity to aquatic invertebrates and toxicity to algae. (Radium-226 was already a study design COPEC for water based on the screening conducted by subwatershed for the biota investigation work plan.) The screening of the 2005 samples confirmed that radium-226 should be considered as a study design COPEC for reaches E-1E, M-1W, M-1E, and M-2W.

In the nonfiltered nonstormwater (see Tables E-1.2-9, E-1.2-10, and E-1.2-11 [Appendix E]), cobalt is also designated as a new study design COPEC in reaches E-1FW and TS-1W. Iron was designated as a new study design COPEC in reaches E-1FW, E-1W, M-1W, M-1E, TS-1C, and TS-1W. Radium-226 was already a study design COPEC for water based on the screening conducted for the biota investigation work plan. The screening of the 2005 samples confirmed that radium-226 should be considered as a study design COPEC for reaches E-1W, M-1W, and M-2W.

No new COPECs were detected in the filtered stormwater samples from 2005; the HQs for filtered stormwater are shown in Table E-1.2-12.

#### 8.1.1.2 Literature Search in Known Ecological Effects

The following is a synopsis of the screening ecological receptors with the highest HQs (HQ >3) and the feeding guilds they represent. This section reviews both the original COPECs from the biota investigation work plan and the new COPECs designated based on the screening of the 2005 data. The toxic effects are based on toxicity studies used as the basis for the ESLs as described in the ECORISK Database Version 2.2 (LANL 2005, 90032) and are summarized in Appendix E in Tables E-1.1-2 through E-1.1-7. The section below also reports the count of sediment investigation reaches in which the study design COPECs are located. The names of these reaches and HQs for screening against individual receptors can be found in Tables D-2.2.1 through 2.2.10 of the biota investigation work plan (LANL 2005, 89328, pp. D-31– D-41).

**Mammals**

***Soil Pathway Receptors***

The deer mouse as a representative for mammalian omnivores had HQs greater than 3 for four COPECs: arsenic, manganese, thallium and naphthalene. Study design COPECs were found in 6 of the 23 reaches.

The montane shrew as a representative for mammalian invertevores had HQs greater than 3 for seven COPECs: arsenic, cadmium, manganese, thallium, vanadium, chrysene and naphthalene. Study design COPECs were found in 10 of the 23 reaches.

The red fox as a representative for mammalian carnivores had HQs greater than 3 for three COPECs: cesium-137, Aroclor-1254, and Aroclor-1260. Study design COPECs were found in 4 of the 23 reaches.

***Sediment Pathway Receptors***

The occult little brown myotis bat as a representative for mammalian aerial insectivores had HQs greater than 3 for three COPECs: aluminum, arsenic, and naphthalene. Study design COPECs were found in 4 of the 23 reaches.

**Birds**

***Soil Pathway Receptors***

The American robin (with invertevore diet) as a representative for avian invertevores had HQs greater than 3 for 10 COPECs: copper, lead, mercury (inorganic), silver, vanadium, zinc, Aroclor-1254, bis-2-ethylhexylphthalate, di-n-butyl phthalate, and cyanide (total). Study design COPECs were found in 13 of the 23 reaches.

The American kestrel (with flesh diet) as a representative for avian carnivores had HQs greater than 3 for three COPECs: mercury (inorganic), cesium-137, and Aroclor-1254. Study design COPECs were found in 1 of the 23 reaches.

***Sediment Pathway Receptors***

The violet green swallow as a representative for avian aerial insectivores had HQs greater than 3 for nine COPECs, including aluminum, barium, cadmium, copper, mercury (inorganic), silver, vanadium, zinc, and cyanide (total). Study design COPECs were found in 14 of the 23 reaches.

**Terrestrial Plants**

The terrestrial plant as a representative of primary producers had HQs greater than 3 for 12 COPECs, including barium, chromium (total), hexavalent chromium, copper, manganese, selenium, silver, thallium, vanadium, zinc, acenaphthene, and endrin aldehyde. Study design COPECs were found in all of the 23 reaches.

**Terrestrial Invertebrates**

The earthworm as a representative of invertebrate detritivores had HQs greater than 3 for six COPECs: chromium (total), hexavalent chromium, copper, mercury (inorganic), americium-241, and plutonium-239,240. Study design COPECs were found in 15 of the 23 reaches.

**Aquatic Community Organisms**

***Water Pathway Receptors***

The aquatic community organism that represents various aquatic functional and feeding guilds had HQs greater than 3 for 13 COPECs: aluminum, barium, cadmium, cobalt, copper, total cyanide, iron, lead, manganese, silver, zinc, americium-241, and radium-226. Most COPECs were identified in samples from station E200, which include COPECs from filtered stormwater.

*Sediment Pathway Receptors*

The aquatic community organism that represents various aquatic functional and feeding guilds had HQs greater than 3 for 15 COPECs, including barium, copper, iron, mercury (inorganic), silver, acenaphthene, anthracene, dibenz(a,h)anthracene, fluorene, methylnaphthalene, naphthalene, Aroclor-1260, chlordane (alpha), chlordane (gamma), and DDT [4,4'-]. Study design COPECs were found in 9 of the 23 reaches.

#### 8.1.1.3 Conceptual Exposure Model

An ecological scoping checklist was completed for the Mortandad watershed during June and July 2003. A separate Part B checklist was completed for each of several subsets of reaches that were similar in habitat. All the completed ecological scoping checklists appear in Appendix C of the "Mortandad Canyon Biota Investigation Work Plan" (LANL 2005, 89308). In Mortandad Canyon above the confluence with Ten Site Canyon (which includes reaches M-1W, M-1C, M-1E, M-2W, M-2E, M-3W, and M-3E), the terrestrial vegetation cover consists primarily of ponderosa pine, mixed-conifer species, box elder, scrub oak, and various deciduous shrubs. Wetland vegetation (e.g., cattails, rushes, and willows) and aquatic receptors are also found in riparian areas along this part of Mortandad Canyon, particularly in reach M-1W, which contains a cattail wetland. Wildlife noted in this part of the canyon included many species of birds (including bluebirds), burrowing animals, garter snakes, lizards, harvester ants, and evidence of large mammals (deer and bear). Chironomids and stonefly larvae were noted in aquatic areas within reach M-1W. A wide selection of wildlife receptors was noted throughout the reaches within Mortandad Canyon. In Mortandad Canyon east of the Ten Site Canyon confluence (which includes reaches M-4, M-5W, M-5E, and M-6), the vegetation cover consists of piñon-juniper woodland, with scattered ponderosa pine, and numerous shrub species and many of the same wildlife species seen in the Mortandad Canyon reaches farther west. In Effluent Canyon (which includes reaches E-1FW, E-1W, and E-1E), terrestrial plant species include ponderosa pine and wetland species (willows, rushes, and cattails) that were common throughout reach E-1W. In Ten Site Canyon (including reaches TS-1W, TS-1C, TS-1E, TS-2W, TS-2C, TS-2E, and TS-3), the vegetation cover includes ponderosa pine, mixed-conifer species, and oak, along with deciduous shrubs and forbs and associated terrestrial wildlife species. Some areas of riparian and aquatic vegetation (willows, rushes, and cattails) occur in reaches TS-1C, TS-2W, TS-2C and TS-2E. Reach TS-2E also contained aquatic insects at the time of the site visits. The unnamed tributary canyon that heads in TA-05 (including reaches MCW-1 and MCW-2) contains ponderosa pine mixed with piñon-juniper woodland and some shrub oak with a low level of vegetative cover.

Some of the reaches also represent potential or actual habitat for T&E species (Keller 2004, 87688). All the reaches considered in this study are rated as low potential forage areas for the bald eagle except for reach M-6, which is rated as a moderate potential forage area for the eagle. The Mexican spotted owl, however, is believed to actively use several reaches within the canyon (E-1E, M-2W, M-2E, and M-3W). Additional reaches (TS-1E, all TS-2 reaches, and M-3E) are designated as very high potential foraging area, with a number of other reaches considered high or moderate as potential foraging area for the Mexican spotted owl (Keller 2004, 87688). Reaches M-1W and E-1W both contain habitat in which the southwestern willow flycatcher may be assumed to forage at a moderate frequency (Keller 2004, 87688), although this species has not yet been observed in the watershed. The biota studies therefore include explicit consideration of risk to both the Mexican spotted owl, which nests within Mortandad Canyon, and the southwestern willow flycatcher, for which potential habitat exists within the Mortandad watershed.

Surface water in the Mortandad watershed originates either as effluent releases, stormwater, or snowmelt runoff. Where present, surface water can be discontinuous within a reach, alternately stopping where the flow entirely infiltrates into alluvium and emerging downstream where the alluvium thins. Transitions from alluvial channels to bedrock channels are common locations of surface water as water discharges from the shallow alluvial groundwater. Table D-2.3-1 in the “Mortandad Canyon Biota Investigation Work Plan” (LANL 2005, 89308) presents the results of a survey of surface water occurrence in the Mortandad watershed.

Historical contaminant releases to the soils, sediments, and persistent surface water in the Mortandad watershed have occurred from multiple SWMUs and AOCs, primarily through releases of effluent, as discussed in Section 2.1. For ecological receptors, the primary impacted media in the canyons are sediment deposits in the canyon bottoms, surface water derived from effluent releases or persistent pools, and reaches of water that remain for some time after periods of runoff. Active channel sediments (c1 geomorphic unit), potentially subject to persistent water, are referred to as “sediment” in this section. Sediment in other geomorphic units (abandoned channels and floodplains) is referred to as “soil” in this section. The active channel sediments in the Mortandad watershed were also evaluated as part of the soil because all sediments within any of the reaches may be exposed and dry for at least some period of the year, and therefore terrestrial receptors could also be exposed to these sediments.

Persistent surface water exists only in limited sections of the active channel in the watershed. Even so, all active channel deposits are considered in this assessment to be potentially subject to persistent flow under different climatic conditions and therefore to potentially harbor aquatic receptors, i.e., organisms dependent on water, such as algae or chironomids (LANL 2004, 87630, p.26). Floodplains and abandoned channels generally have well-developed terrestrial plant and animal populations and do not support truly aquatic species. Thus, only active channel sediments and surface water potentially have complete exposure pathways to truly aquatic species, whereas terrestrial animals and plants are exposed to COPECs in surface water, soil, or sediment. It is important to recognize that the aquatic species in the watershed represent a fairly simple food web that does not include aquatic vertebrates because surface water is limited both spatially and temporally.

**Historical observations of surface water flow and analytical data from sediment samples indicate that there has been no recognized transport of Laboratory-derived contaminants past SR 4, as discussed in Section 7.1.1.6, and that there is no connectivity between Laboratory SWMUs or AOCs and the Rio Grande in the Mortandad watershed. Therefore, the assessment of potential ecological risks is restricted to the part of the watershed west of SR 4 with known Laboratory-derived contaminants.**

Exposure pathways to terrestrial receptors can occur through the following:

- Air—through respiration of vapors, inhalation, and deposition of particulates
- Surface soil—through root uptake and rain splash on plants, food web transport to plants and animals, incidental ingestion of soil, dermal contact with contaminated soil, and external irradiation
- Persistent surface water and sediments—through root uptake and rain splash on plants, food web transport to animals, incidental ingestion of water and sediment, dermal contact with contaminated water or sediment, and external irradiation from sediment

The major soil-related exposure pathways are plant uptake, food web transport, incidental ingestion of contaminated soil, and external gamma radiation exposure. Water and sediment pathways are of lesser importance to terrestrial receptors because of the limited temporal and/or spatial extent of persistent surface water in the watershed. Exposure to vapors is unlikely because of the infrequent detection of VOCs in the watershed, the low VOC concentrations measured in sediment and water, and the rapid volatilization of VOCs in sediments near the ground surface. Exposure to airborne particulates is a minor pathway because of the limited amount of contamination at the ground surface and the dense plant cover in some reaches.

The remaining pathways related to exposure to surface soil (dermal contact) and surface water and sediment (food web transport, incidental ingestion of contaminated sediment and water, dermal contact, and external radiation exposure) are also minor because of the limited amount of contamination at the ground surface or in surface water. In addition, soil exposure pathway analysis EPA performed to support the development of its ecological soil screening levels (Eco-SSLs) has shown that inhalation and dermal pathways contribute a small fraction of the dose obtained orally (EPA 2003, 76077). All complete exposure pathways are at least qualitatively evaluated in the assessment in this report because some of the measures proposed in this investigation are field measures of effect or exposure.

#### 8.1.1.4 Assessment Endpoints

Assessment endpoints consist of an entity (a receptor species) and an attribute (survival, growth, or reproduction) of that entity that is being assessed. Seven assessment endpoints for the Mortandad watershed are identified based on the study design COPECs summarized in Section 8.1.1.1 (and the associated tables) and the conceptual exposure model. These endpoints were selected to represent T&E receptors (the Mexican spotted owl and the southwestern willow flycatcher) as well as receptors that are representative of the terrestrial and aquatic food web in the Mortandad watershed (food webs are shown in Figures 3.4-1 and 3.4-2 of LANL 2004, 87630). The conceptual exposure model indicates that ingestion exposure pathways and, in particular, food web transport, are important pathways for these COPECs. Assessment endpoints were developed for the five terrestrial feeding guilds (including aerial insectivores) that represented the receptors with the highest HQs, as well as for the surrogates for the T&E species. Because aquatic environments in the Mortandad watershed are generally not perennial and rely on effluent and persistent water from storm runoff, a single assessment endpoint for the aquatic study design was selected. The seven assessment endpoints (AE1 through AE7) are as follows:

- Survival and reproduction of the Mexican spotted owl (AE1)
- Population abundance or persistence and species diversity of avian ground invertevore feeding guild species (e.g., American robin, bluebird) (AE2)
- Population abundance or persistence and diversity of mammalian invertevore and omnivore feeding guild species (e.g., shrews and deer mice) (AE3)
- Survival and growth of detritivore species (earthworms) (AE4)
- Native plant species presence and diversity (AE5)
- Survival and reproduction of ~~the southwestern willow flycatcher~~ **aerial insectivores** (AE6)
- Abundance and survival of the aquatic community in the reaches of the Mortandad watershed that retain surface water long enough to support aquatic communities (AE7)

Assessment endpoints were used as the basis for developing the measures of exposure and the measures of effects. Those measures evaluate impacts to the attributes of survival, growth, or reproduction in the receptor species and in the feeding guilds that those receptor species represent. The measures included field, laboratory, and model data. For the biota investigation in the Mortandad watershed, the measures are based on extension of the field biota investigation done in the Los Alamos and Pueblo watershed (LANL 2004, 87390).

### 8.1.2 Study Design, Field Verification, and Site Investigation

This section discusses the ecological risk assessment study design, field verification, and site investigation; this encompasses ERAGS steps 4 and 5 and the first part of step 6. Biological data were collected as measures of exposure and effect (lines of evidence) to evaluate the potential for adverse ecological effects from contaminants in soil, sediment, and persistent surface water. The initial design of each study is documented in the "Mortandad Canyon Biota Investigation Work Plan" (LANL 2005, 89308). As a result of discussions with NMED during the review of the biota investigation work plan, an additional measure was added. Algal toxicity tests were added to assess potential risk to algae from radionuclides in surface water. These algal toxicity tests are described in Section 8.1.2.11. Figure 8.1-1 shows reaches and the sample locations in the Mortandad watershed and the background site (reach LA-BKG). Shrews were trapped in two of the reaches (E-1W and LA-BKG) designated for the general small mammal trapping. The plant diversity field studies were conducted in the same reaches indicated for the plant and earthworm toxicity studies. Field bird surveys are not indicated on the map because they did not correspond directly to individual locations in reaches, as explained in Section 8.1.2.5. The rapid bioassessment characterization studies were collocated with the chironomid toxicity tests indicated in Figure 8.1-1. Table 8.1-1 shows the reaches included in each type of study, as well as the study design COPECs used as the basis for including that reach for that type of study.

#### 8.1.2.1 Small Mammal Trapping and Analysis of Pelts and Carcasses

Trapping small mammals was conducted in three reaches within the Mortandad watershed and one background reach in Los Alamos Canyon. The results of the trapping determined measures of effect on the small mammal population including relative abundance, species composition, reproductive status, and body weight. The field measures of the small mammals were lines of evidence for the effects to the small mammals themselves (see Table D-4.0-4 in LANL 2005, 89308) in support of AE3.

Small mammals were also collected for laboratory analysis to determine the concentration of COPECs in tissues. The concentrations in the tissues were lines of evidence for the exposure of the Mexican spotted owl (AE1) as well as for the mammalian carnivore (the red fox), which was not designated as an individual assessment endpoint. All the individuals of most species from each reach were separated into pelts and carcasses; the pelts and carcasses were then combined so that one pelt and one carcass sample from each species was sent for analytical analysis for each reach. The exception is for shrews, which were too small to allow separation into pelt and carcass, and instead whole body samples were submitted. Table B-3.0-2 shows the sample IDs associated with these tissue samples as well as the weights for the composite pelt and tissue samples from each species. Individuals of some species (particularly wood rats) have enough mass that not all animals trapped were included in the composite pelt and carcass samples. Also, animals that tested positive for Hanta virus after collection were not included in the composite samples. The total number of animals trapped of each species is discussed in Section 8.1.3.4. The number of animals collected (excluding released or hanta virus infected animals) for each pelt or carcass sample from each reach is shown in Table 8.1-2.

The analytical suites were prioritized based on study design COPECs for predators, as shown in Table D-6.0-2 (LANL 2005, 89308). Analyses conducted on these carcass and pelt samples included EPA Method SW-846 6010B metals, perchlorate, mercury, PCBs, americium-241, cesium-137, and strontium-90.

As discussed in Section 7.1.2, cyanide is designated as a study design COPEC based on sediment concentrations exceeding the BV only in reach MCW-2W. Resampling done in that location and two adjacent locations in the same area produced values below the BV (see Section 7.1.2 and Tables E-1.2-1 and Table E-1.2-4). Cyanide was therefore not considered further in sediment in this investigation report. Total cyanide was also designated as a study design COPEC for aquatic organisms in the biota work plan based on detected concentrations in water at gage station E200 (Table B-7.1-1 in LANL 2005, 89308). Water from E200 was collected as the reach M-2W sample and included in the algae toxicity studies. Neither this water sample nor any other new water samples from other reaches contained cyanide at concentrations that would make cyanide a study design COPEC (see Table E-1.2-7 and E-1.2-9) at this water station or the others sampled. Cyanide was detected in water for the algae test only in the samples from TS-1C and TS-2C, and the concentrations were less than 3 μg/L. Sediment from reach M-2W was also used for the chironomid toxicity test to assess risk to aquatic organisms. Regression analysis was conducted for each analyte detected (except sodium) in the carcass or pelt samples of each species, even if the analyte was not a study design COPEC. These regression analyses compared the concentration of a COPEC in the composite sediment samples collected at the trapping arrays, discussed in Section 8.1.2.2, against the concentration of the COPEC detected in tissues. Some analytes were detected in some tissue samples but not other samples; plots and regressions for analytes that were detected at least once in tissue include nondetects for that analyte as values at their detection limit

#### 8.1.2.2 Soil Characterization

Samples of sediment were collected from the locations in the Mortandad watershed used for laboratory toxicity tests and also from sediment within the small mammal trapping arrays for additional characterization of exposure to small mammals. Table B-3.0-3 shows the reach, location ID, and geomorphic unit associated with each of these samples. For the earthworm and plant toxicity tests, discrete samples were collected from 0–30 cm (0–1 ft) for the toxicity assays and for the analytical analysis of the same samples. Samples for the earthworm and plant toxicity tests were collected from geomorphic units outside the active channel (generally c2, c3, or f1 units). Sediment samples for the *Chironomus tentans* toxicity tests were collected from 0–15 cm (0-0.5 ft) in the c1 geomorphic unit (the active channel) to represent the sediment to which these aquatic organisms would be exposed. At the four sites for the small mammal trapping, composite samples were collected for Laboratory analysis to estimate COPEC concentrations the mammals would be exposed to. The composite samples consisted of 10 subsamples collected from 0–15 cm (0–0.5 ft) at 10 locations within each trap array.

#### 8.1.2.3 Owl Pellet Analysis

Owls regurgitate pellets containing fur and bones from prey items they have consumed; the contents of these pellets were examined to determine the species of prey consumed as an ancillary line of evidence for AE1. For this study, 46 pellets collected from four owl roosting sites were sent for taxonomic identification of the bone and tooth fragments (Bennett et al. 2006, 93774). Three of the roosting sites are known to be occupied by the Mexican spotted owl. One roosting site lies within Mortandad Canyon near reach M-2W. Two additional Mexican spotted owl roosting sites are in Cañon de Valle. The analysis of species included 17 taxonomic groups of mammals as well as birds. The complete list of number and type of each species found is described in Bennett et al. (2006, 93774). The primary use of this information in this study was to determine which species of small mammals from the tissue COPEC concentration analysis were appropriate to use for modeling the COPEC concentrations ingested during prey consumption by the Mexican spotted owl, as described in Section 8.1.2.1. The results of this comparison are described in Section 8.1.3.1.

### 8.1.2.4 Nest Box Studies

An avian nest box monitoring network has existed in the vicinity of the Laboratory since 1997; the network includes both potentially contaminated and noncontaminated areas. As part of the baseline ecological risk assessment for the Mortandad watershed, additional nest boxes were placed in the canyon bottoms or canyon bench areas within Mortandad Canyon and its major tributary canyons. Figure 8.1-1 shows the boxes within the Mortandad watershed that were sampled for the biota studies. Both the western bluebird (*Sialia mexicana*) and the ash-throated flycatcher (*Myiarchus cinerascens*) occupy these boxes. Measures collected using the nest box network included field measures of effect on reproductive success of these avian species (including clutch size, fledgling success, growth of fledglings, etc.) and measures of exposure through analysis of COPEC concentrations in unhatched western bluebird eggs and unconsumed prey (insects) collected within the boxes. Table B-3.0-5 shows the egg and insect samples collected for analytical analysis within the Mortandad watershed; the locations of the boxes within the reaches are shown in Figure 8.1-1. Boxes in Cañada del Buey and in the Cañada del Buey watershed (near TA-51) and boxes from two areas outside the Laboratory (the Los Alamos golf course and the Guaje Pines Cemetery; LANL 2004, 87390, Figure 8.1-1) were also included in the study for reference. Eggs from individual boxes within a reach were submitted as samples. In some cases, individual boxes contained sufficient material for analysis, but in other cases insects from more than one box in a reach were combined to obtain sufficient sample size for analysis. Table 8.1-3 shows a summary of the eggs and insects collected per reach.

Because of sample size limitations, egg and insect samples were analyzed only for metals. These measures were collected to evaluate AE2, the endpoint for avian ground invertevores. The COPEC concentrations in nest box insects were used as a measure for AE6~~,~~ **for** the avian insectivore (southwestern willow flycatcher) and the mammalian insectivore (the occult little brown myotis bat)~~; the bat is being evaluated for possible exposure through prey even though this species does not represent a specific assessment endpoint in the baseline ecological risk assessment studies~~. Results of the field measures of effect through reproductive success are discussed in Section 8.1.3.3. The measures of exposure through COPEC concentrations measured in insects are discussed in Section 8.1.3.2 and exposure based on COPEC concentrations in eggs is discussed in Section 8.1.3.3.

### 8.1.2.5 Breeding Bird Survey

An additional study done as a measure for AE2 and AE6 for the avian ground invertevore and the avian insectivore was a survey of the level of use of upper Mortandad Canyon and Ten Site Canyon by avian species. The survey recorded species, sex, and age of birds within these canyon bottom areas and provides an estimate of the diversity of species in the survey areas. The survey areas were not restricted to the designated reach areas but included birds seen or heard in the majority of the canyon bottoms in these areas during the walkover survey. The complete survey results are presented in Keller (2005, 93690). The results relevant to this investigation are discussed in Section 8.1.3.3.

### 8.1.2.6 Earthworm Toxicity Tests

Sediment collected from the 0- to 30-cm (0- to 1-ft) depth interval was used for the earthworm toxicity tests (a measure for AE4). The earthworm tests used the standard American Society for Testing and Materials (ASTM) method E1676-97. The toxicity tests compared the growth and mortality of the earthworms from the seven reaches shown in Table 8.1-1 with the reference site in reach LA-BKG. As shown in the table, the reaches were selected to represent a gradient of concentrations for COPECs associated with both the soil invertebrate receptor and the mammalian and avian receptors that feed on the soil invertebrate. The biota investigation work plan (LANL 2005, 89308) originally proposed that this assay would also include a bioaccumulation test to determine concentrations of COPECs in the worm tissues after 28 days' exposure to the sediment samples. Unfortunately, the earthworms were inadvertently discarded at the conclusion of the test before being sent for laboratory analysis for COPEC concentration. Therefore, the dose to avian receptors in Section 8.1.3.3 is calculated based on concentrations detected in earthworms in the Los Alamos and Pueblo Canyon studies (LANL 2004, 87390) from sediments with the same COPEC concentrations or on extrapolated values from those studies. Section 8.1.3.5 discusses the results of the statistical analysis of the growth and mortality between sites.

#### 8.1.2.7 Seedling Germination Tests

Sediment collected from the 0-30-cm (0-1-ft) depth interval was used for the plant toxicity tests (a measure for AE5). The plant toxicity tests used the standard ASTM method E1963-98. The plant toxicity tests compared survival rates, shoot height, root length, and shoot and root mass in plants grown in soil the same seven locations used for the earthworm toxicity tests with plants grown in the soil sample from the background site. The tests used yarrow (*Achillea millefolium* L. var *occidentalis*), which has more variable results than some other available test species of plant but is more relevant to the ecosystems found at the Laboratory. Section 8.1.3.6 discusses the results of the statistical analysis of the growth and mortality between sites.

#### 8.1.2.8 Plant Survey

A field plant survey was conducted in reaches within the Mortandad watershed to provide ancillary information for the small mammal trapping (AE3); significant differences in the amount of plant cover may affect the number or type of small mammals caught. The field plant survey also serves as an ancillary line of evidence for ecological risk to plants (AE5), although the plant toxicity test is the major line of evidence for that assessment endpoint. The plant survey encompassed nine reaches (see Table 8.1-1) including all of the mammal trapping reaches, all reaches for the plant and earthworm toxicity tests, and the background reach.

In these surveys, vegetation was identified as tree, shrub, forb, cacti, or graminoid (with identification to species where possible) and percent canopy cover for each species was categorized (Balice and Sandoval 2006, 93689). Two measures of diversity, the Shannon diversity function and species richness, were used to compare the vegetation between sites. A brief summary of the results and their relevance to other measures is provided in Section 8.1.3.6.

#### 8.1.2.9 *Chironomus tentans* Toxicity Test

Sediment samples from the eight reaches shown in Table 8.1-1 were used in the EPA Method 100.2 (EPA 2000, 73776) 10-day growth and survival test with the larval insect *Chironomus tentans*. Each sediment sample was tested at 100% only; dilution series were not run on the sites. Standard control and reference toxicants were included. The endpoints for this test include both survival and growth (as ash-free dry weight). The results of the test are discussed in Section 8.1.3.7.

#### 8.1.2.10 Rapid Bioassessment Characterization

Rapid bioassessment characterization was conducted at five reaches in the Mortandad watershed that had sufficient flow to potentially support aquatic macroinvertebrate communities (Henne and Buckley 2006, 93687), using the EPA Rapid Bioassessment Protocol (EPA 1999, 73728). Collection of aquatic macroinvertebrates was conducted in association with the bioassessment. Collection and assessment were attempted at all reaches specified in Table 8.1-1 in June and September 2005, but because of absence of water, neither TS-1C nor TS-2C underwent an assessment or invertebrate collection in June 2005. Similarly, reaches M-2W and TS-1C could not be sampled in September due to lack of water. The biota investigation work plan (LANL 2005, 89308) specified use of a Hess sampler to collect aquatic macroinvertebrates when sufficient water was present to use this sampler. However, none of the sites had sufficient water to use the Hess sampler in either June or September 2005. The Hess sampler is needed to collect data for comparison to the NMED Stream Condition Index (SCI); therefore, no comparisons to the SCI were done for the aquatic macroinvertebrate sampling in the Mortandad watershed. Semiquantitative sampling using a D-frame dip net to determine taxonomic composition of macroinvertebrates was done at the sites. The biota investigation work plan indicated that the collected macroinvertebrates would be submitted for Laboratory analysis if sufficient mass could be collected for analysis. The field team was unable to collect sufficient mass of aquatic macroinvertebrates to submit for analysis.

#### 8.1.2.11 Algal Toxicity Test

Water samples collected from the reaches shown in Table 8.1-1 were used for the EPA Method 1003.0 short (96-hr) chronic toxicity algal growth test. This test uses the green algae *Selenastrum capricornutum*. The test methods, conditions, and results are described in Pacific Ecorisk (2005, 91270). Samples were collected from M-2W, E-1W, E-1E, M-1W, and LA-BKG in July 2005 for the test. Locations in TS-1C, TS-1E, and TS-2C were dry at that time, but water samples were collected from these locations in August 2005 for the toxicity test. Controls and reference toxicants were run with both sets of samples. The results of the test are discussed in Section 8.1.3.7.

#### 8.1.2.12 Spatial Modeling Using ECORSK.9.

The ECORSK.9 model was used to model HQs and hazard indices (HIs) across the Mortandad watershed for the Mexican spotted owl, southwestern willow flycatcher, deer mouse, and western bluebird, as presented in Gonzales et al. (2006, 93786). ECORSK.9 includes both canyon and noncanyon sources as well as measured and interpolated concentrations of COPECs from these sources. The model estimates exposure based on an environmental exposure unit (EEU) that consists of foraging throughout the home range centered on known or potential nest sites input into the model. For the Mexican spotted owl, the model restricted the nest sites to within the buffer area for this T&E species. For the southwestern willow flycatcher, the model restricted the nest sites to within the wetland area designated as potential flycatcher habitat. For the deer mouse and western bluebird, the modeled area included the entire Mortandad watershed west of SR 4. The model produces mean total HIs that provide an estimate of risk to populations and are most useful for species such as the deer mouse and western bluebird. For evaluating T&E species, risk to individuals and therefore the number of individual grid cells with elevated HIs are a better indicator of locations and COPECs that may need additional investigation. The model calculates both unadjusted HQs and HIs and adjusted HQs and HIs; the adjusted values do not include the contribution of background concentrations of COPECs. For this investigation report, the model was run with two scenarios: In the first scenario all nondetects were included as values at one-half of their detection limit. For many organic chemicals, nondetects constituted 75% to 98% of the data set values, resulting in detection limits heavily influencing the HQ and HI values. To overcome this problem, a second scenario was run in the model in which nondetects for organic chemicals were treated as zeros to focus the results on the actual detected COPECs in the model.

### 8.1.3 Characterization of Exposure and Effects

This section discusses the baseline ecological risk assessment characterization of exposure and effects, which represents the second part of ERAGS Step 6. This section provides the results from the studies and their interpretation as well as the supporting information in tables and figures. Revised calculations of dose to predators based on concentrations of COPECs in prey are also presented in this section. Although the screening of concentrations of COPCs in sediment and water samples collected in 2005 is also a line of evidence supporting the evaluation of potential ecological risk in the Mortandad watershed, that evaluation is separate from the field studies conducted for the base line ecological risk assessment. Screening the 2005 sediment and water samples against ESLs is presented in Appendix E and summarized in Section 8.1.1.1.

#### 8.1.3.1 Mexican Spotted Owl

**ECORSK.9 Model**

In the ECORSK.9 model, a number of grid cells within the Mortandad watershed with elevated HIs indicated there may be areas of potential risk to individual Mexican spotted owls (Gonzales et al. 2006, 93786). This was true for both the unadjusted and adjusted mean HI. The adjusted mean HQ and mean HI values calculated in the second scenario (all organic nondetects treated as zeros, as explained in Section 8.1.2.12) are considered the most representative of potential risk from Laboratory sources to the modeled receptors, although the adjustment for background made little difference for the HQ and HI values for the owl. The adjusted total mean HI with nondetects treated as zeros for the owl is 1.6; only bis(2-ethylhexyl)phthalate had an HQ >1.0. Lead was the second most important COPEC (HQ = 0.6). The HI was ≥1 in 49% of the focal points; almost all of these HIs were less than 10. The area with the highest adjusted HI values indicating potential risk to the Mexican spotted owl were in part of Ten Site Canyon, including TA-35 and reaches TS-2E and TS-2C, and in Mortandad Canyon reach M-2E. Although it is difficult to pinpoint the individual source of elevated HIs in the model for a receptor with a home range as large as the owl, the primary sources of high HI values in the model appear to be from samples from noncanyon sources, particularly sources of COPECs associated with TA-35.The adjusted HI for the grid cell in Mortandad Canyon in which a pair of owls has nested was only 0.2. Therefore, the adjusted HI for the grid cell in Mortandad Canyon containing a confirmed owl nest indicates little to no threat of potential adverse effects from Laboratory-related contaminants.

**Concentrations of COPECs in Prey**

**Table 8.1-3-AWD provides the results of the analysis of the prey composition in 48 owl pellets.** Remains of prey found in the owl pellets from the collection site near reach M-2W in Mortandad Canyon were dominated by wood rats (*Neotoma sp.*), which made up approximately half the identified pellets (Bennett et al. 2006, 93774). Wood rats were collected and analyzed from all trapping sites except the LA-BKG site. Deer mice, brush mice, and pinyon mice were also found in pellets from this site. All these species were collected during the small mammal trapping done for this study. Two other pellet collection sites lie outside of the Mortandad watershed but within the home range of Mexican spotted owls at the Laboratory. These two other sites are also used for roosting by the Mexican spotted owl. Pellets from both these sites also contained wood rats; in addition, one site contained the remains of brush mice and another site contained pellets with the remains of long-tailed voles. The analysis of the pellets collected from these three sites indicate that the species collected from the small mammal trapping locations are appropriate to use in the refined calculation of the estimated doses to the Mexican spotted owl. The dose was calculated using the maximum detected concentrations in any prey species, although because wood rats may represent the dominant prey species; use of maximum concentrations from other species may overestimate the dose to the Mexican spotted owl.

COPECs for the Mexican spotted owl were identified in the initial screening of the sediment data (LANL 2005, 89308, p. D-37). While only Aroclor-1254 met the criterion for a study design COPEC (HQ >1 for a T&E species), mercury and cesium-137 had HQs just above 0.8. These three COPECs were not detected in the tissues of the small mammals sent for Laboratory analysis in this study. The detection limits for mercury and Aroclor-1254 are conservatively used to represent the tissue concentration in the refined dose calculation for the Mexican spotted owl. Cesium-137 results are not used in the dose calculations, as discussed below. Based on comments by NMED (NMED 2005, 92084), selenium is also a study design COPEC for all avian receptors although the HQ did not indicate that selenium should be included.

Small mammals are also assumed to be the prey of the receptor representing the carnivorous mammal, the red fox. Study design COPECs for the fox identified in the screening conducted for the biota investigation work plan (LANL 2005, 89308, p. D-35) include cesium-137, Aroclor-1254, and Aroclor-1260. Detected concentrations of Aroclor-1260 are used in the refined estimate of the dose to the fox, and the detection limit for Aroclor-1254 is conservatively used as tissue concentrations for this COPEC.

As described in the biota investigation work plan (LANL 2005, 89308 p. D-14), an HQ for the owl can be calculated by dividing the avian toxicity reference value (TRV) for a COPEC from the ECORISK Database, Version 2.2 (LANL 2005, 90032) by the normalized food intake of the owl of 0.102 mg fresh weight (fw) food/kg body weight (bw)/day (LANL 2005, 89308, p. D-14). Because the TRV for cesium-137 is based on a radiation dose to the organism and not on an amount ingested, this COPEC is not amenable to these calculations. Table 8.1-4 shows the calculations to combine the maximum detected concentrations in carcass and pelt into the equivalent concentration in a whole animal. This table also shows the HQ calculated by dividing the concentration in the reconstructed whole animal by the food ESL calculated as described above. **Potential risk from mercury was estimated based on the assumption that either the total detected mercury concentration was inorganic mercury or that the total detected mercury concentration was methyl mercury. (No methyl mercury analyses were obtained, and the second case represents a conservative upper-bound constraint.)** The proportions of methylated mercury and inorganic mercury in the tissues were not measured, but the calculations in Table 8.1-4 demonstrate that the HQ is <0.5 for the owl regardless of whether the mercury is in the inorganic or methylated form.

### 8.1.3.2 ~~Southwestern willow flycatcher~~Aerial Insectivores

**ECORSK.9 Model for the Southwestern Willow Flycatcher**

In the ECORSK.9 model, a number of grid cells within the Mortandad watershed with elevated HIs indicated there may be areas of potential risk to southwestern willow flycatchers (Gonzales et al. 2006, 93786). This was true for both the unadjusted and adjusted HI. The adjusted mean HI value for the flycatcher was 6.2. The dominant COPECs were mercury (HQ = 1.7), di-n-butyl phthalate (HQ = 1.5), boron (1.4), and bis (2 ethylhexyl) phthalate (HQ = 0.48). HIs were ≥1.0 in 81% of the grids; approximately half of these HIs were less than 10. The flycatcher was modeled only for areas that contain flycatcher habitat; therefore, the area with elevated HIs are limited to the Effluent Canyon area. The elevated HQs for di-n-butyl phthalate resulted primarily from measured values in the noncanyons portion of the data set used in the ECORSK.9 model. There is no BV for boron, and it is unknown whether the detected boron values represent releases from Laboratory sites or instead background levels.

**Concentrations of COPECs in Prey for the Southwestern Willow Flycatcher**

This section estimates the potential dose to the southwestern willow flycatcher using the concentrations in the insects collected from the nest boxes. As described in the biota investigation work plan (LANL 2005, 89308, p. D-14), an HQ for the flycatcher can be calculated by dividing the avian TRV for a COPEC from the ECORISK Database Version 2.2 (LANL 2005, 90032) by the normalized food intake. For the flycatcher, normalized food intake was calculated from the body weight of 12.7 g (LANL 2005, 89308, p. D-14) and estimating the food ingestion rate using the allometric equation for passerine birds from EPA's Wildlife Exposure Factors Handbook (EPA 1993, 59384, equation 3-4). The calculated food ingestion rate is 0.0034 kg/day. This food ingestion rate is in grams of dry weight per day, and was converted to fresh weight using the dry weight to fresh weight ratio for honeybees (Fresquez and Ferenbaugh 1999, 91269). The final insect ingestion rate used in the calculations for the southwestern willow flycatcher is therefore 0.79 kg fw food/ kg bw/day. Table 8.1-5 shows the calculated HQs for the flycatcher based on ingestion of the concentration measured in nest box insects. In some reaches, more than one insect sample could be analyzed, so the arithmetic mean of the concentrations was used (nondetects treated as one-half of the detection limit) as the sample size was too small for calculation of a UCL of the mean. In reaches with only one insect sample analyzed, the maximum detected concentration was used.

The HQs for food ingestion are shown in Table 8.1-5 and predict a much lower level of potential ecological risk than the screening against ESLs did, even though HQs for five COPECs still exceed one (barium, copper, mercury [assumed to be methyl], vanadium, and zinc). Four of these COPECs also had HQs elevated above one in samples collected outside the Mortandad watershed in the Cañada del Buey, Pueblo, and Rendija watersheds. The concentration of these metals in insects is therefore unlikely to be correlated with the concentration of COPECs in soil. The TRVs for these metals probably result in an overprediction of risk because the TRV is likely to be based on a more toxic form of the COPEC than is found in the insects. In addition, the southwestern willow flycatcher has not been observed in this part of the Laboratory, so the risk is hypothetical at this time. However, further evaluation may be warranted if the flycatcher is observed to utilize this area in the future.

Bis(2-ethylhexyl)phthalate could not be evaluated in this study, as the mass of insect tissue collected was sufficient only to run the metals analytical suite. However, potential effects of bis(2-ethylhexyl)phthalate are considered in the nest box study evaluation described in Section 8.1.3.3.

**Estimate of COPEC Dose through Food to the Bat**

**Although several COPECs in the Mortandad watershed had HQs >3 for the bat (aluminum, arsenic, and naphthalene), the bat was not identified as a measure for an assessment endpoint in the biota investigation work plan because its large home range and high food ingestion rate indicate that much of a bat's food would be obtained from outside the watershed. However, because nest box insect tissues were analyzed to evaluate avian receptors, these analytical results were used to refine the potential COPEC dose through food to the occult little brown myotis bat, as shown in Table 8.1-5-AWD. Because of the size of the insect samples, only metals analyses could be run on the insects. Therefore, naphthalene was not included in these calculations. Aluminum was included in the analytical suite for the nest box insects, but aluminum is only a potential COPEC in soils with a pH below 5.5 (EPA 2003, 85645); therefore, aluminum no longer fits the ESL model for accumulation through the food chain and is also not included in Table 8.1-5-AWD. The HQ for arsenic for bioaccumulation through insects into the bat is 0.6, indicating no potential risk to the bat through ingestion of insects even if all insects come from the canyon bottom areas within the Mortandad watershed.**

#### 8.1.3.3 Avian Invertevore Feeding Guild

This section provides results for trends of COPEC concentration in sediment versus field measures for the avian invertevore feeding guild in the Mortandad watershed, such as nest success and eggshell thickness. This section also evaluates trends of COPEC concentration in sediment versus concentration in eggs. Field measures are derived from Colestock and Fair (2005, 93691).

**Nest Success for Bluebirds**

As part of the Laboratory's nest box monitoring program, a large number of field measures are collected from the nest boxes each year (Colestock and Fair 2005, 93691). Two of these measures that relate to juvenile survival were selected for this study for comparison to concentrations of COPECs in sediment. The measures selected are percent fledged and percent female (the latter may relate to specifically to PCBs as COPECs). Occupied bird boxes were found in five reaches within the Mortandad watershed: M-3, M-4, M-5, TS-2C, and TS-2W. All species occupying the nest boxes (western bluebirds, violet green swallows, ash-throated flycatchers, and mountain bluebirds) are included in the analysis of the measures to provide a larger dataset as the overall number of occupied boxes in the reaches is fairly small. Appendix E provides box plots comparing these two measures between species; no significant differences are seen. Comparisons of the selected nest measures between these reaches are shown in Figure 8.1-2 for percent fledged and Figure 8.1-3 for percent female. Boxes in these figures indicate the interquartile range of the sample results, with the upper and lower ends defined by the 75th and 25th percentiles, respectively. Horizontal lines within the boxes indicate median values, and horizontal lines above and below the boxes represent the 5th and 95th percentiles of the data. Neither measure appears to differ significantly between the reaches, but there are small sample sizes for some measures (e.g., percentage of females in reaches TS-2C and TS-2W). These measures were recorded from 1997 to 2005; bivariate plots of each measure versus year were made and are shown in Appendix E. These measures do not correlate significantly with the year, so data from all years are included on the plots.

In addition to the comparison conducted between reaches, the combined data from all reaches within the Mortandad watershed are compared with other areas within the nest box monitoring network. The groups are Mortandad (Mort), Cañada del Buey (CdB), the cemetery (Cem, unimpacted area), the golf course (GC, unimpacted area), TA-35 (impacted, boxes are near SWMUs or AOCs), Los Alamos and Pueblo Canyons (LA/P, impacted by SWMUs and AOCs), and other (representing the boxes in the nest box network not included in the other groups). Figure 8.1-4 shows a comparison of the percent fledged between the groups and Figure 8.1-5 shows a comparison of the percent female nestlings between the groups. For both measures the results for the Mortandad watershed do not differ from the other areas.

**Eggshell Thickness**

Another set of parameters collected as part of the nest box network are related to the condition of the eggs. Numerous parameters have been collected; three of these parameters were chosen for inclusion in this study. Eggshell length (in millimeters) and total egg weight correlate well with each other and provide an estimate of egg size. Eggshell thickness was also chosen because previous studies had shown that some thinning of eggshells has occurred in Sandia Canyon (Fair and Meyers 2002, 82655). As with the other nest measures described above, all species are included to provide a larger dataset. Appendix E shows the comparison between species for egg length, egg weight, and eggshell thickness; the comparison shows no significant differences between species for these parameters. Appendix E also compares length, weight, and thickness across years in bivariate plots. None of the three measures vary significantly with year, so data from all years are included in the analysis.

The measures for the eggs are compared between the same five reaches (M-3, M-4, M-5, TS-2C, and TS-2W) as the other nest measures and are also compared among the same areas (Mortandad, cemetery, golf course, Cañada del Buey, TA-35, Los Alamos and Pueblo Canyons, and other). Figures 8.1-6 to 8.1-8 show the comparisons for the egg measures between reaches within the Mortandad watershed. Figures 8.1-9 to 8.1-11 show the comparisons for these measures between the areas. The sample sizes vary between reaches and between groups; however, the three measures do not show any significant differences between reaches or between groups.

**COPEC Concentration in Eggs**

The concentrations of metals measured in eggs were plotted against the reach average sediment concentration of that COPEC in the reach from which the egg was collected. The concentration in eggs does not correlate significantly with the concentration in sediment for any of the metals. The plots and regression calculations for all metals are presented in Appendix E. For two of the metals that generated higher HQs for the robin—mercury and copper—in the screening conducted for the biota plan and that were detected in the eggs, the graphs are presented in Figures 8.1-12 and 8.1-13. In addition, NMED requested retaining selenium for all evaluations in the report (NMED 2005, 92084), even though the initial screening did not show this as a COPEC; therefore the graph for selenium is presented in this section in Figure 8.1-14.

**COPEC Concentration in Worms**

As discussed in Section 8.1.2.6, COPEC concentrations in earthworms were not obtained from the Mortandad watershed in this study. Therefore estimates of potential risk to birds in the avian invertevore feeding guild cannot be directly made using measured concentrations in earthworms. In this report, regressions based on data from the Los Alamos and Pueblo watershed (LANL 2004, 87390) are used to estimate potential concentrations in earthworms in the Mortandad watershed for COPECs that had a significant correlation between detected concentrations in soil and worms in the Los Alamos and Pueblo watershed. For COPECs without significant correlations, the transfer factor from the ECORISK Database Version 2.2 (LANL 2005, 90032) is used. For both types of calculations, the concentration of the COPEC in the composite sample used for the earthworm toxicity test in a reach is used to estimate the concentration in earthworms from that reach. This estimated concentration in the worms is then compared with the concentration in food items expected to have no toxic effects (the food ESL) to derive an HQ for each reach reflecting risk from consumption of earthworms exposed to soil from that reach. Table 8.1-6 shows the basis of the calculations of the estimated concentrations in the worms, the food for each COPEC, the concentration in each soil composite sample by reach, and the HQ from worm ingestion. Two of the two organic COPECs (bis(2-ethylhexyl)phthalate, di-n-butyl phthalate) are not included in Table 8.1-6 because neither COPEC was detected in any of the soil composite samples used in the earthworm toxicity tests. An HQ >3 appears in all reaches, including the reference reach, for mercury based on assuming ~~all~~ **the detected concentration of** mercury is **entirely** in the methylated form. Only reach E-1E shows an HQ >3 for mercury ~~in the non methylated form~~**as inorganic mercury**. Risk from both types of mercury are included in the table to provide bounding estimates. Because mercury speciation was not measured, the actual ratio of methylated to non methylated mercury in soil and worms is not known. No COPECs, except mercury, produced an HQ >3 in the modeling of dose through earthworms.

### Field Surveys of Bird Abundance and Diversity

Field surveys of bird species were done in two areas: Mortandad Canyon from reaches M-1 through M-2, and adjacent parts of Effluent Canyon, and Ten Site Canyon from reaches TS-1 through TS-2, and adjacent areas in Pratt Canyon (Keller 2005, 93690). Species diversity was measured by calculating a Shannon-Weaver Index for each site. The index value was 2.7 for Mortandad and Effluent Canyons and 2.5 for Ten Site Canyon, indicating similar diversity of species between the two areas. The composition of species based on diet type was also similar between the two areas: most of the species in both areas were insectivores (including both ground-feeding insectivores and aerial insectivores). This finding supports using COPEC analysis in earthworms for assessing the risk to avian receptors in the Mortandad watershed.

The surveys yielded similar results for both areas even though there are some differences in bird COPECs between Mortandad and Effluent Canyons and Ten Site Canyon. As shown in Tables D-2.2-6 and D-2.2-8 (LANL 2005, 89308; pp. D-36 and D-38), the study design COPECs for the robin in that part of Mortandad Canyon are predominantly copper, lead, mercury, vanadium, and Aroclor-1254. In Ten Site Canyon, Aroclor-1254 and mercury are also study design COPECs, but other metals have HQs less than 3. Di-n-butyl phthalate was also a study design COPEC only in Ten Site Canyon. Study design COPECs for the violet-green swallow in Mortandad and Effluent Canyons included primarily aluminum and zinc. Other metals (cadmium, copper, mercury, and vanadium) were the dominant COPECs for the swallow in Ten Site Canyon. Both areas have a number of study design COPECs for birds, but the field surveys support that a good diversity of avian species are still found in these areas.

### ECORSK.9 Model for Western Bluebird

Based on the ECORSK.9 model (Gonzales et al. 2006,93786), the percentage of the western bluebird population in the Mortandad watershed that has potential for adverse effects predicted by elevated HIs is too low to affect population viability. The adjusted mean HI for the bluebird is 1.2. The dominant COPEC for this receptor based on the adjusted HI is mercury (mean HQ = 0.38). Other metals (cyanide, zinc, and vanadium) dominated the unadjusted HI, but the entire contribution of these three COPECs was attributable to background. HIs in 24% of the focal points were greater than 1.0.

### 8.1.3.4 Mammalian Invertevore Feeding Guild

### Field Surveys of Small Mammal Relative Abundance and Reproductive Status

A variety of field measures were collected during the trapping and collection of small mammals for this biota investigation (Bennett et al. 2006, 93701). The mean percent daily capture rate, which is an estimate of relative population density, was highest in reach E-1W at 22% and lowest in reach LA-BKG at 7%. The results are shown in Figure 8.1-15. The trend within the Mortandad watershed reaches of decreasing mean daily capture rates with distance downcanyon is probably related to habitat; the trend is consistent with the total percent vegetation canopy cover discussed in Section 8.1.3.6. Species diversity expressed as a Shannon-Weaver Index (see Figure 8.1-16) follows the same trend. **The total number of animals captured and the Shannon-Weaver Index for each reach are provided in Table 8.1-6-AWD. Shannon-Weaver Index values were calculated using the on-line diversity calculator at http://math.hws.edu/javamath/ryan/DiversityTest.html.** The HQ and HI values for deer mouse COPECs also decrease downcanyon; so increasing COPEC concentrations cannot be responsible for the drop in capture rates.

Species composition (the frequency of capture for each species at a site) was very similar between the three Mortandad watershed reaches; species composition in all the Mortandad reaches differed from the Los Alamos Canyon reference site. Data collected during the trapping study indicated no differences in ratios of males to females, body weights, or reproductive status between reaches, using chi square analysis (Bennett et al. 2006, 93701); however, the size of the sample set in this study is somewhat small for evaluation of effects on these parameters.

**Concentrations of COPECs in Small Mammals**

As described in Section 8.1.3.4, several species of small mammals were trapped and collected in each reach used in the study. All the individuals of most species from a reach were separated into pelt and carcass; the pelts and carcasses were combined so that one pelt and one carcass sample from each species was sent for analysis for each reach. The exception is for shrews, where whole bodies were sent for analysis because of the small size of these mammals. Distinct differences in tissue concentration versus sediment concentration were not seen between species. Regression analysis of concentrations of study design COPECs in carcasses of all species and concentrations in sediment are presented in Appendix E and show statistically significant correlations **($p<0.05$)** for only three of the detected COPECs: aluminum, iron, and perchlorate, although two of the correlations are negative. As shown in Figures 8.1-17 and 8.1-18, aluminum and iron concentrations in tissue are negatively correlated with sediment concentrations, indicating no significant uptake by small mammals from the soil. Figure 8.1-19 shows perchlorate in body tissue; perchlorate was positively correlated with sediment concentrations, indicating uptake by small mammals from the soil. At NMED's request (NMED 2005, 92084), selenium was retained as a COPEC in this evaluation. Selenium concentrations in small mammal tissue did not have a significant correlation with concentrations in soil, as shown in Figure 8.1-20. Figures presenting concentrations in carcass and concentrations in soil for all other detected analytes are in Appendix E.

Regression analysis of concentrations in pelts of all species and COPEC concentrations in sediment showed statistically significant correlations **($p<0.05$)** for only two of the detected analytes: americium-241 and arsenic. Concentrations of both these COPECs in pelts were positively correlated with sediment concentration. Figure 8.1-21 shows the concentration of americium-241 in pelt versus sediment. Figure 8.1-22 shows the concentration of arsenic in pelt versus sediment. Selenium concentrations in pelt versus sediment are shown in Figure 8.1-23, and indicate a positive correlation. In contrast, lead concentrations in pelts seem to be negatively correlated with sediment concentrations, although the regression was not statistically significant ($p = 0.07$ for regression). Because analyses of pelts include soil particles adhering to the pelt, these analyses are not as useful as concentrations in carcasses in indicating potential uptake, although they still provide information for possible transfer to higher levels of the food chain. Appendix E presents regression equations and figures showing concentrations in soil versus concentrations in pelts for other detected analytes. The other study design, COPECs detected in pelt and carcass samples were not correlated with sediment concentrations in the study reaches. Graphs of carcass and pelt concentration versus sediment concentration for all other detected COPECs are presented in Appendix E. For some COPECs, this result may indicate that concentrations in tissues are unrelated to environmental exposure. For COPECs that are known bioaccumulators, such as Aroclor-1260, these results indicate that the sediment in the study reaches is not a significant contributor to the total body burden of these small mammals.

Concentrations in the pelts and carcasses were multiplied by the proportional masses of the pelts and carcasses to reconstruct an estimate of the whole animal body tissue concentration. This information was used in Section 8.1.3.1.1 to refine the estimate of dose to the Mexican spotted owl. The same information is used here for comparison to the results of small mammal trapping studies conducted in other canyons; those studies all used concentrations determined from analysis of whole animals. Regression analysis of estimated concentrations in whole bodies of all species and concentrations in sediment show statistically significant correlations **($p<0.05$)** for only two of the detected analytes, with positive correlations for americium-241 and perchlorate. Regression equations and figures showing concentrations in soil versus concentrations in whole animals for other detected analytes are presented in Appendix E.

Concentrations of Aroclor-1260 in small mammals from the Mortandad watershed (except for the shrew, which was not included in previous studies) are similar to concentrations detected in small mammals trapped in the Los Alamos and Pueblo watershed. These two watersheds have similar concentrations of Aroclor-1260 in soil from the mammal trapping areas. This indicates a consistent relationship between this COPEC in soil and in small mammal tissue, indicating that this correlation may have some predictive value.

**ECORSK.9 Model for Deer Mouse**

The percentage of deer mouse population in the Mortandad watershed that has potential for adverse effects predicted by elevated HIs in the ECORSK.9 model is too low to affect population viability (Gonzales et al. 2006, 93786). Mean HI values exceeded 1.0 in only 8% of the focal points for the deer mouse. Based on the unadjusted HI (the adjusted HI showed no COPECs with an HQ >0.3), the dominant COPEC would be thallium. Nondetects constituted 72.5% of the thallium values used in the data set, and the mammalian TRV for thallium is very low. The model likely overpredicts the potential risk from thallium based on detection limits; thallium was detected in relatively few of the canyon bottom samples (37% detection frequency). In addition, thallium was only detected above the BV in five sediment samples in the Mortandad watershed, three in E-1E and 2 in M-2W. This indicates relatively small releases of thallium from the TA-50 RLWTF and low levels of thallium contamination in a small area, as discussed in Section 7.1.2.

**Refinement of COPEC Dose to the Shrew from Earthworms**

Some COPECs in the ecological screening in the biota investigation work plan had HQs exceeding three for deer mice and for shrews. All deer mouse COPECs were also shrew COPECs. Therefore, the shrew (which has a higher exposure because the diet is modeled as 100% earthworm versus 50% earthworm for the deer mouse) was evaluated through modeling of the dose through earthworms based on estimated concentrations in earthworms. Regression equations or concentrations based on transfer factors from the ECORISK Database Version 2.2 were used, as explained for the avian receptors in Section 8.1.3.3. The results of the calculations are shown in Table 8.1-7. Only thallium has an HQ >3 for the shrew; this would also be the case for the deer mouse. Thallium has a very low TRV for mammals and uses a default transfer factor of one to estimate the concentration in earthworms. Table 8.1-8 provides some additional information on the comparison of thallium HQs between reaches. Because these factors are so conservative, the thallium HQ shown in the table is likely to overestimate risk. As discussed above and in Section 7.1.2, there is also evidence of only very small releases of thallium into the canyon bottoms.

### 8.1.3.5 Detritivores

The earthworm toxicity tests measured growth and survival of earthworms at seven locations in the Mortandad watershed in comparison with the background location in reach LA-BKG (EP&T 2005, 91267). The results for this test, including all replicates, are summarized with box plots for survival and growth (as weight change) in Figures 8.1-24 and 8.1-25. Negative and positive control samples from the laboratory are also shown (LAEW-Neg and LAEW-Pos). The boxes on these plots indicate the interquartile range of the sample results, with the upper and lower ends defined by the 75th and 25th percentiles, respectively.

Horizontal lines within the boxes indicate median values, and lines above and below the boxes represent the 5th and 95th percentiles of the data. Dunnett's t-Test results are presented in the right-hand section of each figure. The comparison circles indicate statistical differences between the tests and the reference site (LA-BKG). The background sample for the Dunnett's t-Test is displayed as a heavy red circle, and the text for the reference site is printed in bold red text on the x-axis. Thin red circles represent samples that are not statistically different ($p < 0.05$), and the reach names for these reaches are in red on the axis. Heavy gray circles represent samples that are statistically different, and these reach names are printed in black on the x-axis. No significant differences in survival were seen between any of the sites and the reference site; survival was almost 100% in all replicates, except the Laboratory positive controls (LAEW-Pos samples). In all treatments, including the negative Laboratory control (LAEW-Neg sample), worms showed weight loss, which is typical of earthworms in this assay (EP&T 2005, 91267). Only one reach, M-2W, showed a significant decrease in weight compared with the reference site in LA-BKG. The composite sediment samples from each reach were also analyzed for COPECs; the concentrations of all earthworm study design COPECs in M-2W were lower than the concentrations of these COPECs in some other reaches that did not have as high a weight loss (Table 8.1-9). The higher weight loss of worms in the sample from this reach is therefore unlikely to be related to the presence of earthworm COPECs in the soil.

Organic matter in soil can serve as a food source for earthworms during this type of test. The organic matter was measured in each of these samples, but the organic matter in the sample did not correlate with the percent survival or weight change in the test groups (see figures in Appendix E).

#### 8.1.3.6 Plant (Primary Producers)

**Seedling Germination and Growth**

A number of measures of plant growth and survival are included in the Laboratory toxicity test on samples collected from the Mortandad watershed; these measures include mass of dry shoots, mass of dry roots, mass of wet shoots, mass of wet roots, percent survival, mean root length, and mean shoot length. The complete results are provided in EP&T (2005, 91268). The results are plotted on box plots with the results of the Dunnett's t-Test comparison printed on the right-hand side of the figure; this type of figure is explained in Section 8.1.3.5. As shown in Figure 8.1-26, the dry mass of roots, dry mass of shoots, and mean root length showed no significant differences between reaches, although the test sites did differ from the negative and positive (boric acid) laboratory control samples. In the analysis of wet root length shown in Figure 8.1-27, the plants grown in soil from reach TS-2C had significantly higher mass of wet roots and wet shoots than the other reaches, which were not significantly different from each other. The dry weight of roots and shoots in TS-2C did not differ from the other reaches.

The soil samples used in the plant toxicity test were also analyzed for study design COPECs. The results of those analyses show that reach TS-2C had lower concentrations of chromium, copper, manganese, thallium, vanadium, and zinc than some of the other reaches, although that soil sample had the maximum detected concentration of silver (Table 8.1-9).

Plant survival by reach is shown in Figure 8.1-28. The Dunnett's test results indicate the reaches can be divided into two groups. Reaches E-1W, E-1E, and M-2W represent a group with the highest survival rate. Reaches E-1FW, M-4, TS-1C, TS-2C, and the reference site (LA-BKG) form a second group with slightly lower survival. Although survival in the two groups differ statistically, it is important to note that survival in all replicates from all reaches (except a single replicate from M-4) exceeded 87%, and the background sample was also in the lower survival group. Differences in survival are therefore unlikely to have population level effects and are not related to the presence of COPECs.

Mean shoot length is shown in Figure 8.1-29. The Dunnett's test for this measure also divided the reaches into two groups; these groups did not contain the same reaches as seen in the results for survival discussed above. For the measure of shoot length, reaches E-1E and TS-2C are statistically the same as the reference site (LA-BKG). Reaches E-1FW, E-1W, M-2W, M-4, and TS-1C form a second group with a slightly decreased mean shoot length.

Nutrients in soil can strongly influence growth in soils during this test. Therefore, nutrient parameters such as phosphate, nitrate, and percent organic matter were measured on the soils used in the plant toxicity test. The laboratory negative control sample, for example, contains 10% organic matter, which is the primary reason the control growth always exceeds the growth in the soils from the Laboratory, which are much lower in organic matter. Each growth measure is compared with phosphate, nitrate, and percent organic matter in the bivariate plots in Appendix E. Based on the bivariate plots, percent organic matter may influence plant growth measures in the test regardless of the presence of COPECs in the soil sample.

**Abundance and Diversity of Plants**

Data from a field survey of plant abundance and diversity in the Mortandad watershed (Balice and Sandoval 2006, 93689) provide supplemental information on plant communities between reaches and possible effects of COPECs on plants. Table 8.1-10 provides the total species richness, the Shannon diversity index for all species, and the total percent canopy cover for all species. These same reaches were surveyed in 2003 for species richness, and the average species richness of 36 from 2005 is much higher than the 2003 species richness of 25. This increase in species richness occurred for all vegetation categories except cacti and is associated with the lessening of drought conditions between surveys. The increase in plant species richness with higher precipitation from one survey year to the next supports the results of the toxicity assay, indicating that COPECs in the canyon soils are not inhibiting the germination or growth of plants in these areas. Part of the variability in species between reaches is caused by variations in climate, including the general increase in annual precipitation from east to west across the study area. Differences in local topography and hydrology, such as canyon width and depth and presence or absence of wetlands, also affect plant communities. Total species richness, Shannon diversity index, and total percent canopy cover for each reach are plotted versus distance from the Rio Grande as a measure of relative precipitation in Figure 8.1-30. The Shannon diversity index has a significant positive correlation with distance from the Rio Grande (primarily caused by diversity at reach LA-BKG representing an outlier value), suggesting that climate is a primary control on this measure. In contrast, total species richness and total percent canopy cover have much variability with distance, which suggests other factors are important. Total species richness is least in reaches M-2W, E-1W, and E-1E, and total percent canopy cover is also least in E-1E at intermediate distances from the Rio Grande. E-1E and M-2W are the narrowest reaches included in this study, bounded by Bandelier Tuff bedrock, and E-1W is the reach with the largest wetland in this study, suggesting that these factors have negatively affected species richness and canopy cover. The presence of COPECs in canyon soils may also potentially affect these parameters, although the results of the toxicity assay indicate that COPECs in the canyon soils are not inhibiting the germination or growth of plants in these areas.

#### 8.1.3.7 Aquatic Community

**Screening against ESLs and BCGs for 2005 Sediment and Water Data**

**As summarized in Section 8.1.1.1, iron and bis(2-ethylhexyl)phthalate are identified as new COPECs for sediment based on the screening of data obtained in 2005. The minimum ESL for iron is based on exposure to aquatic community organisms (LANL 2005, 90032). The minimum ESL for**

**bis(2-ethylhexyl)phthalate is based on the avian receptor (the violet green swallow). At least one of the reaches with these new COPECs was included in studies of the aquatic community (*C. tentans* test) and the avian insectivore (swallow), respectively. For surface water, two new COPECs (cobalt and iron) were identified as a result of the screening of the 2005 data. Cobalt above the minimum ESL was detected only a few times in one reach, and is unlikely to contribute significantly to potential ecological risk in surface waters in the Mortandad watershed because of its limited spatial distribution. Some of the reaches in which iron was detected were included in the studies of aquatic community (E-1W and M-1W). Because the new COPECs (except cobalt) were detected in reaches already designated for field studies, no additional study reaches are necessary.**

***Chironomus Tentans* Toxicity Bioassay**

The *Chironomus tentans* toxicity test measures survival and growth of larval insects in active channel sediment collected from the eight reaches specified in Table 8.1-1. A complete description of the test conditions and results is contained in Pacific Ecorisk (2005, 91271). Figure 8.1-31 shows box plots of the number of live larvae remaining per replicate per reach at the conclusion of the test. This box plot shows no significant differences in larval survival between the selected reaches or between the reaches with COPECs and the reference site in reach LA-BKG. Figure 8.1-32 shows the mean dry weight of surviving larvae in each replicate test for each reach. This box plot also shows no significant difference between reaches for this measure of larval growth. Box plots of two other measures of larval growth, total ash-free dry larvae weight and mean ash-free dry larvae weight, are presented in Appendix E. Neither of those growth measures showed any difference between reaches. These results indicate that sediment COPECs do not have an effect on the growth or survival of *C. tentans*.

**Rapid Bioassessment Characterization**

Data on collected macroinvertebrates, habitat scores, and dissolved oxygen levels in reaches E-1W, M-1W, and M-2W indicate that these sites are marginal for sustaining a diverse community of aquatic life (Henne and Buckley 2006, 93687). However, the assessment protocols used are based on perennial streams and may be biased toward rating ephemeral streams as degraded. Hess sampling could not be used because of low flow conditions, so quantitative estimates are not available for comparison to the NMED metric. **Reach E-1W contained an abundance of algae and also exhibited a high proportion of fine sediment and a lack of habitat complexity. Habitat in reach M-1W consisted primarily of pools with fine sediment on the bottom. The habitat in reach M-2W consisted primarily of a single large pool with a fine sediment bottom. All of these sites exhibited low water flow during both assessments (June and September 2005). Reaches TS-1C and TS-2C had no flow during either assessment period, and so provided poor habitat for aquatic species.**

Macroinvertebrates were collected from each reach by D-frame dip net. During both sampling events (June and September 2005), 25% of the taxa in reach E-1W were chironomids. In June, chironomids constituted 85% of the identified individuals from this site as well. Chironomids represented 25% of the taxa and 92% of the individuals in M-1W in June, and 16% of taxa and 71% of individuals in September. The site in reach M-2W also contained predominantly chironomids; chironomids were 33% of the taxa and 69% of individuals in June, and the site was dry in September. **Table 8.1-10-AWD provides the habitat assessment scores by parameter for each reach and sampling date. Data on physical and chemical surface water parameters are provided in Table 8.1-10-AWD2 and macroinvertebrate sample abundance and number of taxa are provided in Table 8.1-10-AWD3.** The predominance of chironomids at the sites also supports the use of the *Chironomus tentans* Laboratory toxicity test as the appropriate assay to determine if sediment COPECs are adversely impacting the macroinvertebrate communities in these ephemeral stream systems.

**Algal Toxicity Test**

Water was collected from areas of intermittent or persistent water in reaches E-1W, E-1E, M-1W, M-2W, and LA-BKG in July 2005 for tests of algal toxicity, and from reaches TS-1C, TS-1E, and TS-2C in August 2005 after summer rainstorms provided enough water in these drier reaches. These two sampling events resulted in two separate tests for toxicity of water to algae. For these short-term tests, the endpoint is growth expressed as number of cells versus the control. The results of the toxicity tests are reported in Pacific Ecorisk (2005, 91270). Different rates of growth were seen in the controls between the two tests, so the results for the two tests are shown separately. Figure 8.1-33 shows a box plot comparing the samples from each reach (this type of plot is explained in Section 8.1.3.5) with the July samples, which include the reference site (LA-BKG). Laboratory controls are labeled ”control” and “0.5 ZN” (0.5 ppm zinc as a positive control) through “20 ZN” (20 ppm zinc as a positive control). Figure 8.1-34 shows a box plot for the laboratory controls and samples from Ten Site Canyon collected in August. The box plots show that for both sets of tests, growth in all reaches except TS-1C exceeded both the negative (Laboratory control water) and positive laboratory controls (the range of zinc growth-inhibiting concentrations) for the test.

Table 8.1-11 shows the concentrations of detected radionuclides in algal test samples that are study design COPECs and the value for the algal HQ based on these concentrations. Radium-226 was detected in the M-1W sample, and americium-241 was detected in the E-1E, M-2W, and TS-1C samples. A comparison between Figures 8.1-33 and 8.1-34 and Table 8.1-11 shows that the differences in growth do not correspond to the detected concentrations of radium-226 and americium-241. The only reach sample in which algal growth was inhibited was in TS-1C; this sample contained the lowest detected concentration of americium-241, and radium-226 was not detected in that sample. The growth rates for all reaches were compared with general water quality parameters, which can strongly influence the results of this type of test. For both tests, the mean algal cell density correlates extremely well with water hardness, as shown in the bivariate plots in Figure 8.1-35. These results indicate that differences in the growth rates of algal cells between reaches (including reach TS-1C) result from the differences in water hardness between samples from the reaches and not from the concentrations of radionuclides in the water samples. Bivariate plots of algal cell density against conductivity and alkalinity are presented in Appendix E. None of these parameters correlated with cell growth as well as the water hardness.

The detected concentration of radium-226 in the M-1W sample has an HQ >3 (equivalent to a study design COPEC), but this sample did not show adverse impacts to the growth of green algae when compared with positive controls in the test. The detected concentrations of americium-241 are below the ESL, and the test results do not indicate adverse impacts to populations of green algae.

~~**Estimate of COPEC Dose through Food to the Bat**~~

~~Although several COPECs in the Mortandad watershed had HQs >3 for the bat (aluminum, arsenic, and naphthalene), the bat was not identified as an appropriate measure for an assessment endpoint in the biota investigation work plan because its large home range and high food ingestion rate indicate that much of a bat’s food would be obtained from outside the watershed. However, because nest box insect tissues were analyzed to evaluate avian receptors, these same analytical results were used to refine the potential COPEC dose through food to the occult little brown myotis bat, as shown in Table 8.1-12. Because of the size of the insect samples, only metals analyses could be run on the insects. Therefore, naphthalene was not included in these calculations. Aluminum was included in the analytical suite for the~~

~~nest box insects, but the ESL for aluminum has been updated to follow EPA guidance that aluminum is only a potential COPEC in soils with a pH below 5.5 (EPA 2003, 85645); therefore, aluminum no longer fits the ESL model for accumulation through the food chain and is also not included in Table 8.1-12. The HQ for arsenic for bioaccumulation through insects into the bat is 0.6, indicating no potential risk to the bat through ingestion of insects even if all insects come from the canyon bottom areas within the Mortandad watershed.~~

#### 8.1.3.8 Refinement of COPEC Dose to the Fox through Ingestion of Small Mammals

The red fox was not evaluated as the measure for a specific endpoint in this study, but Aroclor-1254, Aroclor-1260, and cesium-137 had HQs greater than 3 for the red fox in the ecological risk screening (LANL 2005, 89308, p. D-35). For the two PCBs, maximum detected concentrations in whole small mammals were used to refine the dose estimate. These calculations and the resulting HQs are shown in Table 8.1-13. Aroclor-1254 and cesium-137 were not detected in small mammal tissues, so this COPEC is not evaluated further. For Aroclor-1260, the maximum whole body concentration was detected in a montane shrew. The calculated HQ for Aroclor-1260 is 0.003, indicating no potential risk to the red fox from PCBs through ingestion of small mammals

### 8.1.4 Risk Characterization

ERAGS Step 7 is risk characterization, which includes risk estimation and the uncertainty analysis. Risk estimation includes a summary of the results for the measures used to evaluate potential for ecological effects. A qualitative weight of evidence (WOE) criterion was assigned to each measure in Appendix D of the biota investigation work plan (LANL 2005, 89308). If measures indicate different outcomes, meaning one measure indicates a potential for adverse effects and one does not, then the overall conclusion would be weighted toward the measure with the higher WOE.

#### 8.1.4.1 Risk Estimation

**Mexican Spotted Owl**

The two main measures for the Mexican spotted owl are the ECORSK.9 modeling and the modeling of estimated dose through the food chain from the study design COPECs detected in small mammals. The WOE assigned to each measure is shown in Table 8.1-14. In the ECORSK.9 model, the total adjusted mean HI (using zero for nondetects) across the core and buffer areas for the owl was 1.6. This value exceeds the HI target of 1.0, indicating a small potential for effects to individual owls, primarily from bis(2-ethylhexyl)phthalate (Section 8.1.3.1 and Gonzales et al. 2006, 93786). This SVOC has a high frequency of nondetects in sediment samples from the Mortandad watershed (99.5% nondetects; Section 7.1.3.3), and the potential risk is largely from analyses of samples collected outside the canyon bottoms. One Mexican spotted owl nest currently exists in the Mortandad watershed, and the adjusted HI for this nest location is 0.2, which does not indicate potential risk to the Mexican spotted owl. The other measure estimated the dose to the Mexican spotted owl based on detected concentrations in mammal tissue (Section 8.1.3.1). The dose modeling was conducted for the nonradionuclide COPECs for the owl (Aroclor-1254, mercury, and selenium) as determined by the screening against ESLs in the biota investigation work plan. The dose modeling shows no HQs greater than 0.5, indicating no potential risk to the owl. Small mammals were not analyzed for SVOCs. Bis(2-ethylhexyl)phthalate was not a study design COPEC in the original screening because it had a higher ESL in the version of the ECORISK Database (Version 2.1, LANL 2004, 87386), which was current at that time. The owl pellet analysis showed that the small mammal species used in the dose modeling are among the species consumed by the Mexican spotted owl in the Mortandad watershed. Based on the dose modeling and on the ECORSK.9 model results for the portion of the canyon in which Mexican spotted owls currently nest, the WOE indicates no adverse effects of COPECs on survival and reproduction of the Mexican spotted owl (AE1).

**~~Southwestern WillowFlycatcher~~Aerial Insectivore Feeding Guild**

The aerial insectivores applicable measures for the southwestern willow flycatcher are the ECORSK.9 model, the results of estimated dose through prey using the concentrations of COPECs detected in nest box insects and the field nest box measures. The WOE assigned to each measure is presented in Table 8.1-15. The ECORSK.9 model had a total mean adjusted HI of 6.2, indicating some potential for risk to the flycatcher through exposure to mercury, di-n-butyl phthalate, boron, and bis (2ethylhexyl) phthalate (Section 8.1.3.2 and Gonzales et al. 2006, 93786). The food chain modeling showed HQ values >1 for six metals when the maximum detected concentration in insects was used for the calculation. When the mean detected concentration in the insects is used in the calculations, the HQs are still elevated for mercury (if all the mercury is considered to be in the methylated form), copper, vanadium, and zinc. These calculations indicate potential for risk to flycatchers from ingestion of the nest box insects. The WOE from these measures indicates some potential for adverse effects to survival and reproduction of the southwestern willow flycatcher (AE6) from COPECs in sediment. However, the field measures (nest box studies) of other avian insectivores do not show impacts to nest success, which indicates that the models used for assessing the flycatcher overestimate the potential for ecological risk to avian insectivores. In addition, the southwestern willow flycatcher has not been observed in this part of the Laboratory, so the risk to this species is hypothetical at this time.

**The aerial insectivore applicable measure for the occult little brown myotis bat is the estimated dose through prey using the concentrations of COPECs. No calculation was made for naphthalene (which was not measured in the nest box insects) or for aluminum (because the TRV is based on soil pH). (See Section 8.1.3.2.) Arsenic has an HQ <1.0, indicating no potential risk to the bat through ingestion of insects, even if all insects come from the canyon bottom areas within the Mortandad watershed.**

**Avian Ground Invertevore Feeding Guild**

A number of measures were evaluated for the avian ground invertevore feeding guild. The WOE assigned to each measure is provided in Table 8.1-16. ECORSK.9 modeling using the western bluebird indicated a total mean adjusted HI of 1.2, too low to have effects on populations of avian invertevores (Section 8.1.3.3 and Gonzales et al. 2006,93786). Modeling the estimated dose of COPECs to the robin through earthworms was also done, although this analysis had to employ estimated concentrations of COPECs in the earthworms instead of measured concentrations as initially planned. The dose modeling indicates a potential for risk to avian ground invertevores through ingestion of COPECs in earthworms. The primary COPECs are mercury, bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, and Aroclor-1254. A number of field measures of impacts on avian invertevore species were also conducted. The measures of nest success through percent fledged, percent female nestlings, and egg size and thickness show no differences between reaches with and without COPECs. Concentrations of COPECs in eggs do not correlate with sediment concentrations, indicating that uptake into the birds is less than the levels predicted by models, including the dose modeling from earthworms. Field surveys of avian species in Effluent, Mortandad, and Ten Site Canyons did not show any differences in species diversity or avian diet types represented between the canyons, even though di-n-butyl phthalate was a study design COPEC in Ten Site Canyon and not in Effluent and Mortandad Canyons. Overall, the WOE indicates that COPECs in the Mortandad watershed do not pose a risk to population abundance or persistence and species diversity of avian ground invertevore feeding guild species (AE2).

### Mammalian Invertevore and Omnivore Feeding Guild

The mammalian invertevore and omnivore feeding guild includes both the deer mouse (an omnivore) and the shrew (an insectivore). Four lines of evidence were evaluated for these species, and the WOE for these lines is presented in Table 8.1-17. The unadjusted HI had only thallium as a COPEC; this results because thallium has a low TRV and the data set consisted mostly of nondetects that elevated the HQs. ECORSK.9 modeling for the deer mouse showed no COPECs with the adjustment to remove the contribution of thallium (Section 8.1.3.4 and Gonzales et al. 2006, 93786). The tissue and pelt concentrations of COPECs were measured in small mammals as well. This line of evidence was primarily for dose modeling to receptors that eat small mammals, but the results are also relevant to the small mammals themselves. Very few of the COPECs detected in the small mammals correlated with the concentrations in sediment: three COPECs correlated with body tissue, two with pelt, and two with whole animals. These results indicate that the ESL model overestimates the uptake of COPECs into small mammals. Thallium was one of the COPECs that did not correlate with soil concentrations in any of the tissues tested.

The third measure for the small mammals was to estimate the potential dose to them through ingestion of earthworms. As with the avian receptors, estimated COPEC concentrations in earthworms had to be substituted for the planned analytical results. Both the shrew and deer mouse are modeled for the ESL development with invertebrates in their diet, but as explained in Section 8.1.3, the dose modeling was conducted using the shrew. Only thallium had an HQ >3 for the small mammals; this results because thallium has a low TRV and a default transfer factor of 1. Thallium in earthworms did not correlate with soil concentrations of thallium in the study in the Los Alamos and Pueblo watershed; therefore, the thallium result from the modeling is likely to greatly exceed the actual risk and not be a strong line of evidence for small mammals. Overall, the WOE for small animals indicates that COPECs in soil do not have adverse effects on population abundance or persistence and diversity of mammalian invertevore and omnivore feeding guild species (AE3).

### Mammalian Carnivore Feeding Guild

Although the fox did not represent a specific assessment endpoint because carnivores were evaluated through AE1, the ecological screening presented in the biota investigation work plan indicated that PCBs may impact this receptor. The mammal tissue concentrations of PCBs were used to calculate a refined estimate of dose through the food chain (Section 8.1.3.8). Only Aroclor-1260 was detected in small mammal tissue and the HQ for Aroclor-1260 was less then 0.01, indicating that there is no risk to this receptor through ingestion of small mammals in the Mortandad watershed.

### Detritivores

A laboratory toxicity test measured both survival and weight change in earthworms from samples in reaches with and without soil COPECs (Section 8.1.3.5). The WOE for this measure and measures of detritivores relevant to other receptors is given in Table 8.1-18. There was no difference in survival between any of the reaches. There were differences in weight loss between the reaches, but the differences in weight loss did not correlate with COPEC concentration. The WOE for detritivores indicates that COPECs in soil in the Mortandad watershed do not adversely impact survival and growth of detritivore species (AE4).

**Plants (Primary Producers)**

Lines of evidence and their WOE for plants are provided in Table 8.1-19. The main line of evidence is the seedling germination test with supporting information from the field survey of plants in reaches with different concentrations of COPECs. Survival and most measures of growth in roots and shoots showed no difference between reaches (Section 8.1.3.6). Two measures (wet root length and mean shoot length) differed between reaches but did not correlate with COPEC concentration. The field survey of plants showed no differences between reaches that could be directly related to variations in COPEC concentrations, and all reaches that had been previously surveyed had more species diversity than previously, supporting the finding that germination and growth are not inhibited. The overall WOE indicates no adverse effects of COPECs in soil on native plant species presence and diversity (AE5).

**Aquatic Community**

The measures used as lines of evidence for evaluating impacts to the aquatic community in the Mortandad watershed, and the WOE assigned to each measure are provided in Table 8.1-20. The Laboratory toxicity test using *C. tentans* showed no difference in survival and no difference in growth correlated with COPEC concentration. The field bioassessment characterization indicated that chironomids dominate the aquatic community in sampled reaches and that the toxicity test using chironomids is therefore an appropriate measure of impacts to the aquatic community. The Laboratory algal toxicity test showed differences in cell growth with reaches, but these differences were attributable to water hardness and not to COPECs in water. The WOE for measures of the aquatic community indicates there are no adverse effects from COPECs in sediment and water on abundance and survival of the aquatic community in the reaches of the Mortandad watershed (AE7).

### 8.1.4.2 Uncertainty Analysis

**Exposure Uncertainty**

Uncertainties in the ecological risk assessment are potentially associated with the characterization for sediment and surface water. Maximum detected concentrations were used for some comparisons, which would overestimate the exposure concentration in a reach. For comparisons to bird boxes, arithmetic mean concentrations in soil in each reach were used for comparison; because sampling is biased toward locations where contaminant concentrations are highest, use of straight means generally provide overestimates of actual exposure concentrations, as discussed in Section B-1.0 of Appendix B. Media concentrations for evaluating the results of Laboratory toxicity tests came from the actual water and sediment samples used in those tests and provide a good estimate of the exposure concentration for the assay organisms. These concentrations would overestimate exposure concentrations throughout the sampled reaches because sampling was biased to specific locations with higher concentrations of COPECs in these reaches. For the small mammal trapping, composite soil samples for comparison were obtained from the traps within the array. This provides a good representation of the concentration in the trapping array, but because the arrays were centered in areas with contaminated sediment deposits, the data are expected to overestimate exposure concentrations for mammals that largely forage outside these areas.

Another uncertainty is the adequacy of the toxicity and bioaccumulation data used to develop the assessment endpoints and select the associated measures and develop the study design. In fact, a number of toxicity values and transfer factors in the ECORISK database and the associated food chain and ECORSK.9 modeling were changed between the design of the studies and their evaluation in this investigation report. These changes brought new COPECs into consideration. Gaps also exist for toxicity for some classes of COPECs on some receptors that hamper evaluating those COPEC-receptor combinations except in the field studies. The study design included field, Laboratory, and model components to provide complementary information and reduce uncertainties related to toxicity and bioaccumulation data.

**Field Measures**

Empirical ecological effects data are the most relevant data for determining if there are adverse effects on ecological receptors, especially at the population level. However, these data are inherently more variable and difficult to quantify than laboratory measures. Uncertainty associated with a limited number of locations and a limited number of sampling events is mitigated by collecting information across a variety of measures of exposure and effect. Factors unrelated to COPECs, such as drought and other climatic variations, fire, and annual variation in species, can have confounding effects on analysis of field measures.

Field measures can also provide some information on adverse effects that cannot be obtained with other methods. This includes an estimate of impacts from COPECs for which there are not toxicity values. Field measures also provide valuable information on the usefulness of models and transfer factors in predicting ecological effects.

**Laboratory Measures**

Laboratory toxicity tests provide more standardized results than field data because they are conducted under controlled conditions, but they are still subject to uncertainties associated with sample collection and representativeness. Confounding factors are also possible, as was demonstrated in this investigation by the effect of water hardness on the results of the algal toxicity test (Section 8.1.3.7). Other confounding factors may include variability in the test species selected; for example, the yarrow used in the plant toxicity test for these studies is more variable in growth than standard assay plants, but it is also more relevant to the ecosystems under consideration. Mortandad watershed soils are generally nutrient-poor, which can influence growth in plant, earthworm, algae, and chironomid tests. Sample sites were also selected to represent a gradient of COPEC concentrations to improve the representativeness of the toxicity tests to potential COPEC impacts.

**Model Measures**

ECORSK.9 represents a modified exposure model with many of the limitations of the simple exposure models used of screening-level ecological risk assessments. ECORSK.9 blends more realistic information on spatial use of the watershed with simple models of contaminant bioaccumulation and toxicity (Gonzales et al. 2006, 93786). In ECORSK.9, conservatism is still present for key parameters like TRVs and bioaccumulation factors. For example, the TRVs are based on NOAELs or the geometric mean of NOAEL values, and risks are assessed assuming additivity of response or summing of exposure across COPECs. ECORSK.9 is also based on conservative estimates of COPEC concentrations in soil; it assumes that the average of the sample data for a model grid cell is representative of the true concentration, although sampling is typically biased toward areas with higher concentrations of contaminants (Section B-1.0 of Appendix B). For this study, nondetected concentrations of organic chemicals were handled as either one-half their detection limits or as zero. The different results demonstrate that assumptions regarding nondetects can obscure sources of problem contaminants and overestimate risks. The simple dose modeling from concentrations in food done for this investigation is subject to many of the same uncertainties arising from toxicity values, transfer factors, and assumptions about concentrations and nondetects as the ECORSK.9 modeling.

### 8.1.5 Summary

Many COPECs were identified as study design COPECs in the ecological screening of soil, sediment, and surface water in the Mortandad watershed. The WOE demonstrated by the various lines of evidence for the seven assessment endpoints indicates there are no adverse effects of COPECs on terrestrial and aquatic receptors in the Mortandad watershed. The overall WOE from field studies, analysis of COPEC concentrations in tissues, and Laboratory toxicity tests supports this conclusion. Some of the results from modeling (both ECORSK.9 modeling and the dose through food ingestion modeling) indicate a potential for some ecological risk. However, these two models incorporate many of the same conservative factors (TRVs and transfer factors) inherent to the original screening using ESLs, which are designed to overestimate potential effects to provide a conservative screen. Therefore these models are not as strong a line of evidence as the other studies mentioned. Thus, no COPECs are retained for any further assessment or mitigation as a result of this baseline ecological risk assessment.

## 8.2 Human Health Risk Assessment

This human health risk assessment evaluates the potential for adverse effect on human health in the Mortandad watershed for COPCs identified in Section 6 of this report. The risk assessment approach used in this report follows guidance from EPA (1989, 08021), LANL (2004, 87800), NMED (2006, 92513), and EPA (2005, 91002) and is organized in seven major subsections. The approach utilizes media- and scenario-specific media-based screening levels to evaluate the potential for human health risks from sediment and surface water in the Mortandad watershed. Section 8.2.1 provides the basis for selecting exposure scenarios for the human health risk assessment. In Section 8.2.2, the data collection and evaluation processes described in previous sections of the report are summarized, focusing on aspects of data analysis that are pertinent to the risk assessment. Section 8.2.2 also lays out the logic for selecting COPCs for the human health risk assessment. The exposure assessment (Section 8.2.3) provides information used in quantifying human exposure to COPCs in sediments and water. The toxicity assessment (Section 8.2.4) provides information on potential human health effects from chemicals and radionuclides evaluated in the risk assessment. Section 8.2.4 provides the sources for the media- and scenario-specific screening levels. Risk characterization (Section 8.2.5) is based on the SOF method for evaluating the potential for additive effects with COPCs that are classified as noncarcinogens, carcinogens, or radionuclides. Uncertainty related to the various assumptions and inputs used in the risk assessment is evaluated in Section 8.2.6 to support interpretation of the risk characterization. A summary of the risk assessment is provided in Section 8.2.7.

### 8.2.1 Problem Formulation

The purpose of this risk assessment is to evaluate potential human health risks related to the COPCs identified in sediments and surface water in the Mortandad watershed. This information can be used to inform a risk management decision. This risk assessment uses information pertaining to current and reasonably foreseeable future land use to assess potential impacts under reasonable maximum exposure (RME) conditions. The canyon bottoms in the Mortandad watershed include a mixture of Laboratory property and San Ildefonso Pueblo lands, potentially supporting a variety of land use alternatives.

The assessment in this report primarily employs the trail user exposure scenario to represent the current and reasonably foreseeable future exposure activities for contaminated sediments and surface waters in the watershed. The trail user scenario describes an adult individual who contacts contaminated sediments and surface water while hiking or jogging in the canyons. This use is considered to be inclusive of realistic present-day potential exposure activities in canyon bottoms in areas of the watershed where contaminants are at levels requiring a human health risk assessment.

One supplemental exposure scenario, residential, is evaluated in the human health risk assessment for comparison purposes ~~only~~**per Section XI.E of the Consent Order**. ~~A description of this supplemental exposure scenario is provided in Section 8.2.3.3.~~ Unlike the trail user scenario, residential use is not currently applicable across the watershed. A residential scenario does not represent current or reasonably foreseeable future land uses in the canyon bottoms, and residential development in particular is not a feasible land use within the parts of the canyons subject to flooding.

Assessment results for the trail user scenario are provided in Section 8.2.5. The results of risk calculations for the residential scenario are provided in Section E-3 of Appendix E.

### 8.2.2 Data Collection and Evaluation

The approach to sampling design, data collection, and characterization is described in Sections 3 and 4 and Appendix B. Sample locations, sample results, and data quality for data employed in the human health risk assessment are presented in Appendix C. **Sediment data were evaluated in each reach, as described in Section 6; the association of each sample with a specific reach is provided in Appendix C.** ~~Section 6 describes how sediment data were separated into reaches and status and how sediment data within reaches were combined for the comparison of contaminant data maxima with BVs.~~ Water data were evaluated at each surface water sampling location, as described in Section 6.

**Identifying COPCs for the Human Health Risk Assessment**

COPCs for the human health risk assessment are identified based on screening level risk calculations using a residential exposure scenario. This process is initially inclusive of all COPCs and evaluates the potential for human health risks under a protective residential scenario. This process includes calculating a ratio, which is the maximum concentration of an analyte in a specific media in a reach or at a water sampling station divided by the media-specific risk-based screening level. This is analogous to the HQ as used in Section 8.1 for assessing potential ecological risk. An SOF is also calculated for a risk type; i.e., carcinogens ($SOF_{ca}$), noncarcinogens ($SOF_{nc}$), and radionuclides ($SOF_{rad}$). These are analogous to HIs calculated in Section 8.1. Ratios for all COPCs within a reach or water location are summed to calculate the SOF for the risk class of those analytes (carcinogen, noncarcinogen, or radionuclide). For all reaches or water locations with an SOF >1.0 for a risk class, all COPCs within that risk class with ratios greater than 0.1 are retained as COPCs for the site-specific risk assessment. COPCs with a ratio ≤0.1 based on maximum sample results are excluded because they are unlikely to significantly contribute to risk.

*Sediment COPCs*: The human health screening levels for nonradionuclides in sediment used in this screening assessment are the NMED residential SSLs from Revision 4 of NMED guidance (NMED 2006, 92513). For analytes for which NMED does not provide a value, the residential screening value from EPA Region 6 (EPA 2005, 91002) or EPA Region 9 (epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf) was used as the SSL (carcinogens are adjusted to a $10^{-5}$ risk level to be consistent with the NMED target risk level). NMED-approved surrogate compounds were used for some COPCs that lack NMED or EPA screening levels (NMED 2003, 81172). SALs related to residential land use for radionuclides are based on the soil guidelines for unrestricted release of property (DOE Order 5400.5, “Radiation Protection of the Public and the Environment”); these values are derived using RESRAD version 6.21 as described in “Derivation and Use of Radionuclide Screening Action Levels Revision 1” (LANL 2005, 88493).

Tables 8.2-1 to 8.2-3 contain the set of human health residential SSLs and SALs used to calculate ratios; these tables also provides the SOFs for each reach for each risk class for all sediment COPCs. COPCs and reaches shaded gray are those retained for the risk assessment. Table 8.2-1 provides the results for noncarcinogens, Table 8.2-2 provides the results for carcinogens, and Table 8.2-3 provides the results for radionuclides.

*Surface Water COPCs*: Screening levels for surface water for organic and inorganic chemicals are the EPA Region 6 risk-based screening levels for tap water (EPA 2005, 91002). The EPA Region 6 values were supplemented by screening values from EPA Region 9 , available at (epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf). Radionuclide screening levels are based on a dose of 4 mrem/yr and are from the DOE DCG (DOE Order 5400.5, "Radiation Protection of the Public and the Environment").

Tables 8.2-4 to 8.2-6 contain the set of human health water screening levels used to calculate ratios; these tables also provide the SOFs for each type of field preparation (filtered or unfiltered) for each water location, and each risk class for all surface water COPCs. COPCs and water locations shaded gray are those retained for the further assessment. Table 8.2-4 provides the results for noncarcinogens; Table 8.2-5 provides the results for carcinogens; Table 8.2-6 provides the results for radionuclides. Surface water data have been obtained from the surveillance station "Mortandad at Rio Grande" (monitoring station A-11), and there is no associated reach for this location. The primary source of surface water at station A-11 is effluent from the Los Alamos County wastewater treatment plant in White Rock. The $SOF_{nc}$ for station A-11 was 1.01, and the primary contributors to the sum were fluoride and vanadium. Because station A-11 has no associated sediment sample results, and surface water is wastewater effluent, this location will not be retained for evaluation in the human health risk assessment.

*COPC Summary*: Table 8.2-7 presents a summary of endpoints and reaches considered in the human health risk assessment for the Mortandad watershed. For each reach and endpoint combination with both sediment and water COPCs retained, a multimedia assessment is also assessed for this reach. Table 8.2-7 shows that the most downstream reach in the Mortandad watershed requiring further human health risk assessment is reach M-4.

**Calculating Representative Concentrations**

*Sediment*: The investigation approach for sediments resulted in samples associated with discrete geomorphic units and sediment facies within each reach. These data are combined to estimate weighted averages and weighted 95% upper confidence limits (UCLs) on the averages for COPCs retained for the human health risk assessment in each reach. The approach to estimating weighted averages and weighted 95% UCLs is well established in the statistical methods for stratified sampling, (e.g., Gilbert 1987, 56179; Cochran 1977, 84462). A description of these methods is provided in Section E-3 of Appendix E. Many of the data sets for combinations of COPCs and reaches or COPCs and water sampling locations include nondetect values. The approach to estimating averages and 95% UCLs with data that include nondetects is also described in Section E-3 (Appendix E).

The trail user exposure scenario uses representative sediment concentrations calculated from surface-area weighted averages and surface-area weighted 95% UCLs for sediment facies that typically occur in the uppermost parts of geomorphic units because trail user exposures predominantly occurs with near-surface sediment. In addition, the uppermost sediment facies is usually finer grained and contains higher contaminant concentrations than deeper sediment, thus providing a more protective assessment. The calculation approach for the averages and 95% UCLs uses the relative areas of the different geomorphic units in a reach to derive the weights. The residential exposure scenario includes activities that penetrate the ground surface, resulting in direct exposure to buried sediments. Therefore, the residential exposure scenario uses the volumes of sediment deposits within geomorphic units to derive weights rather than the surface areas. The area weights and volume weights for each unit in each reach are presented in

Table D-1.3-1 in Appendix D. Representative sediment concentrations for the trail user scenario are presented in Section 8.2.5.

*Surface Water*: Water COPC concentrations are evaluated for each sampling location, unlike sediments where multiple sample locations are combined to generate a representative concentration for a reach. The only exception is for locations that are basically collocated within a few meters of each other. As a result, methods to estimate weighted averages and weighted 95% UCLs are not used to calculate water representative concentration. The approach to calculating averages and 95% UCLs for the water data follows the approach described in Section E-3 (Appendix E). Representative surface water concentrations for the trail user scenario are presented in Section 8.2.5.

### 8.2.3 Exposure Assessment

The trail user scenario is the exposure scenario that applies to all reaches identified in Table 8.2-3. Additionally, potential risk associated with the residential scenario is provided as a point of comparison **per Section XI.E of the Consent Order**. The two exposure scenarios employed in the human health risk assessment have been described in other documents. The trail user scenario is the adult receptor in the recreational scenario document (LANL 2004, 87800) and the recreational scenario in the radionuclide SALs document (LANL 2005, 88493). An adult trail user is evaluated in this assessment because access to these reaches is limited to Laboratory workers or trespassers, and it is unlikely that young children would accompany either workers or trespassers on recreational visits to these reaches. Exposures to surface water ingestion are evaluated based on the trail user scenario described in the "Los Alamos and Pueblo Canyon Investigation Report" (LANL 2004, 87390, p. 8-37), which also provides risk-based concentrations for trail user surface water exposures (LANL 2004, 87390, p. E-317). Residential SSLs are in NMED guidance (NMED 2006, 92513), and residential SALs are in LANL guidance (LANL 2005, 88493).

#### 8.2.3.1 Exposure Scenario Description

The human health risk assessment focuses on potential risks resulting from direct exposure to contaminants in sediments through ingestion, inhalation, external irradiation (radionuclides only), and dermal contact (chemicals only). The water pathways for the trail user consist of ingestion and dermal contact (chemicals only) using persistent surface water data. Exposure to stormwater is not assessed because stormwater is transient and does not occur frequently enough to sustain chronic exposures. Exposure to groundwater is not evaluated because no groundwater in the Mortandad watershed is available for human uses under current conditions or for the reasonably foreseeable future. A summary of potentially complete exposure pathways, by scenario, is provided in Table 8.2-8.

Exposure scenario parameters were selected to provide an RME estimate of potential exposures. As discussed in EPA (1989, 8021), the RME estimate is generally the principal basis for evaluating potential health impacts. In general, an RME estimate of risk is at the high end of a risk distribution, i.e., 90th–99.9th percentiles (EPA 2001, 85534). An RME scenario assesses risk to individuals whose behavioral characteristics may result in much higher potential exposure than seen in the average individual.

The trail user scenario addresses limited site use for outdoor activities such as hiking and jogging. The receptor for this scenario is anticipated to be a Laboratory employee using the canyon over an extended period of time. Therefore, receptors for the trail user scenario are defined as adults. A complete description of the parameter values and associated rationale is provided in Laboratory guidance (LANL 2004, 87390, p. 8-37). Exposure parameters for the trail user are provided in Appendix E-3.

#### 8.2.3.2 Supplemental Exposure Scenario

Risk estimates are provided for a resident as a supplemental exposure scenario **per Section XI.E of the Consent Order**. A more detailed discussion of the basis and parameterization of this scenario is provided in NMED guidance (2006, 92513) and Laboratory guidance (LANL 2005, 88493). Exposure parameters for the resident are provided in Appendix E-3.

#### 8.2.3.3 Spatial Scales of Application for the Exposure Scenarios

Each exposure scenario is evaluated at the scale of a reach for sediments and at the scale of individual sampling locations for water. Each of the surface water sampling locations has been associated with a reach for combining results into a multimedia assessment (where appropriate). The investigations evaluated in this report have multiple investigation reaches and water sampling locations. The risk assessment does not attempt to integrate exposure across multiple reaches for sediment or across water sampling locations for surface water. By assessing each reach and associated water sampling locations separately, the impacts of local variability in COPC concentrations upon the risk assessment results are preserved.

### 8.2.4 Toxicity Assessment

This section of the human health risk assessment provides information related to the basis for distinguishing among the three classes of chemicals that are evaluated in this assessment: systemic toxicants (noncarcinogens), chemical carcinogens, and radionuclides. This information provides a context for interpreting the results of the risk assessment, which employs COPC-specific values of toxicity and radiation dose to evaluate potential health impacts.

Using media-specific risk-based screening levels simplifies aspects of the risk assessment in that exposure and toxicity information has been compiled in available guidance documents and reports. The sources for toxicity data used for this risk assessment include NMED and LANL guidance documents and the “Los Alamos and Pueblo Canyon Investigation Report” (LANL 2004, 87390) and its supplement (LANL 2005, 91918). The “Los Alamos and Pueblo Canyon Investigation Report” is used as a source of surface water screening values because there is no guidance document available with such values, and the exposure information provided therein is germane to trail user exposures in other Laboratory canyons. Toxicity information used to develop surface water screening values is also generally consistent with values used in NMED and LANL guidance documents (as discussed below).

Media-specific risk-based screening levels are from seven sources based on COPC type and exposure medium.

- Recreational scenario (trail user) for carcinogens and noncarcinogens
  - ♦ Sediment: used the recreational SSLs developed in Laboratory guidance (LANL 2004, 87800)
  - ♦ Surface water: used the risk-based concentrations for trail user surface water ingestion and dermal contact developed in the “Los Alamos and Pueblo Canyon Investigation Report” (LANL 2004, 87390, except lead is from LANL 2005, 91918)
- Recreational scenario (trail user) for radionuclides
  - ♦ Sediment: used the recreational SALs developed in Laboratory guidance (LANL 2005, 88493)

- Surface water: used the risk-based concentrations for trail user surface water ingestion developed in the "Los Alamos and Pueblo Canyon Investigation Report" (LANL 2004, 87390)

- Residential scenario for carcinogens and noncarcinogens
  - Sediment: used the SSLs from NMED guidance (NMED 2006, 92513), except for certain values from EPA Region 6 (EPA 2005, 91002) and EPA Region 9 (epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf)
- Residential scenario for radionuclides
  - Sediment: used the residential SALs developed in Laboratory guidance (LANL 2005, 88493)

Table 8.2-9 provides the compilation of the sediment and surface water media-specific risk-based screening levels and target adverse effect-levels. Comparing the screening values with COPCs for a given risk endpoint provides some information of the relative toxicity of these analytes. Because these risk-based screening values are obtained from references prepared from 2004 to 2006, there is potential for differences in the toxicity values used in the screening level calculations. The slope factors and reference doses were compared with the COPCs listed in Table 8.2-9 among the sources; differences in these toxicity values are summarized in Table 8.2-10. This information will be considered in the uncertainty analysis of this assessment.

#### 8.2.5 Risk Characterization

In this section of the human health risk assessment, information provided in the exposure and toxicity assessments (Sections 8.2.3 and 8.2.4, respectively) is integrated to characterize potential adverse effects. The risk characterization is conducted on the basis of the general principles described in Section 8.0 of the risk assessment guidance for Superfund (EPA 1989, 8021). Potential adverse effects related to noncarcinogens, chemical carcinogens, and radionuclides are discussed in Sections 8.2.5.1, 8.2.5.2, and 8.2.5.3, respectively. The presentation of potential adverse effects focuses on the quantitative expressions of potential impacts. In the uncertainty analysis (Section 8.2.6), the confidence associated with the quantitative risk estimates is discussed through an evaluation of the uncertainties pertaining to each step of the risk assessment process.

This risk assessment employs media-specific risk-based screening levels to evaluate COPCs for potential adverse health effects. COPC intake and toxicity are combined within the screening value calculations; therefore, separate calculations of intake and health effects (cancer risk, hazard, and dose) were not generated. Human health effects were assessed using the ratios of representative concentrations to media-specific risk-based screening levels for each COPC retained in this assessment for each of the exposure scenarios. These ratios were summed for an investigation reach and (when applicable) a water sampling location within the COPC classes of chemical carcinogens, noncarcinogens, and radionuclides (SOFs). A sum of less than 1 indicates that exposure is unlikely to result in an unacceptable cancer risk, hazard, or radiation dose. The SOF values were multiplied by the target effect level (i.e., HI = 1, risk = $1 \times 10^{-5}$, or dose = 15 mrem/yr) to provide risk estimates for each COPC class.

For the trail user scenario, exposure to sediment and surface water is evaluated through a multimedia sum. For COPCs with a common target adverse effect level (e.g., all carcinogens are based on $1 \times 10^{-5}$ incremental cancer risk), the multimedia sum can be converted into an approximate effect level. Carcinogen and noncarcinogen screening levels are based on a common adverse effect level across sediment and surface water, but the radionuclide adverse effect levels are not the same for sediment (15 mrem/yr) and surface water (4 mrem/yr).

The trail user scenario multimedia sums and the risk values for noncarcinogens, carcinogens, and radionuclides based on 95% UCLs are summarized in Table 8.2-11. Most of the carcinogen and radionuclide multimedia sums are similar to the sediment risk values, which indicate that there is greater potential for effects from the sediment concentrations and exposure pathways than from surface water. For noncarcinogens, this observation is reversed for many reaches: the multimedia sum is similar to the surface water risk values. There is one reach where the multimedia sum and the sediment risk values are greater than the target risk level for the trail user scenario: radionuclide dose in reach E-1E.

Table 8.2-12 presents the COPC and reach-specific recreational risk values for sediment; Table 8.2-13 presents the COPC and reach-specific recreational risk values for surface water. The representative concentrations for sediment are presented in Table 8.2-14; the representative concentrations for surface water are presented in Table 8.2-15. Results for the supplemental exposure scenario (residential) are provided in Tables E-3.5-2 and E-3.5-3.

#### 8.2.5.1 Noncarcinogenic Effects

Chemical hazard for an individual chemical is commonly defined by the HQ, which is calculated as the ratio of the chemical intake to the reference dose (RfD) for that chemical. An HQ greater than 1 is indicative of the potential for adverse effects; therefore, an HQ of 1 was used in the calculation of screening values for noncarcinogenic effects. When the potentially additive effects of two or more chemicals are considered, HQs may be summed to generate an HI. However, summing of chemical HQs to create an HI assumes that the target organs and mechanisms of toxicity are similar. The $SOF_{nc}$ values in this human health risk assessment are functionally equivalent to generating an HI. The protective approach of summing these ratios does not warrant refinement because the HI values are in all cases well below 1.0.

The four largest HI values for the trail user scenario were between 0.4 and 0.7 (Table 8.2-11) and related mostly to the potential for adverse effects from lead in surface water (reaches M-1W and TS-1C; Table 8.2-13) or aluminum and iron in sediment (reaches M-1E and E-1FW; Table 8.2-13). The HI was between 0.1 and 0.4 in four other reaches (E-1W, E-1E, M-2W, and TS-2E) with the key contributors to these noncarcinogenic sums being aluminum, arsenic, iron, and manganese in sediment and lead and perchlorate in surface water.

#### 8.2.5.2 Carcinogenic Effects

Cancer risk for an individual chemical is defined by the incremental cancer risk (ICR), which is calculated as the product of exposure to a single chemical and the cancer slope factor (SF) for that chemical. ICRs for each exposure route and chemical are then summed to calculate the total ICR to an individual. A target risk level of $1 \times 10^{-5}$ was used in this human health risk assessment to calculate risk-based concentrations for carcinogenic effects (NMED 2006, 92513). Lifetime cancer risk is considered to be additive over time; childhood and adulthood exposures are summed to calculate the ICR.

The potential risk from carcinogens was evaluated in 12 investigation reaches, and the range of sediment or multimedia ICR for the trail user scenario was from $8 \times 10^{-7}$ to $6 \times 10^{-6}$ (Table 8.2-7). The maximum ICR ($6 \times 10^{-6}$) was calculated for reach M-1W. The primary contributors to the ICR in these reaches from sediment were arsenic and PAHs (Table 8.2-12). Carcinogenic COPCs were not significant contributors to the ICR for trail users from surface water exposure.

#### 8.2.5.3 Radiation Dose

The radiation dose associated with the EPA dose conversion factors (DCFs) used in the human health risk assessment is the annual committed effective dose equivalent (internal) or annual effective dose equivalent (external), expressed in units of millirems per year. The target dose limit used for calculating media-specific risk-based screening levels related to soil pathways is 15 mrem/yr, which is consistent with guidance from DOE (DOE-AL 2000, 67153). For water-based exposure pathways, media-specific risk-based screening levels were calculated using a target dose limit of 4 mrem/yr. Use of this more protective dose limit for water pathways is based on the radiation dose limit for a public drinking water supply in DOE Order 5400.5, "Radiation Protection of the Public and the Environment." Consistent with EPA guidance (EPA 1989, 8021), dose through dermal absorption is not quantified because it is probably negligible compared with the other exposure pathways.

The potential risk from radionuclides in sediment was evaluated in 12 reaches; the potential risk from radionuclides in surface water was evaluated in four reaches, and multimedia sums were also calculated in these four reaches. The range of sediment or multimedia radionuclide dose was from 0.01 to 44 mrem/yr; the range of surface water radionuclide dose was from 0.04 to 0.3 mrem/yr (Table 8.2-11). One reach had a radionuclide dose value for the trail user scenario greater than 15 mrem/yr: reach E-1E had a multimedia dose of 44 mrem/yr. Americium-241, cesium-137, plutonium-238, and plutonium-239,240 contributed more than 99% of the dose from radionuclide sediment COPCs for all reaches except TS-1C (Table 8.2-8). In reach TS-1C, thorium-228, thorium-230, and thorium-232 contributed approximately 59% of the radionuclide dose from sediment. Approximately 80% of the dose in reach E-1E from sediment was from cesium-137.

### 8.2.6 Uncertainty Analysis

The uncertainty analysis uses qualitative and semiquantitative information to evaluate the uncertainty associated with the risk, hazard, and dose estimates described in Section 8.2.5. This uncertainty analysis pertains to the results of the trail user scenario. The uncertainty analysis is organized according to the major aspects of the human health risk assessment: data collection and evaluation (Section 8.2.6.1), exposure assessment (Section 8.2.6.2), and toxicity assessment (Section 8.2.6.3).

#### 8.2.6.1 Data Collection and Evaluation

All analytes that were identified as COPCs in Section 6 were retained for evaluation in the human health risk assessment. COPCs that were retained for calculation of representative concentrations were those that had ratios greater than 0.1 for endpoints with SOF values greater than 1 for the residential screen. Thus, the analytes retained represent an inclusive list of potential human health risk drivers.

No BVs are available for surface water. The inability to distinguish COPCs in surface water based on comparisons with background concentrations is a substantial source of uncertainty in the results of the human health risk assessment for this media. For example, concentrations of arsenic and iron in surface water, which contribute to HI, could be associated with local background and not with releases from Laboratory SWMUs or AOCs.

Overestimating representative concentrations for investigation reaches is another potential source of uncertainty. Five approaches were used to minimize that possibility. First, the emphasis of the geomorphic characterization and sediment sampling was to identify and sample post-1942 sediment deposits, which focuses sampling on potentially contaminated areas. The process of characterizing reaches and focusing sampling is discussed further in Section 4.1 and Section B-1 of Appendix B.

Second, the canyon bottoms include other geomorphic units that are not impacted or are only minimally impacted by Laboratory releases. Samples from these other geomorphic units were not included in the area-weighted and volume-weighted averages to provide more protective estimates of COPC concentrations for use in the human health risk assessment. Third, 95% UCLs on the area-weighted average sediment concentrations were employed as representative concentrations to minimize the chance of underestimating representative concentrations in a reach. Fourth, it was assumed that exposure in most geomorphic units for the trail user scenario was entirely caused by fine facies sediment deposits where concentrations are generally highest, as discussed in Section 7.1, excluding data from coarse facies sediment deposits where concentrations are generally lower. Fifth, for radionuclides, no correction was made for radioactive decay since the time of sampling, although present-day concentrations are lower than at the time of sampling for some key radionuclides. For example, the maximum concentration of cesium-137 measured in the Mortandad watershed was in a sample collected from reach E-1E in 1998, and concentrations in 2006 when this report was written would be about 17% lower in that sediment layer due to radioactive decay. Accounting for radiological decay would decrease the calculated dose in reach E-1E from 44 mrem/yr to approximately 38 mrem/yr.

A similar uncertainty exists for estimating representative concentrations for water sampling locations. COPC concentrations often change with hydrologic conditions and can either increase or decrease seasonally or related to effluent discharges. The data evaluated in this assessment represent a snapshot of the current hydrological conditions and generally reflects a range of hydrologic conditions at each sampling location. As discussed in Section 7.2.1 and Appendix B, Section B-2, sampling occurred during a range of water-level conditions and field parameters, such as pH and dissolved oxygen. The representative concentrations calculated from these data represent the range of COPC concentrations at the sampling locations. Using the 95% UCL on the average minimizes the chance of underestimating the representative concentrations for a sampling location.

#### 8.2.6.2 Exposure Assessment

Uncertainty pertaining to exposure parameters was addressed in the human health risk assessment by using RME estimates for several exposure parameters (see Appendix E-3). The use of RME assumptions, coupled with upper-bound estimates of the average concentration of COPCs in sediment, is intended to produce a protective bias in the risk calculations. The results of the risk assessment, discussed in Section 8.2.5, include a description of the key COPCs and exposure pathways associated with potential health impacts. This evaluation of uncertainty in exposure is focused on these COPCs and pathways.

Key exposure pathways for contaminated sediments across hazard, ICR, and dose for the trail user exposure scenario include dermal absorption, incidental soil ingestion, and external irradiation. A common source of protective bias in the exposure assessment for these pathways is that the entire 1-h daily exposure time defined for the trail user scenario is spent on contaminated sediment deposits within a reach. To the extent that time may be spent in other canyon areas such as uncontaminated stream terraces, colluvial slopes, or bedrock areas during recreational activities, exposure to contaminated sediment deposits is overestimated.

The assessment also includes no consideration of the current signage in the canyon, which reads “No Trespassing: Access to Mortandad Canyon is Restricted to Workers on Official Business.” In addition, the area at the head of reach E-1E at the TA-50 RLWTF outfall is posted as “Caution: Soil Contamination Area.” Because each reach is treated equally from an exposure perspective, no consideration is made regarding ease of access or land area available for recreation. For example, reach E-1E has the highest estimated radionuclide dose (44 mrem/yr for the trail user scenario), but it is one of the shortest, narrowest, and roughest reaches in the Mortandad watershed and has no developed trails or other features that attract trail users. Reach E-1E is also in a part of the Laboratory with access controls and access requirements and has signs that discourage the specific recreational activity being assessed. In addition, the estimated dose of 44 mrem/yr is below the 100 mrem/yr dose limit established by DOE for radiation workers, indicating that trained workers conducting environmental or other work in this area would not be expected to exceed dose limits for these specific and occasional activities. As a further point of comparison, dose to the trail user would be less than 15 mrem/yr if 50 h/yr was spent in reach E-1E (instead of the 200 h//yr assumed for the trail user).

For both carcinogens and radionuclides, the exposure assessment should be evaluating incremental exposures that are greater than background. Representative concentrations are calculated that include background concentrations. For the most part, background exposures are likely negligible with the exception of some metals in sediment and surface water (e.g., arsenic) and do not lead to overestimating risk or dose.

Dermal contact with sediments and incidental soil ingestion exposure pathways each have a second exposure characteristic in addition to time spent on-site that was biased in a protective manner. The soil adherence factors that were used to define soil loading on skin for children and adults are both protectively biased. The adult adherence factor is based on a high-exposure activity (gardening) that probably would result in greater exposure than would be the case during trail use. Adult soil ingestion was assumed to be 100 mg/d, which is twice the EPA-recommended value for adults (EPA 1997, 66596).

Radionuclides in reach E-1E represent the greatest potential for risk for adult trail users, and the largest fraction of dose is related to external gamma radiation from cesium-137. Because external gamma radiation is the main contributor to radionuclide dose, the assessment should also be protective of child exposures because behaviors that increase child exposure through some pathways (incidental soil ingestion and dermal contact) play basically no role in external gamma dose.

Exposure related to external irradiation from soil is primarily a function of time spent on-site. However, the external DCFs used in the calculation of external dose protectively assume an effectively infinite area and depth of contamination. The contaminated sediments in reach E-1E, where external irradiation was an important contributor to trail user dose, are approximately 200 m long and average 3 m in width and less than 1 m in depth. The calculated dose through external irradiation from cesium-137, assuming an infinite source, would likely be twice as large as would actually be the case given the described source geometry of reach E-1E. Actual external irradiation received during recreational activities would probably be lower, assuming that receptors are not consistently in the center of the contaminated area.

An important aspect of uncertainty in exposure to COPCs in surface water relates to exposure intensity. Dermal contact and surface water ingestion were assumed to occur 20 times per year for 30 years (trail user). There is no empirical basis for this assumption, which was developed to bound a high-end exposure condition. Potential contact by adults with surface water in the Mortandad watershed would be highly intermittent at some locations based on the limited availability of water. It is also unlikely that a Laboratory employee would be drinking surface water, which is in some cases nonpotable effluent.

#### 8.2.6.3 Toxicity Assessment

The evaluation of uncertainty pertaining to the toxicity assessment focuses primarily on the toxicology of cesium-137 because this COPC was primarily responsible for the calculated radionuclide dose to be greater than 15 mrem/yr in one reach. Nearly all of the dose for cesium-137 for the trail user scenario is associated with external gamma radiation (LANL 2005, 88493, Table A-2, p. A-2). The main uncertainties associated with the external radiation DCF relate to the geometry of the source and the receptor. Uncertainties associated with the source term were discussed in Section 8.2.6.2.

Table 8.2-10 provides a summary of the COPCs where the reference dose or SF values differ between various sources used in this assessment. The toxicity values used by NMED or EPA Region 6 are basically the same, but these values differ from the sources used in Laboratory guidance or reports. For barium, copper, and manganese, the Laboratory toxicity values were more protective. There are three cases where the values used by NMED are more protective and the impact on the assessment for these analytes is considered.

- *Aroclor-1254*: The inhalation cancer risk slope factor used by NMED is 6 times more protective than the Laboratory value. However, the inhalation pathway is orders of magnitude less important than soil ingestion from an exposure perspective, so this difference in the inhalation cancer slope would not change the estimated risks from Aroclor-1254.
- *Thallium*: The oral reference dose used by NMED is about 20% lower (more protective) than the Laboratory value. This level of difference in thallium toxicity would not change any of the noncarcinogen assessments because the largest ratio for thallium was 0.003.
- *Vanadium*: The oral reference dose used by NMED is 7 times lower (more protective) than the Laboratory value. This level of difference in vanadium toxicity would not change any of the noncarcinogen assessments because the largest ratio for vanadium was 0.004.

### 8.2.7 Summary of the Human Health Risk Assessment

The health effects associated with COPCs in the Mortandad watershed were assessed relative to a radiological dose criterion of 15 mrem/yr for sediment and 4 mrem/yr for water, a chemical cancer risk criterion of $1 \times 10^{-5}$, and a chemical hazard criterion of 1.0. The risk assessment results are below these thresholds for the trail user with one exception. The calculated radionuclide dose for reach E-1E was 44 mrem/yr, and this was almost entirely related to sediment COPCs and primarily related to external gamma radiation from cesium-137.

The sediment radionuclide dose corresponds to a radiological risk of approximately $2 \times 10^{-4}$ based on risk-based recreational radionuclide SALs. Radiological risks from surface water in reach E-1E will be negligible as sediment contributed about 99.4% of the dose. Radiological risks from sediments for reaches M-2W, M-2E, and M-3 were $2 \times 10^{-5}$ to $3 \times 10^{-5}$, and radiological risks in other reaches ranged from $2 \times 10^{-8}$ to $9 \times 10^{-6}$.

The nonsuitability of E-1E for traditional trail use and access restrictions in this part of the Laboratory, combined with conservatism included in the risk assessment, indicates that it is unlikely that actual recreational users of the Mortandad watershed would receive a dose exceeding 15 mrem/yr. Surface water risk results are below all adverse effect levels.

## Table 8.1-AWD
## COPECs by Media and Lines of Evidence Supporting Investigation of Each COPEC

| Media | Study Design COPEC[a] | Lines of Evidence | Uncertainty in line of evidence |
|---|---|---|---|
| Soil | Arsenic, barium, cadmium, chromium, hexavalent chromium, copper, lead, manganese, selenium, silver, thallium, vanadium, zinc | Earthworm toxicity and bioaccumulation study | Collected soil samples generally represent worst-case concentrations of COPECs and thus likely overestimate exposure concentrations for populations |
| | | | Variability in the test organism response may limit the ability of the test to detect statistical differences |
| | | Plant toxicity study | Collected soil samples generally represent worst-case concentrations of COPECs and thus likely overestimate exposure concentrations |
| | | | Variability in the test organism response may limit the ability of the test to detect statistical differences |
| | | | Confounding factors (e.g., nutrient enrichment) may affect results |
| | | Small mammal study | Mean concentrations in investigation reaches generally represent worst-case concentrations of COPECs and thus likely overestimate exposures to populations |
| | | | Factors other than COPECs (e.g., availability of food) may affect field measures of populations |
| | | | Selected locations or measurements may not capture all potential effects |
| | | Plant diversity | Factors other than COPECs (e.g., elevation, aspect) may affect field measures |
| | | Nest box studies | Mean concentrations in investigation reaches generally represent worst case concentrations of COPECs and thus likely overestimate exposures that resulted in egg or insect concentrations or exposures to populations |
| | | | Factors other than COPECs (e.g., precipitation) may affect field measures of populations |
| | | | Selected locations or measurements may not capture all potential effects |
| | Total cyanide | None, MCW-2W only reach with cyanide as COPEC | Not applicable |

### Table 8.1-AWD (continued)

| Media | Study Design COPEC[a] | Lines of Evidence | Uncertainty in line of evidence |
|---|---|---|---|
| | Mercury | Earthworm toxicity and bioaccumulation study | Collected soil samples generally represent worst-case concentrations of COPECs and thus likely overestimate exposure concentrations for populations |
| | | | Variability in the test organism response may limit the ability of the test to detect statistical differences |
| | | Small mammal study (tissue concentrations for risk to Mexican spotted owl) | Mean concentrations in investigation reaches generally represent worst-case concentrations of COPECs and thus likely overestimate exposures to populations |
| | | | Factors other than COPECs (e.g., precipitation) may affect field measures of populations |
| | | | Selected locations or measurements may not capture all potential effects |
| | | Nest box studies | Mean concentrations in investigation reaches generally represent worst case concentrations of COPECs and thus likely overestimate exposures that resulted in egg or insect concentrations or exposures to populations |
| | | | Factors other than COPECs (e.g., precipitation) may affect field measures of populations |
| | | | Selected locations or measurements may not capture all potential effects |
| | Americium-241, cesium-137, plutonium-238, plutonium-239 | Earthworm toxicity and bioaccumulation study | Collected soil samples generally represent worst-case concentrations of COPECs and thus likely overestimate exposure concentrations for populations |
| | | | Variability in the test organism response may limit the ability of the test to detect statistical differences |
| | | Plant diversity | Factors other than COPECs (e.g., elevation, aspect) may affect field measures of populations |
| | | | Selected locations or measurements may not capture all potential effects |
| | | Small mammal study (including tissue concentrations for risk to red fox) | Mean concentrations in investigation reaches generally represent worst-case concentrations of COPECs and thus likely overestimate exposures to populations |
| | | | Factors other than COPECs (e.g., availability of food) may affect field measures of populations |
| | | | Selected locations or measurements may not capture all potential effects |

## Table 8.1-AWD (continued)

| Media | Study Design COPEC[a] | Lines of Evidence | Uncertainty in line of evidence |
|---|---|---|---|
| | Acenaphthene, bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, endrin aldehyde, | Earthworm toxicity and bioaccumulation study | Collected soil samples generally represent worst-case concentrations of COPECs and thus likely overestimate exposure concentrations for populations |
| | | | Variability in the test organism response may limit the ability of the test to detect statistical differences |
| | | Plant diversity | Factors other than COPECs (e.g., elevation, aspect) may affect field measures of populations |
| | | | Selected locations or measurements may not capture all potential effects |
| | | Nest box studies | Mean concentrations in investigation reaches generally represent worst-case concentrations of COPECs and thus likely overestimate exposures that resulted in egg or insect concentrations or exposures to adult populations |
| | | | Factors other than COPECs (e.g., precipitation) may affect field measures of populations |
| | | | Selected locations or measurements may not capture all potential effects |
| | | Plant toxicity studies | Collected soil samples generally represent worst-case concentrations of COPECs and thus likely overestimate exposure concentrations for populations |
| | | | Variability in the test organism response may limit the ability of the test to detect statistical differences |
| | | | Confounding factor (e.g., nutrient enrichment) may affect results |
| | Chrysene, naphthalene | COPEC only in Pratt Canyon, which was excluded from ecological risk assessment because this site was under separate investigation | Not applicable |

## Table 8.1-AWD (continued)

| Media | Study Design COPEC[a] | Lines of Evidence | Uncertainty in line of evidence |
|---|---|---|---|
| | Aroclor-1254, Aroclor-1260, perchlorate | Small mammal study (tissue concentrations for risk to Mexican spotted owl) | Mean concentrations in investigation reaches generally represent worst-case concentrations of COPECs and thus likely overestimate exposures to populations |
| | | | Factors other than COPECs (e.g., availability of food) may affect field measures of populations |
| | | | Selected locations or measurements may not capture all potential effects |
| | | Nest box studies | Mean concentrations in investigation reaches generally represent worst case concentrations of COPECs and thus likely overestimate exposures that resulted in egg or insect concentrations or exposures to populations |
| | | | Factors other than COPECs (e.g., precipitation) may affect field measures of populations |
| | | | Selected locations or measurements may not capture all potential effects |
| | | Earthworm toxicity and bioaccumulation study | Collected soil samples generally represent worst-case concentrations of COPECs and thus likely overestimate exposure concentrations for populations |
| | | | Variability in the test organism response may limit the ability of the test to detect statistical differences |
| Sediment | Aluminum[b], arsenic, barium, cadmium[b], copper, iron, silver, vanadium, zinc[b] | Nest box studies including insect tissue concentrations | Mean concentrations in investigation reaches generally represent worst-case concentrations of COPECs and thus likely overestimate exposures that resulted in egg or insect concentrations or exposures to populations |
| | | | Factors other than COPECs (e.g., precipitation) may affect field measures of populations |
| | | | Selected locations or measurements may not capture all potential effects |
| | | Chironomid toxicity studies | Collected sediment samples generally represent worst-case concentrations of COPECs and thus likely overestimate exposure concentrations for populations |
| | | | Variability in the test organism response may limit the ability of the test to detect statistical differences |
| | | | Confounding factors (e.g., water quality parameters) may affect results |

Table 8.1-AWD (continued)

| Media | Study Design COPEC[a] | Lines of Evidence | Uncertainty in line of evidence |
|---|---|---|---|
| | Mercury | Nest box studies including insect tissue concentrations | Mean concentrations in investigation reaches generally represent worst-case concentrations of COPECs and thus likely overestimate exposures that resulted in egg or insect concentrations or exposures to populations |
| | | | Factors other than COPECs (e.g., precipitation) may affect field measures of populations |
| | | | Selected locations or measurements may not capture all potential effects |
| | | Chironomid toxicity studies | Collected sediment samples generally represent worst-case concentrations of COPECs and thus likely overestimate exposure concentrations for populations |
| | | | Variability in the test organism response may limit the ability of the test to detect statistical differences |
| | | | Confounding factors (e.g., water quality parameters) may affect results |
| | Total cyanide [b] | None, MCW-2W only reach with cyanide as COPEC | Not applicable |
| | Acetone, anthracene, benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, ideno(1,2,3-c,d)pyrene, pyrene | Chironomid toxicity studies | Collected sediment samples generally represent worst case concentrations of COPECs and thus likely overestimate exposure concentrations for populations |
| | | | Variability in the test organism response may limit the ability of the test to detect statistical differences |
| | | | Confounding factors (e.g., water quality parameters) may affect results |
| | Acenaphthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, fluoranthene, fluorene, 2-methylnaphthalene, naphthalene, phenanthrene, | COPEC only in Pratt Canyon, which was excluded from ecological risk assessment because this site was under separate investigation | Not applicable |

## Table 8.1-AWD (continued)

| Media | Study Design COPEC[a] | Lines of Evidence | Uncertainty in line of evidence |
|---|---|---|---|
| | Aroclor-1260, perchlorate | Chironomid toxicity studies | Collected sediment samples generally represent worst-case concentrations of COPECs and thus likely overestimate exposure concentrations for populations |
| | | | Variability in the test organism response may limit the ability of the test to detect statistical differences |
| | | | Confounding factors (e.g., water quality parameters) may affect results |
| | Alpha-chlordane, gamma-chlordane, DDT[4,4'], methoxychlor[4,4'] | Chironomid toxicity studies | Collected sediment samples generally represent worst-case concentrations of COPECs and thus likely overestimate exposure concentrations for populations |
| | | | Variability in the test organism response may limit the ability of the test to detect statistical differences |
| | | | Confounding factors (e.g., water quality parameters) may affect results |
| | Bis(2-ethylhexyl)phthalate, di-n-butyl phthalate | Nest box studies | Mean concentrations in investigation reaches generally represent worst-case concentrations of COPECs and thus likely overestimate exposures that resulted in egg or insect concentrations or exposures to populations |
| | | | Factors other than COPECs (e.g., precipitation) may affect field measures of populations |
| | | | Selected locations or measurements may not capture all potential effects |
| | Cesium-137[c], strontium-90[c] | Chironomid toxicity studies | Collected sediment samples generally represent worst--case concentrations of COPECs and thus likely overestimate exposure concentrations for populations |
| | | | Variability in the test organism response may limit the ability of the test to detect statistical differences |
| | | | Confounding factors (e.g., water quality parameters) may affect results |

## Table 8.1-AWD (continued)

| Media | Study Design COPEC[a] | Lines of Evidence | Uncertainty in line of evidence |
|---|---|---|---|
| Surface water | Aluminum, barium, cadmium, copper, iron, lead, manganese, silver, zinc | Chironomid toxicity studies (using sediment, which has same metal COPECs | Collected water samples generally represent worst-case concentrations of COPECs and thus likely overestimate exposure concentrations for populations of aquatic organisms |
| | | | Variability in the test organism response may limit the ability of the test to detect statistical differences |
| | Cobalt | COPEC only at water stations in reaches E-1FW and TS-1W; unlikely to be a significant contributor to ecological risk | Not applicable |
| | Total cyanide | Chironomid toxicity studies (using sediment, which has same metal COPECs) | Collected water samples generally represent worst-case concentrations of COPECs and thus likely overestimate exposure concentrations for populations of aquatic organisms |
| | | | Variability in the test organism response may limit the ability of the test to detect statistical differences |
| | Americium-241, radium-226 | Algal toxicity studies | Collected water samples generally represent worst-case concentrations of COPECs and thus likely overestimate exposure concentrations for populations of aquatic organisms |
| | | | Variability in the test organism response may limit the ability of the test to detect statistical differences |
| | | | Confounding factors (e.g., nutrients) may affect results |

[a] Based on HQ >3 using minimum ESL, unless otherwise noted.

[b] Based on HQ >1 using ESL for a T&E species.

[c] Based on HQ >3 using DOE BCG for sediment.

**Table 8.1-1**
**Field Studies in Mortandad Canyon Watershed As Implemented**

| Assay Type | Reach | Rationale for Reach Selection Based on HQ |
|---|---|---|
| **Soil COPECs** | | |
| Earthworm toxicity, plant toxicity, sediment characterization | E-1FW | Plant: high chromium, vanadium (+ other inorganic chemicals)<br>Worm: high chromium, high copper |
| | E-1W | Plant: high chromium, vanadium<br>Worm: high chromium |
| | E-1E | Plant: high chromium, high silver<br>Worm: high chromium, high mercury, high Am-241, high Pu-239 |
| | TS-1C | Plant: high selenium, vanadium<br>Worm: di-n-butyl phthalate |
| | TS-2C | Plant: high silver, high vanadium<br>Worm: moderate chromium, moderate mercury |
| | M-2W | Plant: lower inorganic chemicals<br>Worm: moderate chromium, moderate mercury, high Am-241, Pu-238, and Pu-239<br>High perchlorate |
| | M-4 | Plant: high silver, lower other inorganic chemicals<br>Worm: lower chromium, lower mercury<br>Moderate perchlorate |
| | LA-BKG | Background location |
| General small mammal trapping, sediment characterization | E-1W | Moderate arsenic and manganese |
| | M-2W | High thallium, Aroclor-1260 for potential risk to Mexican spotted owl<br>High perchlorate |
| | M-3 | Low arsenic, no other small mammal COPECs<br>Low perchlorate |
| | LA-BKG | Background location |
| Shrew trapping, sediment characterization | E-1W | 100% wet, high arsenic, high thallium |
| | LA-BKG | Background location |
| Plant diversity | E-1FW | Correlate to plant toxicity |
| | E-1W | Correlate to mammal trapping and plant toxicity |
| | E-1E | Correlate to plant toxicity |
| | TS-1C | Correlate to plant toxicity |
| | TS-2C | Correlate to plant toxicity |
| | M-2W | Correlate to mammal trapping and plant toxicity<br>High perchlorate |
| | M-3 | Correlate to mammal trapping and plant toxicity |
| | M-4 | Correlate to plant toxicity |
| | LA-BKG | Background location |
| Additional nest boxes | E-1FW | Robin: moderate copper, vanadium, PCBs<br>Swallow: no COPECs |
| | E-1W | Robin: high vanadium, lower zinc<br>Swallow: High aluminum, moderate vanadium, lower copper and zinc<br>Kestrel: no COPECs |

**Table 8.1-1 (continued)**

| Assay Type | Reach | Rationale for Reach Selection Based on HQ |
|---|---|---|
| | E-1E (bench above reach) | Robin: high mercury, moderate copper, lead<br>Swallow: low zinc<br>Kestrel: no COPECs but total hazard index (HI)=2 and Cs-137 HQ=0.8 |
| | TS-1C | Swallow: high vanadium, zinc<br>Kestrel: no COPECs but total HI=1.2<br>Robin: highest organic HQ (di-n-butyl phthalate) |
| | M-1E | Robin: high vanadium<br>Swallow: high aluminum and vanadium, lower zinc<br>Kestrel: no COPECs |
| | M-2W (bench above reach) | Robin: lower lead, mercury, zinc, PCBs<br>Swallow: low zinc<br>Kestrel: no COPECs but total HI=1.2<br>High perchlorate |
| | M-2E (bench above reach) | Robin: moderate mercury<br>Swallow: low zinc<br>Kestrel: no COPECs<br>Moderate perchlorate |
| | TS-1E | Add to existing network in area of higher contamination |
| **Sediment/Water COPECs** | | |
| Aquatic Toxicity and rapid bioassessment protocol | E-1W | High barium, PCBs, DDT for aquatic community |
| | E-1E | No aquatic community COPECs |
| | M-1W | Chlordane and DDT COPECs for aquatic community |
| | M-2W | No aquatic community COPECs<br>Low perchlorate |
| | TS-1C | High PCBs and anthracene for aquatic community |
| | TS-1E | High PCBs, anthracene, and copper for aquatic community |
| | TS-2C | High silver for aquatic community<br>Moderate PCBs and dibenz(a,h)anthracene for aquatic community |
| | LA-BKG | Background location. Collect sediment and water for toxicity testing, not used for rapid bioassessment protocol |
| Algal toxicity tests | M-1W | Included to collocate with aquatic toxicity tests |
| | M-2W | sampled at gaging station E200; location with high HQs for algae for radium-226 and americium-241 |
| | E-1W | Just downcanyon from gaging station E196, location with high HQs for algae for radium-226 |
| | E-1E | Upcanyon of high HQ at gaging station E200 for algae for radium-226 and americium-241 |
| | TS-1C | Included to collocate with aquatic toxicity tests |
| | TS-1E | Included to collocate with aquatic toxicity tests |
| | TS-2C | Included to collocate with aquatic toxicity tests |
| | LA-BKG | Background location |

**Table 8.1-2**
**Number of Each Species Collected for Analysis in Each Reach in the Mortandad Watershed**

| Reach | M-3E | M-2W | E-1W | LA-BKG |
|---|---|---|---|---|
| Deer Mouse (*Peromyscus maniculatus*) | 23 | 10 | 8 | 18 |
| Mexican Wood Rat (*Neotoma mexicana*) | 4 | 4 | 2 | 0 |
| Brush Mouse (*Peromyscus boylii*) | 0 | 17 | 7 | 0 |
| Long-tailed Vole (*Microtus longicaudus*) | 0 | 0 | 1 | 5 |
| Pinyon Mouse (*Peromyscus truei*) | 0 | 0 | 0 | 2 |
| Western Harvest Mouse (*Reithrodontomys megalotis*) | 10 | 0 | 0 | 0 |
| Montane Shrew (*Sorex spp*)* | 0 | 0 | 4 | 6 |

*** Numbers for montane shrew include animals caught in both pit fall and Sherman traps, whereas population analysis only includes those caught in Sherman traps.**

**Table 8.1-3**
**Samples Collected from Nest Boxes**

| Reach/Location | Number of Egg Samples | Number of Insect Samples |
|---|---|---|
| E-1FW | 1 | 1 |
| TS-1E | 0 | 1 |
| TS-2W | 1 | 1 |
| M-4 | 2 | 2 |
| M-4E | 1 | 1 |
| M-4W | 1 | 1 |
| M-5W | 9 | 3 |
| TA-51 | 1 | 0 |
| Cañada del Buey | 3 | 1 |
| Guaje Pines Cemetery | 7 | 2 |
| Los Alamos golf course | 6 | 1 |

**Table 8.1-3-AWD**
**Results of Owl Pellet Analysis**

| Common Name | Mortandad Canyon | Threemile Canyon | Cañon de Valle | Total | Relative Abundance |
|---|---|---|---|---|---|
| Mexican woodrat | 7 | 8 | 3 | 18 | 20.9% |
| Botta's pocket gopher | 0 | 11 | 2 | 13 | 15.1% |
| Deer mouse | 3 | 5 | 0 | 8 | 9.3% |
| Cottontail rabbit | 0 | 6 | 0 | 6 | 7.0% |
| Insect | 4 | 2 | 0 | 6 | 7.0% |
| Brush mouse | 1 | 2 | 2 | 5 | 5.8% |
| Unknown woodrat | 2 | 1 | 2 | 5 | 5.8% |
| Northern pocket gopher | 1 | 1 | 1 | 3 | 3.5% |
| Unknown peromyscid mice | 1 | 2 | 0 | 3 | 3.5% |
| Piñon mouse | 0 | 2 | 0 | 2 | 2.3% |
| Unknown large mammal | 1 | 1 | 0 | 2 | 2.3% |
| Unknown mammals | 2 | 0 | 0 | 2 | 2.3% |
| Rock squirrel | 0 | 0 | 2 | 2 | 2.3% |
| Silver-haired bat | 0 | 0 | 1 | 1 | 1.2% |
| Pocket gopher | 0 | 0 | 1 | 1 | 1.2% |
| Northern rock mouse | 1 | 0 | 0 | 1 | 1.2% |
| White-throated woodrat | 0 | 0 | 1 | 1 | 1.2% |
| Bushy-tailed woodrat | 1 | 0 | 0 | 1 | 1.2% |
| Unknown small mammals | 1 | 0 | 0 | 1 | 1.2% |
| Unknown medium mammal | 1 | 0 | 0 | 1 | 1.2% |
| Unknown small bird | 0 | 1 | 0 | 1 | 1.2% |
| Unknown medium bird | 0 | 1 | 0 | 1 | 1.2% |
| Unknown large bird | 0 | 1 | 0 | 1 | 1.2% |
| Northern grasshopper mouse | 0 | 0 | 1 | 1 | 1.2% |
| TOTAL | 26 | 44 | 16 | 86 | 100% |

Note: Data from Bennett et al. (2006, 93744). Values are numbers of pellets in each area that contained each type of prey.

## Table 8.1-4
## Estimate of Risk to Mexican Spotted Owl Through Ingestion of Small Mammals

| COPEC | Maximum Detected Concentration in Carcass (mg/kg) | Carcass wt (kg) | Max Concentration in Pelt (mg/kg) | Pelt wt (kg) | Calculated Whole Animal Concentration (mg/kg) | Avian Soil TRV (mg/kg/d) | Owl Food Ingestion Rate (kg/d) | ESL for Food (in mg/kg) | HQ |
|---|---|---|---|---|---|---|---|---|---|
| Mercury (inorganic) | 0.02 | 0.1025 | 0.07 | 0.0193 | 0.03 | 0.019 | 0.102 | 0.186 | 0.15 |
| Mercury (methyl)* | 0.02 | 0.1025 | 0.07 | 0.0193 | 0.03 | 0.0064 | 0.102 | 0.063 | 0.45 |
| Selenium | 0.58 | 0.1025 | 0.83 | 0.0193 | 0.62 | 0.44 | 0.102 | 4.31 | 0.14 |

*~~Not analyzed; bounding case~~ **Methyl mercury analyses were not obtained; values based on upper-bound assumption that the detected mercury was**~~of~~ 100% methyl mercury.

## Table 8.1-5
## Estimate of Risk to Southwestern Willow Flycatcher through Ingestion of Nest Box Insects by Reach

| COPEC | Avian sediment TRV (mg COPEC/kg bird/day) | SWF food ingestion rate (kg fresh food/kg bird/d) | Food ESL (in mg/kg or pCi/g) | Detected Concentration in Insect Tissue in E-1FW Nest Boxes (mg/kg fresh insect) | HQ for E-1FW | Detected Concentration in Insect Tissue in TS-1E Nest Boxes (mg/kg fresh insect) | HQ for TS-1E | Mean Detected Concentration in Insect Tissue in M-4 Nest Boxes (mg/kg fresh insect) | HQ for M-4 | Mean Detected Concentration in Insect Tissue in M-5W nest boxes (mg/kg fresh insect) | HQ for M-5W | Detected Concentration in Insect Tissue in Cañada del Buey Nest Boxes (mg/kg fresh insect) | HQ for Cañada del Buey | Detected Concentration in Insect Tissue in Pueblo Nest Boxes (mg/kg fresh insect) | HQ for Pueblo | Mean Detected Concentration in Insect Tissue in Rendija Nest Boxes (mg/kg fresh insect) | HQ for Rendija |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Aluminum | pH dependent | 0.79 | n/a[a] | 51 | n/a | 250 | n/a | 118 | n/a | 141 | n/a | 130 | n/a | 70 | n/a | 145 | n/a |
| Barium | 73.5 | 0.79 | 93 | 5.3 | 0.057 | 120 | 1.29 | 6.4 | 0.07 | 6.3 | 0.07 | 5.6 | 0.060 | 4.3 | 0.046 | 17.5 | 0.188 |
| Cadmium | 1.47 | 0.79 | 1.9 | 0.33 | 0.1774 | 0.63 | 0.34 | 0.11 | 0.06 | 0.13 | 0.07 | 0.72 | 0.3871 | 0.13 | 0.0699 | 0.205 | 0.1102 |
| Copper | 2.98 | 0.79 | 3.8 | 41 | 10.87 | 70 | 18.56 | 35 | 9.28 | 12.6 | 3.34 | 28 | 7.42 | 28 | 7.42 | 48 | 12.73 |
| Mercury (inorganic) | 0.019 | 0.79 | 0.024 | ND[±b] | 0.000 | ND | 0.00 | ND | 0.00 | 0.02 | 0.83 | 0.02 | 0.83 | 0.02 | 0.83 | ND | 0.000 |
| Mercury (methyl)[c] | 0.0064 | 0.79 | 0.01 | ND | 0.000 | ND | 0.00 | ND | 0.00 | 0.02 | 2.47 | 0.02 | 2.47 | 0.02 | 2.47 | ND | 0.000 |
| Selenium | 0.44 | 0.79 | 0.6 | 0.19 | 0.341 | 0.31 | 0.56 | 0.425 | 0.76 | 0.29 | 0.52 | 0.13 | 0.23 | 0.13 | 0.233 | 0.165 | 0.296 |
| Silver | 5.44 | 0.79 | 6.9 | 0.02 | 0.00291 | 0.17 | 0.02 | 0.071 | 0.01 | 0.014 | 0.0020 | 0.19 | 0.02760 | 0.02 | 0.00291 | 0.055 | 0.00799 |
| Vanadium | 0.344 | 0.79 | 0.44 | ND | 0.000 | ND | 0.00 | ND | 0.00 | 0.36 | 0.83 | 0.31 | 0.712 | ND | 0.000 | 0.615 | 1.413 |
| Zinc | 37.7 | 0.79 | 48 | 100 | 2.096 | 210 | 4.40 | 99.65 | 2.09 | 73.7 | 1.54 | 100 | 2.096 | 120 | 2.515 | 125 | 2.620 |

***Note*: Gray areas indicate HQs of >1.**

[a] **n/a = Not available.**

[±b] ND = Analyte not detected.

[c] **Methyl mercury analyses were not obtained; values based on upper-bound assumption that the detected mercury was 100% methyl mercury.**

## Table 8.1-5-AWD
## Estimated Risk to the Occult Myotis Little Brown Bat
## from Ingestion of COPECs in the Tissues of Insects Collected from Nest Boxes

| COPEC | Maximum Detected Concentration in Insect Tissue in Nest Box (mg/kg fresh insect) | Mammalian Sediment TRV (mg COPEC/kg bw/day) | Bat Food Ingestion Rate (kg fresh food/kg bird/d) | Food ESL (mg/kg) | HQ |
|---|---|---|---|---|---|
| Aluminum | 250 | pH dependent | 0.410 | n/a* | n/a |
| Arsenic | 1.4 | 1.04 | 0.410 | 3 | 0.55 |

***n/a = Not applicable.**

## Table 8.1-6
## Estimate of Risk to the Insectivorous Robin Using Estimated Concentrations of COPECs in Earthworms

| COPEC | Basis of Estimated Worm Tissue Concentration | Avian Soil TRV (mg COPEC/ kg bw/day) | Robin Food Ingestion Rate for Regression (kgfresh food/kg bird/d) | Robin Food Ingestion Rate for ESL TF (kg dry food/kg bw/d) | Food ESL (in mg/kg) | Concentration in Soil LA-BKG | HQ for LA-BKG | Concentration in Earthworm Toxicity Test Soil - Reach E-1FW | HQ for E-1FW | Concentration in Earthworm Toxicity Test Soil - Reach E-1W | HQ for E-1W | Concentration in Toxicity Test Soil - Reach E-1E | HQ for E-1E | Concentration in Earthworm Toxicity Test Soil - Reach M-2W | HQ for M-2W | Concentration in Earthworm Toxicity Test Soil - Reach M-4 | HQ for M-4 | Concentration in Earthworm Toxicity Test Soil - Reach TS-1C | HQ for TS-1C | Concentration in Earthworm Toxicity Test Soil - Reach TS-2C | HQ for TS-2C |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Copper | regression | 2.98 | 0.897 | na[a] | 3.322185 | 4.2 | 0.65 | 90.9 | 2.80 | 12.2 | 0.85 | 4.2 | 0.27 | 12.4 | 0.86 | 20 | 1.05 | 3.69 | 0.64 | 6.94 | 0.72 |
| Lead | regression | 1.63 | 0.897 | na | 1.817168 | 9.6 | 0.15 | 27.3 | 0.97 | 17.8 | 0.531 | 9.56 | 0.49 | 11.1 | 0.22 | 19 | 0.59 | 5.76 | -0.028 | 10.7 | 0.20 |
| Mercury (inorganic) | regression | 0.019 | 0.897 | na | 0.021182 | 0.01 | 1.200 | 0.09 | 2.9 | 0.04 | 1.826 | 0.01 | 42 | 0.04 | 1.8 | 0.21 | 5.4 | 0.008 | 1.2 | 0.02 | 1.4 |
| Mercury (methyl)[b] | regression | 0.0064 | 0.897 | na | 0.007135 | 0.01 | 3.6 | 0.09 | 8.5 | 0.04 | 5.4 | 0.01 | 126 | 0.04 | 5.4 | 0.21 | 16 | 0.008 | 3.4 | 0.02 | 4.2 |
| Selenium | ESL TF | 0.44 | na | 0.35 | 1.257143 | ND[cb] | 0 | ND | 0 | ND | 0 | 0.75 | 0.28 | ND | 0 | ND | 0 | ND | 0 | ND | 0 |
| Silver | regression | 5.44 | 0.897 | na | 6.06466 | ND | 0 | 0.15 | 0.014 | 0.11 | 0.013 | 0.1 | 0.15 | 0.11 | 0.013 | 0.3 | 0.019 | 0.04 | 0.01 | 0.78 | 0.036 |
| Vanadium | ESL TF | 0.344 | na | 0.35 | 0.982857 | 11 | 0.48 | 30 | 1.3 | 20.5 | 0.88 | 11.3 | 0.36 | 11.9 | 0.51 | 19.1 | 0.82 | 11.9 | 0.51 | 13.3 | 0.57 |
| Zinc | ESL TF | 37.7 | na | 0.35 | 107.7143 | 30 | 1.1 | 75 | 2.6 | 75 | 2.6 | 30 | 0.003 | 79.5 | 2.8 | 55.9 | 2.0 | 45.9 | 1.6 | 46.5 | 1.6 |
| Aroclor-1254 | ESL TF | 0.1 | na | 0.35 | 0.285714 | ND | 0 | 0.04 | 0.95 | ND | 0 | 0.0017 | 1.23 | 0.0059 | 0.140 | 0.01 | 0.24 | 0.01 | 0.24 | 0.01 | 0.24 |

***Note*: Gray areas indicate HQs of >3.**

[a] na = Not applicable to model used for this COPEC.

[b] **Methyl mercury analyses were not obtained; values based on assumption that the inorganic mercury concentration represents 100% methyl mercury**

[bc]ND = Analyte not detected.

## Table 8.1-6-AWD
## Total Number of Animals for Each Species Captured in Each Reach

| Reach | M-3E | M-2W | E-1W | LA-BKG |
|---|---|---|---|---|
| **Deer mouse (*Peromyscus maniculatus*)** | **23** | **10** | **11** | **19** |
| **Mexican wood rat (*Neotoma mexicana*)** | **5** | **14** | **2** | **0** |
| **Brush mouse (*Peromyscus boylii*)** | **0** | **32** | **7** | **0** |
| **Long-tailed vole (*Microtus longicaudus*)** | **0** | **0** | **2** | **5** |
| **Pinyon mouse (*Peromyscus truei*)** | **0** | **0** | **1** | **2** |
| **Western harvest mouse (*Reithrodontomys megalotis*)** | **10** | **0** | **1** | **0** |
| **Montane shrew (*Sorex spp*)** | **0** | **0** | **2** | **1** |
| **Shannon-Weaver First Order Diversity Index for Reach** | **1.33** | **1.41** | **2.25** | **1.26** |

**Table 8.1-7**
**Estimate of Risk to Small Mammals (shrew) from Estimated COPEC Concentrations in Earthworms**

| COPEC | Basis of Concentration | Maximum Detected Concentration Detected in Earthworm Toxicity Test Soil | Estimated Concentration in Earthworm Tissue (mg/kg fresh wt) | Mammalian Soil TRV (mg COPEC/kg bird/day) | Shrew Food Ingestion Rate (kg fresh food/kg bw/d) or if ESL TF Used (kg dry food/kg bw/d) | Food ESL (in mg/kg or pCi/g) | HQ |
|---|---|---|---|---|---|---|---|
| Arsenic | ESL TF | 5.6 | 1.32 | 1.04 | 0.198 | 5.3 | 0.25 |
| Cadmium | Regression | 0.66 | 2.25 | 0.77 | 0.508 | 1.5 | 1.48 |
| Manganese | Regression | 614 | 30.95 | 44 | 0.508 | 86.6 | 0.36 |
| Thallium | ESL TF | 0.87 | 0.87 | 0.0071 | 0.198 | 0.036 | 24 |
| Vanadium | ESL TF | 29.7 | 1.25 | 4.16 | 0.198 | 21.0 | 0.06 |
| Chrysene | ESL TF | 0.62 | 0.15 | 0.17 | 0.198 | 0.86 | 0.17 |

**Table 8.1-8**
**Estimate of Risk to Shrews from Estimated Thallium Concentrations in Earthworms by Reach**

| Reach | Concentration in Earthworm Tox Test Composite Soil | Estimated Concentration in Earthworm Tissue (mg/kg fresh wt) | Mammalian Soil TRV (mg COPEC/kg bird/day) | Shrew Food Ingestion Rate (kgfresh food/kg bw/d) or if ESL TF Used (kg dry food/kg bw/d) | Food ESL (in mg/kg or pCi/g) | HQ |
|---|---|---|---|---|---|---|
| TS-1C | 0.16 | 0.16 | 0.0071 | 0.198 | 0.036 | 4 |
| E-1E | 0.87 | 0.87 | 0.0071 | 0.198 | 0.036 | 24 |
| M-4 | 0.52 | 0.52 | 0.0071 | 0.198 | 0.036 | 15 |
| E-1FW | 0.15 | 0.15 | 0.0071 | 0.198 | 0.036 | 4 |
| E-1W | 0.2 | 0.20 | 0.0071 | 0.198 | 0.036 | 6 |
| M-2W | 0.14 | 0.14 | 0.0071 | 0.198 | 0.036 | 4 |
| TS-2C | 0.13 | 0.13 | 0.0071 | 0.198 | 0.036 | 4 |
| LA-BKG | 0.1 | 0.10 | 0.0071 | 0.198 | 0.036 | 3 |

## Table 8.1-9
## Plant and Earthworm HQs for Study Design COPECs in Soil from Laboratory Toxicity Tests

| | | HQ of Soil Sample from Toxicity Test for Receptor at Left | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Plant COPEC** | **Plant ESL** | **LA-BKG** | **E-1FW** | **E-1W** | **E-1E** | **M-2W** | **M-4** | **TS-1C** | **TS-2C** |
| Barium | 110 | 0.39 | 0.93 | 1.1 | 0.81 | 0.52 | 1.1 | 0.26 | 0.70 |
| Chromium | 2.4 | 2.2 | 218 | 8.4 | 20 | 3.24 | 5.7 | 1.7 | 2.8 |
| Copper | 10 | 0.42 | 9.1 | 1.2 | 0.03 | 1.2 | 2.0 | 0.37 | 0.69 |
| Manganese | 50 | 3.1 | 5.9 | 11 | 12 | 7.5 | 9.4 | 5.1 | 5.5 |
| Selenium | 0.1 | ND[a] | ND | ND | 7.50 | ND | ND | ND | ND |
| Silver | 0.05 | ND | 3.0 | 2.2 | 2.0 | 2.2 | 6.0 | 0.80 | 15.60 |
| Thallium | 0.1 | 1.0 | 1.5 | 2.0 | 8.7 | 1.4 | 5.2 | 1.6 | 1.3 |
| Vanadium | 0.025 | 440 | 1200 | 820 | 452 | 476 | 764 | 476 | 532 |
| Zinc | 10 | 3.0 | 7.5 | 7.5 | 3.0 | 8.0 | 5.6 | 4.6 | 4.7 |
| Acenapthene | 0.25 | ND | ND | ND | ND | ND | ND | ND | ND |
| Endrin aldehyde | 0.0034 | ND | ND | ND | ND | ND | ND | ND | ND |
| **Plant HI** | | 450 | 1446 | 853 | 507 | 500 | 799 | 490 | 563 |
| **Worm COPEC** | **Worm ESL** | **LA-BKG** | **E-1FW** | **E-1W** | **E-1E** | **M-2W** | **M-4** | **TS-1C** | **TS-2C** |
| Chromium | 2.3 | 2.3 | 228 | 8.78 | 21 | 3.4 | 6.0 | 1.8 | 2.9 |
| Copper | 13 | 0.32 | 7.0 | 0.94 | 0.021 | 0.95 | 1.5 | 0.28 | 0.53 |
| Mercury | 0.05 | 0.20 | 1.8 | 0.80 | 0.20 | 0.80 | 4.2 | 0.16 | 0.40 |
| Amercium-241 | 44 | NA[b] | ND | 0.01 | 0.73 | NA | 0.23 | 0.00 | 0.01 |
| Plutonium-238 | 44 | ND | ND | ND | 0.48 | 0.14 | 0.43 | 0.13 | 0.03 |
| Plutonium-239 | 47 | ND | 0.0011 | 0.01 | 1.8 | 0.20 | 0.29 | 0.02 | 0.01 |
| **Worm HI** | | 2.8 | 237 | 11 | 25 | 5.5 | 13 | 2.4 | 3.9 |

[a] ND = Not detected.

[b] NA = Not analyzed.

**Table 8.1-10**
**Summary of Field Plant Survey Results**

| Reach | Approximate Distance Above Rio Grande (km) | Total Species Richness | Shannon Diversity Index (All Species) | Total Percent Canopy Cover |
|---|---|---|---|---|
| LA-BKG | 19.5 | 55 | 3.19 | 235.25 |
| E-1E | 13.8 | 21 | 2.23 | 124.25 |
| E-1FW | 14.3 | 32 | 2.52 | 190.75 |
| E-1W | 14.0 | 18 | 2.15 | 247.25 |
| M-2W | 13.4 | 16 | 2.27 | 208.25 |
| M-3 | 11.5 | 35 | 2.10 | 194.25 |
| M-4 | 10.9 | 45 | 2.32 | 155.50 |
| TS-1C | 13.5 | 56 | 2.61 | 177.75 |
| TS-2C | 12.6 | 43 | 2.57 | 147.75 |

**Table 8.1-10-AWD**
**Habitat Assessment Scores**

| Parameter | Reach and Date | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | E-1W | E-1W | M-1W | M-1W | M-2W | M-2W | TS-1C | TS-2C |
| | 6/21/05 | 9/26/05 | 6/21/05 | 9/26/05 | 6/21/05 | 9/26/05 | 9/26/05 | 9/26/05 |
| Epifaunal Substrate & Cover | 1/20 | 3/20 | 6/20 | 8/20 | 11/20 | 3/20 | 1/20 | 3/20 |
| Embeddedness | 0/20 | 1/20 | 8/20 | 5/20 | 10/20 | 3/20 | 1/20 | 1/20 |
| Velocity/Depth Regime | 1/20 | 3/20 | 6/20 | 6/20 | 0/20 | 0/20 | 0/20 | 0/20 |
| Sediment Deposition | 1/20 | 4/20 | 8/20 | 5/20 | 8/20 | 1/20 | 2/20 | 6/20 |
| Channel Flow Status | 6/20 | 14/20 | 1/20 | 4/20 | 1/20 | 1/20 | 0/20 | 0/20 |
| Channel Alteration | 18/20 | 17/20 | 13/20 | 17/20 | 13/20 | 15/20 | 19/20 | 20/20 |
| Frequency of Riffles | 1/20 | 1/20 | 1/20 | 3/20 | 16/20 | 2/20 | 1/20 | 1/20 |
| Bank Stability | | | | | | | | |
| Left Bank | 8/10 | 8/10 | 9/10 | 8/10 | 5/10 | 8/10 | 2/10 | 9/10 |
| Right Bank | 8/10 | 8/10 | 7/10 | 8/10 | 8/10 | 8/10 | 4/10 | 9/10 |
| Vegetative Bank Protection | | | | | | | | |
| Left Bank | 9/10 | 9/10 | 9/10 | 9/10 | 9/10 | 7/10 | 2/10 | 6/10 |
| Right Bank | 9/10 | 9/10 | 9/10 | 9/10 | 9/10 | 7/10 | 4/10 | 6/10 |
| Riparian Vegetative Zone | | | | | | | | |
| Left Bank | 10/10 | 10/10 | 9/10 | 10/10 | 9/10 | 10/10 | 10/10 | 10/10 |
| Right Bank | 9/10 | 10/10 | 9/10 | 10/10 | 9/10 | 10/10 | 10/10 | 10/10 |
| Habitat Assessment Score | 81/200 | 97/200 | 95/200 | 102/200 | 108/200 | 75/200 | 56/200 | 81/200 |

Note: Values from Henne and Buckley (2006, 93687), indicating the score for each parameter in each reach on each sampling date and the total score possible for that parameter.

## Table 8.1-10-AWD2
## Physical and Chemical Surface Water Parameters

| Parameter | Reach and Date | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | E-1W | E-1W | M-1W | M-1W | M-2W | M-2W | TS-1C | TS-2C |
| | 6/21/05 | 9/26/05 | 6/21/05 | 9/26/05 | 6/21/05 | 9/26/05 | 9/26/05 | 9/26/05 |
| Temperature (°C) | 15.1 | 12.7 | 18.3 | 12.9 | 16.6 | —* | — | — |
| Dissolved Oxygen (mg/l) | 4.61 | 1.10 | 4.05 | 3.24 | 4.59 | — | — | — |
| Dissolved Oxygen (% saturation) | 45.9 | 11.1 | 43.3 | 25.8 | 46.9 | — | — | — |
| Conductivity (µmos/cm) | 335 | 309 | 3 | 220 | 311 | — | — | — |
| pH | — | 6.9 | — | 7.0 | — | — | — | — |

* Dash indicates no data were obtained for parameter.

## Table 8.1-10-AWD3
## Macroinvertebrate Sample Abundance and Number of Taxa

| Parameter | Reach and Date | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | E-1W | | M-1W | | M-2W | | TS-1C | TS-2C |
| | 6/21/05 | 9/26/05 | 6/21/05 | 9/26/05 | 6/21/05 | 9/26/05 | 9/26/05 | 9/26/05 |
| Percent of Sample Processed | 63% | 100% | 6% | 100% | 100% | —* | — | — |
| Number of Individuals Identified | 647 | 76 | 720 | 687 | 48 | — | — | — |
| Number of Taxa | 16 | 12 | 16 | 25 | 12 | — | — | — |
| Estimated Total Number of Individuals in Entire Sample | 1023 | 76 | 10,545 | 687 | 48 | — | — | — |

* Dash indicates no water was present.

**Table 8.1-11**
**Detected Radionuclide Concentrations in Algal Toxicity Test Samples**

| Reach | Sample ID | Radionuclide | Result (pCi/L) | HQ Based on Algae ESL |
|---|---|---|---|---|
| TS-1C | CAMO-05-61178 | Americium-241 | 0.2 | 0.03 |
| M-2W | CAMO-05-61170 | Americium-241 | 1.88 | 0.32 |
| E-1E | CAMO-05-61174 | Americium-241 | 5.29 | 0.91 |
| M-1W | CAMO-05-61176 | Radium-226 | 0.43 | 4.3 |

**~~Table 8.1-12~~**
**~~Estimate Risk to the Occult Myotis Little Brown Bat~~**
**~~from Ingestion of COPECs in the Tissues of Insects Collected from Nest Boxes~~**

| ~~COPEC~~ | ~~Maximum Detected Concentration in Insect Tissue in Nest Box (mg/kg fresh insect)~~ | ~~Mammalian Sediment TRV (mg COPEC/kg bw/day)~~ | ~~Bat Food Ingestion Rate (kgfresh food/kg bird/d)~~ | ~~Food ESL (in mg/kg or pCi/g)~~ | ~~HQ~~ |
|---|---|---|---|---|---|
| ~~Aluminum~~ | ~~250~~ | ~~pH dependent~~ | ~~0.410~~ | ~~n/a*~~ | ~~n/a~~ |
| ~~Arsenic~~ | ~~1.4~~ | ~~1.04~~ | ~~0.410~~ | ~~3~~ | ~~0.55~~ |

~~*n/a = Not applicable.~~

**Table 8.1-13**
**Estimate of Risk to the Red Fox from Ingestion of COPECs in the Tissues of Small Mammals**

| COPEC | Measured Whole Animal Concentration | Mammalian TRV (mg/kg/d) | Fox Food Ingestion Rate (kg food fresh weight/kg bird/d) | ESL (in mg/kg) | HQ |
|---|---|---|---|---|---|
| Aroclor-1260 | 0.32 | 13.8 | 0.14 | 98 | 0.003 |

**Table 8.1-14**
**Lines of Evidence and Rationale for the Mexican Spotted Owl (AE1)**

| Line of Evidence | Weight of Evidence Criteria | Result |
|---|---|---|
| (1) Modeled exposure and literature toxicity information to calculate spatially weighted HQ values using ECORSK.9 (includes consideration of nesting and foraging habitat based on vegetation class coverage) | Medium | Total mean adjusted HI across watershed for owl equals 1.6, indicating a slight potential fro risk (mostly associated with non-canyons contaminants). Mean adjusted HI for reach with known owl nest is 0.2, indicating no potential for risk to owl. |
| (2) Modeled and measured concentrations in prey species (small mammals)—compare prey COPEC concentrations across gradient and determine division of contaminants between carcass and pelt | Medium | Dose of COPEC ingested had HQ<1.0 for all COPECs when compared to TRV, indicating that the risk through food ingestion was much lower than that predicted by the ESL screening. |
| (3) Analysis of owl pellets | Low | Results of pellet analysis confirmed that the small mammal prey species captured and used for tissue analysis are the species consumed by the owl, supporting the use of these species in the food chain modeling |
| (4) Comparison of concentrations in 2005 sediment samples to ESLs | Low | Screening of 2005 sediment data against ESLs resulted in addtion of bis (2ethylhexyl) phthalate as a new COPEC for this receptor |

**Table 8.1-15**
**Lines of Evidence and Rationale for Avian and Mammalian Aerial Insectivores (AE6)**

| Line of Evidence | Weight of Evidence Criteria | Result | Aerial Insectivore Receptors |
|---|---|---|---|
| (1) Nest box study—determine nest success rate by bluebirds along a gradient of COPEC concentrations in the Mortandad Canyon watershed; need to account for other factors known to influence nest success (food, predators, etc.) | Medium (new boxes)<br>High (established boxes) | Percent fledged and percent female nestlings were not different between Mortandad watershed reaches or between Mortandad watershed and other canyons, indicating no effect on population (measured as nest success) | Southwestern willow flycatcher/Violet-green swallow |
| (2) Nest box study—determine eggshell thickness for bluebirds along a gradient of COPEC concentrations in Mortandad, Effluent, and Ten Site Canyons; need to account for other factors known to influence eggshell thickness (amount of calcium in diet, etc.) | Medium | Egg size (length and weight), and eggshell thickness were not different between Mortandad reaches or between Mortandad and other canyons, indicating no effect on nest success | Southwestern willow flycatcher/Violet-green swallow |
| (3) Nest box study—compare COPEC concentrations in eggs within Mortandad Canyon watershed and also compare concentrations with "reference" locations | Medium-low | Concentrations of metals in eggs did not correlate with concentrations of metals in soil, indicating soil is not a source of bioaccumulation into eggs | Southwestern willow flycatcher/Violet-green swallow |
| (4) Compare the measured concentrations of COPECs in insects with the TRV | Medium | Potential dose through food to Southwestern willow flycatcher and little myotis bat modeled based on measured COPEC concentrations in nest box insects. Copper, mercury, vanadium, and zinc had 1.0<HQ<10 for flycatcher using mean concentrations. Bat had no COPECs with HQ>1.0 using maximum detected concentrations. | Southwestern willow flycatcher/Violet-green swallow<br><br>Occult little myotis bat |
| (5) Comparison of concentrations in 2005 sediment and water samples to ESLs | Low | Only new COPEC to swallow or flycatcher from screening of 2005 sediment samples is bis (2 ethylhexyl) phthalate. No new COPECs for bat. Some existing study design COPECs are now COPECs in additional reaches | Southwestern willow flycatcher/Violet-green swallow<br><br>Occult little myotis bat |
| (6) Modeled exposure and literature toxicity information to calculate spatially weighted HQ values using ECORSK.9 (includes consideration of nesting and foraging habitat based on vegetation class coverage)—could be based on a frequency of HQ values greater than 1 for the watershed | Medium | The mean adjusted total HI for the SWF was 6.2, based on mercury, di-n-butyl phthalate, boron, and bis (2ethylhexyl) phthtalate. These values indicate a potential for risk to the flycatcher. | Southwestern willow flycatcher |

**Table 8.1-16**
**Lines of Evidence and Rationale for Avian Ground Invertevores (AE2)**

| Line of Evidence | Weight of Evidence Criteria | Result |
|---|---|---|
| (1) Nest box Study-Compare the measured concentrations of COPECs in insects with the TRV for the robin with the invertevore diet | Medium | Substituted calculations with earthworms for this measure |
| (2) Nest box study—determine nest success rate by bluebirds along a gradient of COPEC concentrations in the Mortandad Canyon watershed; need to account for other factors known to influence nest success (food, predators, etc.) | Medium (new boxes)<br>High (established boxes) | Percent fledged and percent female nestlings were not different between Mortandad watershed reaches or between Mortandad watershed and other canyons, indicating no effect on population (measured as nest success) |
| (3) Nest box study—determine eggshell thickness for bluebirds along a gradient of COPEC concentrations in Mortandad, Effluent, and Ten Site Canyons; need to account for other factors known to influence eggshell thickness (amount of calcium in diet, etc.) | Medium | Egg size (length and weight), and eggshell thickness were not different between Mortandad watershed reaches or between Mortandad watershed and other canyons, indicating no effect on nest success |
| (4) Nest box study—compare COPEC concentrations in eggs within Mortandad Canyon watershed and also compare concentrations with "reference" locations | Medium-low | Concentrations of metals in eggs did not correlate with concentrations of metals in soil, indicating soil is not a source of bioaccumulation into eggs |
| (5) Modeled and measured concentrations in food (earthworm bioaccumulation test)—determine if exposure concentrations differ within the watershed in relation to sediment concentrations; design used a gradient in COPEC concentrations with the Mortandad Canyon watershed and also compared concentrations with "reference" locations | Medium | HQs based on modeled doses from estimated concentrations in earthworms indicated that some COPECs (mercury, bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, and Aroclor-1254) may have potential for ecological risk to avian ground invertevores |
| (6) Modeled exposure and literature toxicity information to calculate spatially weighted HQ values using ECORSK.9 (includes consideration of nesting and foraging habitat based on vegetation class coverage) for bluebird populations in the watershed; will be based on a frequency of HQ values greater than 1 for the watershed (or assessment population area) | Medium | Western bluebird served as a surrogate for the robin representing avian invertevores in the model. The mean adjusted total HI for the bluebird is 1.2, too low for population level effects. |
| (7) Field surveys of avian ground invertevore abundance and diversity in the Mortandad Canyon watershed; and also compare abundance/diversity with "reference" locations | Low | Field surveys of Upper Mortandad and Ten Site Canyon had similar diversity indices and most species in both areas were invertevores, no population level effects seen |
| (8) Comparison of concentrations in 2005 sediment samples to ESLs | Low | Only new COPEC from screening of 2005 sediment samples is bis(2-ethylhexyl)phthalate. Some existing study design COPECs are now COPECs in additional reaches. |

**Table 8.1-17**
**Lines of Evidence and Rationale for Mammalian Invertevores and Omnivores (AE3)**

| Line of Evidence | Weight of Evidence Criteria | Result |
|---|---|---|
| (1) Field surveys to determine small mammal reproduction status along gradient of COPEC concentrations in the Mortandad Canyon watershed and also compare reproduction rates with “reference” locations | Medium high | No differences seen in relative population abundance, gender, or body weight between reaches |
| (2) Modeled and measured concentrations in food (earthworms)—could determine if exposure concentrations differ within the watershed in relation to sediment concentrations; design could use a gradient in COPEC concentrations with the Mortandad Canyon watershed and also compare concentrations with “reference” location | Medium | Modeling of potential risk through food to the shrew or mouse using estimated concentrations in earthworms showed only thallium with an HQ elevated enough to indicate potential for population-level effects. Thallium has a very low TRV and high default TF in model |
| (3) Modeled exposure and literature toxicity information to calculate spatially weighted HQ values using ECORSK.9 (includes consideration of nesting and foraging habitat based on vegetation class coverage) for deer mouse and shrew populations in the watershed—could be based on a frequency of HQ values greater than 1 for the watershed | Medium | Mean HI exceeded 1 in only 8% of sites across watershed. Dominant COPEC in this model is also thallium |
| (4) Comparison of concentrations in 2005 sediment samples to ESLs | Low | Screening of 2005 sediment sample data did not show any new COPECs for these receptors |

**Table 8.1-18**
**Lines of Evidence and Rationale for Detritivores (AE4)**

| Line of Evidence | Weight of Evidence Criteria | Result |
|---|---|---|
| (1) Toxicity test (earthworm mortality) along gradient of COPEC concentrations in the Los Alamos and Pueblo watershed—compare mortality rates with “reference” locations | High | No differences in earthworm mortality seen between reaches, indicating no effect along COPEC gradient. Weight loss differed between reaches, but did not correlate with COPEC concentration. |
| (2) The concentration of COPECs in earthworms | Contributor to other AEs | Not measured due to laboratory error |
| (3) Comparison of concentrations in 2005 sediment samples to ESLs | Low | Screening of 2005 sediment data indicates that hexavalent chromium would be a study design COPEC for this receptor. Existing studies included reaches with this COPEC. |

**Table 8.1-19**
**Lines of Evidence and Rationale for Plants (AE5)**

| Line of Evidence | Weight of Evidence Criteria | Result |
|---|---|---|
| 1) Toxicity test (seedling germination) along gradient of COPEC concentrations in the Los Alamos and Pueblo watershed and also compare germination rates with "reference" locations | High | No differences in mortality, dry root mass, dry shoot mass, or mean root length. Some differences in wet root length and mean shoot length between reaches, but effect did not match with COPEC concentration |
| 2) Abundance and diversity of plants along gradient of COPEC concentrations in the Mortandad watershed and also compare plant abundance/diversity with "reference" locations | Medium | Plant survey showed differences between reaches, but not attributable to COPEC gradient. Differences attributable to climate factors, and species in all reaches increased since previous survey during dry year. |
| (3) Comparison of concentrations in 2005 sediment samples to ESLs | Low | Screening of 2005 sediment data indicates that hexavalent chromium would be a study design COPEC for this receptor. Existing studies included reaches with this COPEC. |

**Table 8.1-20**
**Lines of Evidence and Rationale for the Aquatic Community (AE7)**

| Line of Evidence | Weight of Evidence Criteria | Result |
|---|---|---|
| (1) Estimates of growth and mortality of aquatic invertebrates based on toxicity tests using *Chironomus tentans* compared with the reference location | High | No significant differences in larval survival or mean dry weight of larvae between reaches, indicating no effect of COPECs on larval survival and growth. |
| (2) A rapid bioassessment characterization to evaluate habitat ratings at selected locations based on watershed features, riparian vegetation, in-stream features, aquatic vegetation, and benthic substrate; assessment will also include measures of abundance and diversity of aquatic invertebrates through Hess sampling and dip net capture | Medium | Physical aspects of habitat similar between reaches; all rated as marginal using index scores. Chironomids made up majority of biomass in all reaches, supporting their use as toxicity indicator organism. |
| (3) Comparison of concentrations in 2005 sediment and water samples to ESLs | Low | Screening of 2005 sediment data indicated iron should be a new COPEC for this receptor. Screening of water data also indicated iron should be a new COPEC, and cobalt would be a COPEC at one water location |
| (4) Algae toxicity test | High | Differences seen between water samples from different reaches attributable to differences in water hardness. Algal cell growth in all samples except TS-1C exceeded negative and positive laboratory control sample growth. Results indicate no impairment of algal cell growth due to COPECs in water. |

## Table 8.2-1
## Identifying Sediment COPCs, Non-carcinogens

| Reach | Aluminum | Antimony | Barium | Beryllium | Boron | Cadmium | Chromium hexavalent ion | Cobalt | Copper | Cyanide (Total) | Fluoride | Iron | Lead | Manganese | Mercury[a] | Nickel |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Residential SSL** | **77800** | **31.3** | **15600** | **156** | **15600** | **39** | **234** | **1520** | **3130** | **1220** | **3670** | **23500** | **400** | **3590** | **23** | **1560** |
| M-1W | - | 0.35 | - | - | - | 0.02 | - | - | <0.01 | <0.01 | - | - | 0.06 | - | <0.01 | 0.02 |
| M-1C | - | - | <0.01 | - | - | - | - | - | - | - | - | - | 0.06 | - | - | - |
| M-1E | **0.33** | - | 0.02 | <0.01 | <0.01 | 0.02 | - | <0.01 | <0.01 | - | - | **0.89** | 0.08 | **0.46** | <0.01 | <0.01 |
| E-1FW | **0.27** | - | 0.01 | - | - | 0.02 | <0.01 | <0.01 | **0.12** | - | <0.01 | **0.78** | **0.14** | **0.29** | <0.01 | <0.01 |
| E-1W | **0.24** | 0.05 | 0.02 | 0.02 | - | 0.04 | - | <0.01 | <0.01 | <0.01 | <0.01 | **1.06** | 0.09 | **0.70** | 0.01 | <0.01 |
| E-1E | - | - | <0.01 | - | - | 0.06 | - | <0.01 | 0.04 | - | <0.01 | - | **0.13** | **0.47** | **0.12** | 0.03 |
| M-2W | - | **0.42** | <0.01 | - | - | 0.02 | - | - | 0.02 | - | 0.02 | **0.60** | **0.15** | - | 0.03 | - |
| M-2E | - | - | - | - | - | 0.01 | - | - | 0.01 | - | <0.01 | - | - | - | 0.05 | - |
| M-3 | - | - | - | - | - | 0.01 | - | - | <0.01 | - | <0.01 | 0.59 | - | - | 0.02 | - |
| TS-1W | - | **0.36** | <0.01 | - | - | 0.03 | - | <0.01 | - | - | - | - | - | - | - | - |
| TS-1C | - | **0.36** | <0.01 | - | - | 0.04 | - | <0.01 | <0.01 | - | - | **1.23** | 0.10 | - | - | 0.04 |
| TS-1E | - | - | - | - | - | 0.02 | - | <0.01 | 0.04 | - | - | - | 0.06 | 0.18 | - | - |
| TS-2W | - | - | - | - | - | 0.02 | - | - | <0.01 | - | <0.01 | - | - | - | - | - |
| TS-2C | - | - | - | - | - | 0.02 | - | - | 0.02 | - | <0.01 | - | 0.07 | - | 0.04 | - |
| TS-2E | **0.21** | - | - | - | - | 0.02 | - | <0.01 | 0.02 | - | <0.01 | **0.59** | 0.07 | - | 0.06 | - |
| TS-3 | **-** | - | - | - | - | 0.01 | - | - | <0.01 | - | - | - | 0.05 | 0.16 | <0.01 | - |
| M-4 | - | 0.06 | <0.01 | - | - | 0.02 | - | <0.01 | 0.01 | - | <0.01 | 0.64 | 0.06 | - | 0.01 | - |
| MCW-1 | - | - | - | - | - | 0.01 | - | - | - | - | - | - | 0.05 | - | - | - |
| MCW-2N | - | - | - | - | - | 0.01 | - | - | - | - | - | - | - | - | - | - |
| MCW-2W | - | - | - | - | - | 0.01 | - | - | <0.01 | <0.01 | - | - | - | - | - | - |
| MCW-2E | - | - | - | - | - | 0.01 | - | - | - | - | - | - | - | - | - | - |
| M-5W | - | - | <0.01 | - | - | - | - | - | - | - | - | 0.60 | - | - | - | - |
| M-5E | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| M-6 | - | - | - | - | - | 0.01 | - | - | - | - | - | - | - | - | - | - |

| Reach | Nitrate | Nitrite | Perchlorate[a] | Selenium | Silver | Thallium | Uranium[b] | Vanadium | Zinc | Acenaphthene | Acetone | Anthracene | Aroclor-1254 | Aroclor-1260 | Benzo(g,h,i)perylene[c] | Benzoic Acid[a] | Bromomethane | Butanone[2-] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Residential SSL** | **100000** | **7820** | **55** | **391** | **391** | **5.16** | **16** | **78.2** | **23500** | **3730** | **28100** | **22000** | **1.12** | **1.12** | **2290** | **100000** | **8.51** | **31800** |
| M-1W | - | - | - | <0.01 | <0.01 | - | - | - | <0.01 | <0.01 | <0.01 | <0.01 | - | 0.05 | <0.01 | - | - | - |
| M-1C | - | - | - | <0.01 | - | - | - | - | <0.01 | <0.01 | <0.01 | <0.01 | - | 0.13 | <0.01 | - | - | <0.01 |
| M-1E | - | - | - | 0.03 | <0.01 | - | - | **0.47** | <0.01 | - | <0.01 | - | - | - | - | - | - | <0.01 |
| E-1FW | - | - | <0.01 | 0.03 | - | - | - | **0.68** | <0.01 | <0.01 | <0.01 | <0.01 | **0.14** | 0.03 | <0.01 | - | <0.01 | <0.01 |
| E-1W | - | - | - | 0.01 | 0.01 | - | **0.27** | **0.38** | <0.01 | - | - | - | - | 0.02 | <0.01 | - | - | - |
| E-1E | - | - | <0.01 | <0.01 | <0.01 | **0.31** | **0.26** | - | <0.01 | - | <0.01 | <0.01 | **0.12** | 0.10 | <0.01 | <0.01 | - | <0.01 |
| M-2W | - | - | 0.02 | <0.01 | <0.01 | **0.16** | - | - | <0.01 | - | <0.01 | <0.01 | **0.13** | **0.19** | <0.01 | <0.01 | - | <0.01 |
| M-2E | - | - | <0.01 | <0.01 | <0.01 | - | - | - | <0.01 | <0.01 | <0.01 | <0.01 | 0.04 | 0.04 | - | - | - | - |
| M-3 | - | - | <0.01 | <0.01 | - | - | - | - | <0.01 | - | <0.01 | - | - | 0.35 | - | - | - | - |
| TS-1W | - | - | - | <0.01 | <0.01 | **0.19** | - | **0.29** | - | <0.01 | <0.01 | <0.01 | **0.51** | **1.22** | <0.01 | <0.01 | - | - |
| TS-1C | - | - | - | <0.01 | <0.01 | **0.19** | - | **0.33** | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | **1.16** | <0.01 | <0.01 | - | <0.01 |
| TS-1E | - | - | - | <0.01 | - | - | - | - | - | <0.01 | <0.01 | <0.01 | 0.03 | 0.17 | <0.01 | - | - | <0.01 |
| TS-2W | <0.01 | <0.01 | - | <0.01 | - | - | - | - | - | - | - | <0.01 | - | 0.09 | <0.01 | - | - | <0.01 |
| TS-2C | <0.01 | <0.01 | - | <0.01 | 0.11 | - | - | 0.28 | <0.01 | - | <0.01 | <0.01 | 0.05 | 0.14 | <0.01 | - | - | <0.01 |
| TS-2E | <0.01 | <0.01 | - | 0.03 | 0.09 | - | - | **0.35** | <0.01 | - | <0.01 | - | - | **0.28** | <0.01 | - | - | <0.01 |
| TS-3 | - | - | - | <0.01 | 0.01 | - | - | - | <0.01 | - | - | - | - | 0.06 | - | <0.01 | - | - |
| M-4 | - | - | 0.01 | <0.01 | 0.02 | - | - | - | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.11 | <0.01 | <0.01 | - | <0.01 |
| MCW-1 | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MCW-2N | - | - | - | <0.01 | - | - | - | - | - | <0.01 | - | - | - | - | - | <0.01 | - | - |
| MCW-2W | - | - | - | <0.01 | - | - | - | - | - | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 |
| MCW-2E | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| M-5W | - | - | - | - | - | - | - | - | <0.01 | - | <0.01 | - | - | - | - | - | - | <0.01 |
| M-5E | - | - | - | <0.01 | - | 0.19 | - | - | - | <0.01 | <0.01 | - | - | - | - | - | - | <0.01 |
| M-6 | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

## Table 8.2-1 (continued)

| Reach | Butylbenzylphthalate[a,d] | Chlorophenol[2-] | Dibenzofuran | Dichlorobenzene[1,2-][d] | Dichloroethene[1,1-] | Dichloroethene[cis-1,2-] | Diethylphthalate | Di-n-butylphthalate | Endosulfan Sulfate | Endrin Aldehyde | Fluoranthene | Fluorene | Hexachlorobutadiene | Hexanone[2-] | Isopropylbenzene | Isopropyltoluene[4-][c] | Methoxychlor[4,4'-][a] | Methyl-2-pentanone[4-] | Methylnaphthalene[2-][c] | Naphthalene[a] | Nitroaniline[2-][a] | Nitroaniline[4-][a] | Nitrophenol[2-] | Phenanthrene | Pyrene | Toluene[d] | Trichloroethane[1,1,1-][d] | Trichlorofluoromethane | Trichlorophenol[2,4,6-] | Trimethylbenzene[1,2,4-] | Xylene (Total)[d] | Xylene[1,2-][d] | Xylene[1,3-][d] | SOFnc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Residential SSL** | **240** | **166** | **142** | **37.4** | **206** | **76.5** | **48900** | **6110** | **18.3** | **18.3** | **2290** | **2660** | **12.2** | **31800** | **271** | **271** | **306** | **5510** | **79.5** | **79.5** | **180** | **180** | **166** | **1830** | **2290** | **252** | **563** | **588** | **6.11** | **58** | **82** | **99.5** | **82** | |
| M-1W | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 | - | - | - | - | <0.01 | - | - | - | - | - | - | <0.01 | <0.01 | - | - | - | - | - | - | - | - | 0.55 |
| M-1C | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 | <0.01 | - | - | - | <0.01 | <0.01 | - | - | 0.01 | - | - | - | <0.01 | <0.01 | - | - | - | - | - | - | - | - | 0.21 |
| M-1E | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | **2.34** |
| E-1FW | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 | - | - | <0.01 | <0.01 | - | <0.01 | <0.01 | 0.02 | - | - | - | <0.01 | <0.01 | <0.01 | - | - | - | - | <0.01 | - | - | **2.58** |
| E-1W | - | - | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 | - | - | - | - | - | - | - | - | **2.96** |
| E-1E | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 | - | - | - | - | <0.01 | - | - | - | - | - | - | - | <0.01 | <0.01 | - | - | <0.01 | - | - | - | - | - | **1.66** |
| M-2W | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 | - | - | - | - | <0.01 | - | - | - | - | - | - | - | <0.01 | <0.01 | - | - | <0.01 | - | - | - | - | - | **1.76** |
| M-2E | - | - | - | - | - | - | - | - | <0.01 | - | <0.01 | <0.01 | - | - | - | - | <0.01 | - | - | <0.01 | - | - | - | <0.01 | <0.01 | - | <0.01 | <0.01 | - | - | - | - | - | 0.18 |
| M-3 | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 | - | - | - | - | <0.01 | - | - | - | - | - | - | - | <0.01 | - | <0.01 | - | - | - | - | - | - | - | 0.99 |
| TS-1W | - | - | - | - | - | - | - | <0.01 | - | - | <0.01 | - | - | <0.01 | - | <0.01 | - | - | - | - | <0.01 | <0.01 | - | <0.01 | <0.01 | <0.01 | - | - | - | - | - | - | - | **2.63** |
| TS-1C | <0.01 | - | <0.01 | - | - | - | <0.01 | <0.01 | - | - | <0.01 | <0.01 | - | <0.01 | <0.01 | <0.01 | - | <0.01 | <0.01 | <0.01 | - | - | - | <0.01 | <0.01 | <0.01 | - | - | - | - | - | - | - | **3.50** |
| TS-1E | - | - | <0.01 | - | - | - | - | - | - | - | <0.01 | - | - | - | - | <0.01 | - | - | <0.01 | - | - | - | - | <0.01 | <0.01 | <0.01 | <0.01 | - | - | <0.01 | - | - | - | 0.51 |
| TS-2W | - | - | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 | - | <0.01 | - | - | <0.01 | - | - | - | 0.12 |
| TS-2C | - | - | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | <0.01 | - | - | - | - | - | - | - | <0.01 | <0.01 | <0.01 | <0.01 | - | - | <0.01 | - | - | - | 0.74 |
| TS-2E | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | <0.01 | - | <0.01 | - | - | - | - | - | **1.71** |
| TS-3 | - | - | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | - | 0.32 |
| M-4 | - | - | - | - | - | <0.01 | - | - | - | - | <0.01 | <0.01 | - | - | - | - | - | - | - | <0.01 | - | - | - | <0.01 | <0.01 | <0.01 | - | <0.01 | - | <0.01 | - | <0.01 | <0.01 | 0.97 |
| MCW-1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.07 |
| MCW-2N | - | <0.01 | <0.01 | - | - | - | - | <0.01 | - | - | - | <0.01 | <0.01 | - | - | <0.01 | - | - | <0.01 | - | - | - | <0.01 | - | - | - | - | - | <0.01 | - | - | - | - | 0.03 |
| MCW-2W | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.02 |
| MCW-2E | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | 0.01 |
| M-5W | - | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | - | - | 0.61 |
| M-5E | - | - | - | <0.01 | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | - | - | <0.01 | - | - | - | 0.20 |
| M-6 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.01 |

*Notes:* Residential SSL values are in mg/kg. Ratios in bold and gray shading show where the SOFnc>1 and the ratio is >0.1.

[a] EPA Region 6 residential SSL (EPA 2005, 91002).

[b] EPA Region 9 residential SSL (epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf).

[c] Pyrene used as surrogate for benzo(g,h,i)perylene. Isopropyltoluene uses isopropylbenzene SSL as surrogate and 2-methylnaphthalene uses naphthalene as surrogate.

[d] Screening value is based on saturation, not risk based.

## Table 8.2-2
## Identifying Sediment COPCs, Carcinogens

| Reach | Arsenic | Chromium* | Aroclor-1254 | Aroclor-1260 | Aroclors (Mixed)* | Benzene | Benzo(a)anthracene | Benzo(a)pyrene | Benzo(b)fluoranthene | Benzo(k)fluoranthene | BHC[alpha-] | BHC[beta-] | BHC[gamma-] | Bis(2-ethylhexyl)phthalate | Bromodichloromethane | Carbazole* | Carbon Tetrachloride | Chloroform | Chloromethane | Chrysene | DDD[4,4'-] | DDE[4,4'-] | DDT[4,4'-] | Dibenz(a,h)anthracene | Dichlorobenzene[1,4-] | Dichlorobenzidine[3,3'-] | Dieldrin | Heptachlor Epoxide* | Hexachlorobenzene | Indeno(1,2,3-cd)pyrene | Methylene Chloride | Nitrosodiphenylamine[N-] | Tetrachloroethene | Trichloroethene | SOFca |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Residential SSL** | **3.9** | **2100** | **2.22** | **2.22** | **2.22** | **10.3** | **6.21** | **0.62** | **6.21** | **62.1** | **0.9** | **3.16** | **4.37** | **347** | **14.4** | **240** | **0.97** | **4** | **21.8** | **615** | **24.4** | **17.2** | **17.2** | **0.62** | **39.5** | **10.8** | **0.3** | **0.53** | **3.04** | **6.21** | **182** | **993** | **12.5** | **0.64** | |
| M-1W | **1.13** | - | - | 0.03 | - | - | **0.44** | **3.40** | **0.40** | <0.01 | 0.01 | <0.01 | <0.01 | - | - | - | - | - | - | <0.01 | <0.01 | - | <0.01 | - | - | - | 0.01 | - | - | **0.20** | - | - | <0.01 | - | **5.62** |
| M-1C | - | <0.01 | - | 0.06 | - | - | 0.06 | 0.72 | 0.05 | <0.01 | 0.02 | <0.01 | <0.01 | - | - | - | - | - | - | <0.01 | <0.01 | <0.01 | <0.01 | - | - | - | - | - | - | 0.04 | - | - | <0.01 | - | 0.97 |
| M-1E | **2.15** | <0.01 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.01 | <0.01 | **2.16** |
| E-1FW | **4.26** | **1.05** | 0.07 | 0.01 | - | - | 0.07 | **0.81** | 0.08 | <0.01 | - | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | 0.05 | - | - | <0.01 | - | **6.41** |
| E-1W | **2.82** | **0.30** | - | <0.01 | - | - | 0.04 | **0.42** | 0.08 | - | - | - | - | <0.01 | - | - | - | - | - | <0.01 | - | - | <0.01 | - | - | - | - | - | - | - | - | - | - | - | **3.67** |
| E-1E | **1.56** | 0.07 | 0.06 | 0.05 | 0.02 | - | 0.02 | **0.40** | 0.07 | <0.01 | <0.01 | - | - | <0.01 | - | - | - | <0.01 | - | <0.01 | - | <0.01 | <0.01 | - | - | - | - | <0.01 | - | 0.02 | - | - | - | - | **2.29** |
| M-2W | **1.10** | 0.01 | 0.07 | 0.09 | - | - | 0.06 | **0.60** | 0.06 | <0.01 | - | - | - | <0.01 | - | - | - | - | - | <0.01 | - | - | <0.01 | - | - | - | - | - | - | <0.01 | - | - | - | - | **2.01** |
| M-2E | - | <0.01 | 0.02 | 0.02 | - | - | 0.04 | 0.26 | 0.02 | <0.01 | - | <0.01 | - | <0.01 | - | - | - | - | - | <0.01 | - | - | <0.01 | - | - | - | 0.01 | - | - | - | - | - | - | - | 0.38 |
| M-3 | **1.03** | <0.01 | - | **0.18** | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | <0.01 | - | - | - | **1.21** |
| TS-1W | - | - | **0.26** | **0.62** | **0.68** | - | 0.07 | **1.08** | **0.14** | <0.01 | - | - | - | <0.01 | - | - | <0.01 | - | - | <0.01 | - | - | - | - | - | - | - | - | - | 0.04 | <0.01 | - | - | - | **2.89** |
| TS-1C | - | - | <0.01 | **0.59** | - | <0.01 | **0.30** | **3.29** | **0.41** | 0.02 | - | - | - | <0.01 | - | - | - | - | - | <0.01 | - | - | - | **0.29** | - | - | - | - | - | **0.23** | - | - | - | <0.01 | **5.13** |
| TS-1E | - | - | 0.01 | 0.09 | - | - | **0.12** | **1.37** | **0.26** | <0.01 | - | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | 0.08 | - | - | <0.01 | <0.01 | **1.93** |
| TS-2W | - | - | - | 0.05 | - | - | 0.05 | 0.61 | 0.06 | <0.01 | - | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | 0.05 | - | - | <0.01 | <0.01 | 0.82 |
| TS-2C | - | 0.01 | 0.03 | 0.07 | - | - | 0.02 | 0.27 | 0.06 | - | - | - | - | <0.01 | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | 0.02 | - | - | <0.01 | <0.01 | 0.48 |
| TS-2E | **1.14** | 0.01 | - | **0.14** | - | <0.01 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | **1.29** |
| TS-3 | - | - | - | 0.03 | - | - | <0.01 | 0.13 | 0.01 | <0.01 | <0.01 | - | - | <0.01 | - | - | - | - | - | <0.01 | - | - | <0.01 | - | - | - | - | - | - | - | - | - | - | - | 0.19 |
| M-4 | **1.18** | <0.01 | <0.01 | 0.05 | - | - | 0.09 | **0.95** | 0.10 | <0.01 | - | - | - | <0.01 | <0.01 | <0.01 | - | - | <0.01 | <0.01 | - | - | <0.01 | - | - | 0.06 | - | - | - | 0.05 | <0.01 | - | <0.01 | - | **2.50** |
| MCW-1 | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.00 |
| MCW-2N | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.01 | - | - | 0.00 |
| MCW-2W | - | - | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | 0.00 |
| MCW-2E | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.00 |
| M-5W | - | - | - | - | - | - | - | - | - | - | 0.04 | <0.01 | <0.01 | - | - | - | - | - | - | - | <0.01 | <0.01 | <0.01 | - | - | - | - | - | - | - | <0.01 | - | <0.01 | <0.01 | 0.06 |
| M-5E | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.01 | - | <0.01 | 0.02 | 0.02 |
| M-6 | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 0.00 |

*Notes:* Residential SSL values are in mg/kg. Ratios in bold and gray shading show where the SOFnc>1 and the ratio is >0.1.
*EPA Region 6 residential SSL (EPA 2005, 91002), multiplied by 10 to account for target risk level of 1E-5.

**Table 8.2-3**
**Identifying Sediment COPCs, Radionuclides**

| Reach | Americium-241 | Cesium-134 | Cesium-137 | Cobalt-60 | Europium-152 | Plutonium-238 | Plutonium-239 | Ruthenium-106 | Sodium-22 | Strontium-90 | Thorium-228 | Thorium-230 | Thorium-232 | Tritium | Uranium-234 | Uranium-235 | Uranium-238 | SOFrad |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Residential SAL*** | **30** | **2.4** | **5.6** | **1.3** | **2.9** | **37** | **33** | **20** | **1.6** | **5.7** | **2.3** | **5** | **5** | **750** | **170** | **17** | **86** | |
| M-1W | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | <0.01 | - | - | - | <0.01 |
| M-1C | 0.03 | 0.03 | - | - | - | <0.01 | - | - | - | - | - | - | 0.7 | - | - | - | - | 0.76 |
| M-1E | <0.01 | - | - | - | - | <0.01 | 0.16 | - | - | - | - | - | - | - | - | - | - | 0.17 |
| E-1FW | - | 0.03 | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | - | - | 0.04 |
| **E-1W** | 0.01 | - | **0.38** | - | - | 0.01 | **0.91** | - | - | - | - | - | - | - | - | - | 0.03 | **1.35** |
| **E-1E** | **21.4** | 0.08 | **452** | **4.02** | - | **2.4** | **41.2** | - | **0.31** | **47.9** | - | - | - | **0.14** | 0.09 | 0.04 | 0.08 | **569** |
| **M-2W** | **17.5** | 0.1 | **155** | **1.88** | - | **5.49** | **18.1** | - | 0.09 | **6.3** | - | - | - | 0.01 | 0.09 | 0.05 | **0.12** | **205** |
| **M-2E** | **7.03** | 0.05 | **99.5** | **0.38** | - | **3.05** | **4.76** | - | - | **3.51** | - | - | - | <0.01 | - | - | - | **118** |
| **M-3** | **7.43** | 0.07 | **53.2** | **1.13** | - | **1.11** | **3.73** | 0.04 | - | **1.51** | - | - | - | <0.01 | - | 0.03 | - | **68.3** |
| **TS-1W** | **0.14** | 0.03 | **0.64** | **0.99** | - | **1.83** | **0.59** | - | - | **0.55** | - | - | - | <0.01 | 0.02 | - | 0.04 | **4.82** |
| **TS-1C** | 0.08 | - | **0.57** | - | - | **8.49** | **1.07** | - | - | - | **6.61** | **5.7** | **2.71** | <0.01 | - | 0.01 | 0.03 | **25.3** |
| **TS-1E** | - | - | - | - | - | **9.14** | **1.15** | - | - | - | - | - | - | - | - | - | - | **10.3** |
| **TS-2W** | 0.02 | 0.03 | - | - | - | 0.06 | 0.02 | - | - | **1.18** | - | - | - | <0.01 | - | - | - | **1.30** |
| **TS-2C** | 0.01 | 0.04 | - | - | - | 0.05 | 0.03 | - | - | **0.98** | - | - | - | <0.01 | - | 0.01 | - | **1.13** |
| **TS-2E** | - | 0.03 | - | - | - | 0.04 | **0.16** | - | - | **1.46** | - | - | - | - | - | - | 0.03 | **1.71** |
| TS-3 | - | - | 0.22 | - | - | 0.04 | 0.02 | - | - | 0.54 | - | - | - | <0.01 | - | - | - | 0.83 |
| **M-4** | **3.73** | 0.08 | **49.3** | **0.34** | **0.12** | **0.87** | **1.95** | - | - | **1.69** | - | - | - | <0.01 | - | 0.02 | - | **58.1** |
| MCW-1 | - | - | - | - | - | - | <0.01 | - | - | - | - | 0.49 | - | - | - | - | - | <0.01 |
| MCW-2N | - | - | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | - | - | <0.01 |
| M-5W | - | - | 0.16 | - | - | - | <0.01 | - | - | 0.29 | - | - | - | - | - | 0.01 | - | 0.48 |
| M-5E | - | 0.04 | 0.17 | - | - | <0.01 | <0.01 | - | - | - | - | - | - | - | - | 0.02 | - | 0.23 |

*Note:* Ratios in bold and gray shading show where the SOFrad>1 and the ratio is >0.1.
*LANL (2005, 88493).

## Table 8.2-4
## Identifying Surface Water COPCs, Non-carcinogens

| Location ID | Reach | Media Code | Field Preparation | Aluminum | Antimony | Barium | Beryllium | Boron | Cadmium | Cobalt | Copper | Cyanide (Total) | Fluoride | Iron | Lead[a] | Manganese | Mercury | Molybdenum | Nickel | Selenium | Silver | Strontium | Thallium | Vanadium | Zinc | Perchlorate | Uranium[b] | Acetone | Butanone[2-] | Methyl-2-pentanone[4-] | Pyrene | Benzoic Acid | SOFnc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Tap Water Screening Level** | | | | **36500** | **14.6** | **7300** | **73** | **7300** | **18.3** | **730** | **1460** | **730** | **2190** | **11000** | **15** | **5110** | **11** | **183** | **730** | **183** | **183** | **21900** | **2.41** | **36.5** | **11000** | **25.6** | **7.3** | **5480** | **7060** | **1990** | **183** | **146000** | |
| **MO-24786** | east of E-1FW | WS | Filtered | <0.01 | - | 0.03 | - | <0.01 | <0.01 | 0.02 | 0.02 | <0.01 | 0.04 | **0.52** | 0.07 | **0.16** | <0.01 | **0.48** | 0.02 | <0.01 | - | - | <0.01 | **0.25** | 0.05 | **0.11** | <0.01 | - | - | - | - | - | **1.80** |
| **MO-24786** | east of E-1FW | WS | Unfiltered | 0.03 | - | 0.03 | - | <0.01 | <0.01 | 0.02 | 0.03 | - | **0.16** | **0.38** | **0.21** | **0.17** | - | **0.51** | 0.02 | - | - | - | <0.01 | - | 0.06 | **0.23** | <0.01 | <0.01 | - | - | - | - | **1.86** |
| **MO-24787** | E-1W | WS | Filtered | 0.04 | - | 0.02 | - | <0.01 | - | <0.01 | - | - | **0.34** | **0.41** | 0.05 | **0.19** | <0.01 | **0.25** | <0.01 | - | 0.05 | - | <0.01 | - | 0.04 | 0.10 | <0.01 | - | - | - | - | - | **1.50** |
| **MO-24787** | E-1W | WS | Unfiltered | 0.09 | - | 0.02 | <0.01 | <0.01 | <0.01 | <0.01 | <0.01 | - | **0.35** | **0.57** | **0.12** | **0.21** | - | **0.35** | <0.01 | - | - | - | <0.01 | - | 0.07 | **0.17** | <0.01 | <0.01 | - | - | - | - | **1.98** |
| MO-24788 | E-1E | WS | Filtered | 0.03 | 0.06 | <0.01 | - | 0.01 | - | <0.01 | <0.01 | - | 0.24 | 0.05 | 0.04 | <0.01 | <0.01 | 0.19 | 0.02 | 0.01 | - | - | <0.01 | 0.17 | 0.07 | 0.06 | <0.01 | - | - | - | - | - | 0.98 |
| **MO-24788** | E-1E | WS | Unfiltered | 0.09 | 0.05 | <0.01 | <0.01 | 0.01 | <0.01 | - | 0.02 | - | **0.28** | **0.19** | **0.15** | 0.01 | - | **0.19** | 0.02 | 0.03 | - | - | <0.01 | - | 0.09 | 0.09 | <0.01 | <0.01 | <0.01 | - | <0.01 | - | **1.24** |
| **MO-24789** | M-1W | WS | Filtered | **0.34** | 0.08 | 0.01 | - | <0.01 | 0.01 | <0.01 | <0.01 | 0.01 | **0.12** | **0.66** | **0.54** | <0.01 | <0.01 | **0.64** | <0.01 | 0.02 | - | - | <0.01 | - | 0.06 | **0.56** | <0.01 | - | - | - | - | - | **3.11** |
| **MO-24789** | M-1W | WS | Unfiltered | **1.20** | 0.07 | 0.03 | 0.03 | <0.01 | 0.03 | <0.01 | 0.04 | - | **0.33** | **2.34** | **1.80** | 0.02 | <0.01 | **0.66** | 0.02 | - | - | - | <0.01 | - | 0.10 | **1.32** | 0.02 | - | - | - | - | - | **8.02** |
| **MO-24790** | M-1E | WS | Filtered | **0.12** | - | 0.02 | - | <0.01 | - | 0.01 | <0.01 | - | 0.08 | **0.21** | **0.11** | **0.36** | <0.01 | 0.03 | 0.01 | - | - | - | <0.01 | - | 0.04 | 0.10 | <0.01 | - | - | - | - | - | **1.09** |
| **MO-24790** | M-1E | WS | Unfiltered | **0.20** | - | 0.02 | - | <0.01 | <0.01 | <0.01 | <0.01 | - | **0.23** | **0.38** | **0.21** | **0.39** | - | 0.03 | 0.01 | - | - | - | <0.01 | - | 0.05 | **0.21** | <0.01 | <0.01 | - | - | - | - | **1.76** |
| MO-24808 | M-2W | WS | Unfiltered | 0.02 | - | <0.01 | <0.01 | - | <0.01 | - | <0.01 | - | - | 0.04 | 0.04 | 0.02 | - | - | <0.01 | <0.01 | - | - | - | - | - | 0.06 | <0.01 | - | - | - | - | - | 0.22 |
| **Mortandad at GS-1** | M-2W | WS | Filtered | 0.03 | 0.07 | <0.01 | <0.01 | <0.01 | 0.06 | <0.01 | 0.02 | - | **0.41** | 0.05 | 0.10 | <0.01 | <0.01 | **0.53** | 0.02 | - | <0.01 | <0.01 | <0.01 | **0.11** | **0.52** | **0.12** | 0.02 | - | - | - | - | - | **2.08** |
| **Mortandad at GS-1** | M-2W | WS | Unfiltered | 0.03 | - | <0.01 | <0.01 | - | 0.01 | <0.01 | 0.01 | 0.01 | - | 0.06 | 0.03 | <0.01 | <0.01 | - | 0.02 | **3.89** | 0.01 | <0.01 | - | 0.09 | **0.52** | **0.16** | - | - | - | - | - | - | **4.87** |
| **Mortandad below Effluent Canyon** | M-2W | WS | Filtered | 0.08 | 0.04 | <0.01 | - | 0.01 | <0.01 | - | <0.01 | - | **0.25** | **0.14** | 0.10 | <0.01 | <0.01 | **0.20** | <0.01 | 0.02 | - | - | <0.01 | 0.08 | - | **0.13** | <0.01 | - | - | - | - | - | **1.09** |
| Mortandad below Effluent Canyon | M-2W | WS | Unfiltered | 0.12 | - | <0.01 | - | <0.01 | - | - | <0.01 | - | 0.14 | 0.22 | 0.18 | <0.01 | - | - | - | 0.02 | 0.01 | - | <0.01 | - | - | - | <0.01 | 0.01 | - | - | - | <0.01 | 0.74 |
| **MO-24791** | M-2E | WS | Filtered | <0.01 | 0.04 | <0.01 | - | <0.01 | - | - | <0.01 | - | **0.27** | <0.01 | - | - | <0.01 | **0.18** | <0.01 | **0.97** | - | - | <0.01 | - | 0.09 | 0.03 | <0.01 | - | - | - | - | - | **1.62** |
| MO-24791 | M-2E | WS | Unfiltered | 0.03 | 0.04 | <0.01 | - | <0.01 | - | - | <0.01 | - | 0.28 | 0.04 | - | <0.01 | - | 0.17 | <0.01 | - | - | - | <0.01 | - | 0.10 | 0.04 | <0.01 | - | - | - | - | - | 0.72 |
| MO-24792 | TS-1C | WS | Filtered | 0.04 | - | 0.01 | - | <0.01 | - | <0.01 | <0.01 | 0.01 | 0.03 | 0.08 | - | 0.09 | <0.01 | 0.07 | <0.01 | <0.01 | - | - | <0.01 | 0.37 | 0.03 | - | <0.01 | - | - | - | - | - | 0.76 |
| **MO-24792** | TS-1C | WS | Unfiltered | **1.03** | - | 0.05 | 0.05 | <0.01 | 0.07 | 0.02 | 0.02 | <0.01 | **0.10** | **3.44** | **2.24** | **0.33** | - | 0.08 | 0.02 | - | - | <0.01 | <0.01 | **0.30** | **0.40** | **1.00** | 0.02 | <0.01 | - | - | - | - | **9.18** |
| MO-24793 | TS-2E | WS | Filtered | 0.01 | - | 0.02 | - | <0.01 | - | <0.01 | <0.01 | - | 0.14 | 0.05 | 0.04 | 0.17 | <0.01 | 0.20 | 0.01 | - | - | <0.01 | <0.01 | - | 0.11 | 0.11 | <0.01 | - | - | - | - | - | 0.88 |
| **MO-24793** | TS-2E | WS | Unfiltered | 0.06 | - | 0.02 | - | <0.01 | <0.01 | <0.01 | <0.01 | - | **0.14** | **0.10** | **0.11** | **0.17** | - | **0.20** | 0.01 | - | - | <0.01 | <0.01 | - | **0.11** | **0.12** | <0.01 | <0.01 | - | - | - | - | **1.09** |
| MO-24794 | TS-1E | WS | Unfiltered | 0.03 | - | 0.02 | <0.01 | - | - | - | <0.01 | - | 0.15 | 0.06 | 0.08 | 0.02 | - | - | <0.01 | - | - | - | - | - | - | 0.09 | <0.01 | - | - | - | - | - | 0.45 |
| MO-24795 | TS-2C | WS | Unfiltered | 0.02 | - | 0.02 | <0.01 | - | 0.03 | <0.01 | 0.02 | <0.01 | 0.20 | 0.04 | 0.11 | 0.08 | - | - | 0.01 | - | - | 0.03 | - | - | - | 0.07 | <0.01 | - | - | - | - | - | 0.64 |
| **Mortandad at Rio Grande (A-11)** | none | WS | Filtered | <0.01 | - | <0.01 | - | 0.08 | <0.01 | 0.02 | 0.02 | - | **0.51** | <0.01 | 0.04 | <0.01 | <0.01 | 0.01 | <0.01 | - | - | - | <0.01 | - | 0.07 | **0.22** | <0.01 | - | - | - | - | - | 1.00 |

*Notes:* All values in ug/L. Ratios in bold and gray shading show where the SOFnc>1 and the ratio is >0.1.

[a] EPA Region 6 screening value (EPA 2005, 91002).

[b] EPA Region 9 screening value (epa.gov/region09/waste/sfund/prg/files/04prgtable.pdf).

**Table 8.2-5**
**Identifying Surface Water COPCs, Carcinogens**

| Location ID | Reach | Media Code | Field Preparation | Arsenic | Chromium[a] | Aroclor-1260 | SOFca |
|---|---|---|---|---|---|---|---|
| **Tap Water Screening Level[b]** | | | | **0.44** | **1100** | **0.33** | |
| **MO-24786** | east of E-1FW | WS | Filtered | **17.6** | 0.03 | - | **17.7** |
| **MO-24786** | east of E-1FW | WS | Unfiltered | **17.2** | 0.04 | - | **17.2** |
| MO-24787 | E-1W | WS | Filtered | - | <0.01 | - | - |
| **MO-24787** | E-1W | WS | Unfiltered | **14.9** | <0.01 | - | **14.9** |
| MO-24788 | E-1E | WS | Filtered | - | <0.01 | - | - |
| MO-24788 | E-1E | WS | Unfiltered | - | <0.01 | - | - |
| MO-24789 | M-1W | WS | Filtered | - | <0.01 | - | - |
| **MO-24789** | M-1W | WS | Unfiltered | **14.7** | 0.03 | - | **14.7** |
| MO-24790 | M-1E | WS | Filtered | - | <0.01 | - | - |
| MO-24790 | M-1E | WS | Unfiltered | - | <0.01 | - | - |
| **Mortandad at GS-1** | M-2W | WS | Filtered | **5.43** | <0.01 | - | **5.4** |
| **Mortandad at GS-1** | M-2W | WS | Unfiltered | **5.86** | <0.01 | - | **5.9** |
| Mortandad below Effluent Canyon | M-2W | WS | Filtered | - | <0.01 | - | - |
| Mortandad below Effluent Canyon | M-2W | WS | Unfiltered | - | <0.01 | - | - |
| MO-24791 | M-2E | WS | Filtered | - | - | - | - |
| MO-24791 | M-2E | WS | Unfiltered | - | <0.01 | - | - |
| MO-24792 | TS-1C | WS | Filtered | - | <0.01 | - | - |
| **MO-24792** | TS-1C | WS | Unfiltered | **17.0** | <0.01 | **3.31** | **20.3** |
| MO-24793 | TS-2E | WS | Filtered | - | 0.02 | - | 0.0 |
| MO-24793 | TS-2E | WS | Unfiltered | - | <0.01 | - | - |
| MO-24794 | TS-1E | WS | Unfiltered | - | <0.01 | - | - |
| MO-24795 | TS-2C | WS | Unfiltered | - | - | - | - |
| MO-24808 | M-2W | WS | Unfiltered | - | <0.01 | - | - |
| Mortandad at Rio Grande (A-11) | none | WS | Filtered | - | - | - | - |

*Notes:* All values in ug/L. Ratios in bold and gray shading show where the SOFca>1 and the ratio is >0.1.

[a] Used hexavalent chromium screening value.

[b] EPA Region 6 screening value (EPA 2005, 91002).

**Table 8.2-6**
**Identifying Surface Water COPCs, Radionuclides**

| Location ID | Reach | Media code | Field Preparation | Americium-241 | Cesium-137 | Plutonium-238 | Plutonium-239 | Plutonium-239/240[a] | Potassium-40 | Radium-226 | Sodium-22 | Strontium-90 | Technetium-99 | Thorium-228 | Thorium-230 | Thorium-232 | Tritium | Uranium-234 | Uranium-235 | Uranium-235/236[b] | Uranium-238 | SOFrad |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Tap Water Screening Level[c]** | | | | **1.2** | **120** | **1.6** | **1.2** | **1.2** | **280** | **4** | **400** | **40** | **4000** | **16** | **12** | **2** | **80000** | **20** | **24** | **24** | **24** | |
| MO-24786 | east of E-1FW | WS | Unfiltered | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | <0.01 | <0.01 | - | - | <0.01 | 0.03 |
| MO-24786 | east of E-1FW | WS | Filtered | - | - | - | <0.01 | - | - | - | - | - | - | - | - | - | - | <0.01 | - | - | <0.01 | 0.01 |
| MO-24787 | E-1W | WS | Unfiltered | - | - | - | - | - | - | 0.19 | - | 0.01 | - | - | - | - | <0.01 | <0.01 | - | - | <0.01 | 0.23 |
| MO-24787 | E-1W | WS | Filtered | - | - | - | <0.01 | - | - | - | - | 0.01 | - | - | - | - | - | <0.01 | - | - | <0.01 | 0.02 |
| **MO-24788** | E-1E | WS | Unfiltered | **7.2** | **0.30** | **1.97** | **1.78** | **4.04** | **0.23** | - | - | 0.10 | - | - | - | - | 0.014 | 0.03 | - | - | <0.01 | **15.7** |
| **MO-24788** | E-1E | WS | Filtered | **3.39** | **0.19** | **0.94** | <0.01 | **2.13** | - | **0.10** | - | **0.11** | - | - | - | - | - | 0.02 | - | - | 0.02 | **6.90** |
| MO-24789 | M-1W | WS | Unfiltered | - | - | 0.08 | 0.07 | - | - | 0.11 | - | 0.01 | - | - | - | - | <0.01 | 0.02 | - | - | 0.02 | 0.31 |
| MO-24789 | M-1W | WS | Filtered | - | - | - | <0.01 | - | - | 0.36 | - | - | - | - | - | - | - | <0.01 | - | - | <0.01 | 0.38 |
| MO-24790 | M-1E | WS | Unfiltered | - | - | - | - | - | - | - | - | 0.01 | - | - | - | - | <0.01 | <0.01 | - | - | <0.01 | 0.02 |
| MO-24790 | M-1E | WS | Filtered | - | - | - | <0.01 | - | - | 0.09 | - | 0.02 | - | - | - | - | - | <0.01 | - | - | <0.01 | 0.12 |
| **MO-24808** | M-2W | WS | Unfiltered | **1.57** | - | **0.47** | **0.68** | - | - | - | - | - | - | - | - | - | - | 0.02 | - | - | <0.01 | **2.74** |
| **Mortandad at GS-1** | M-2W | WS | Unfiltered | **5.45** | **0.26** | **3.13** | - | **5.63** | - | - | 0.02 | **1.19** | - | - | - | - | **0.658** | **0.17** | - | <0.01 | 0.05 | **16.6** |
| **Mortandad at GS-1** | M-2W | WS | Filtered | **0.5** | - | **0.94** | - | **0.68** | - | - | - | **1.13** | - | - | - | - | - | **0.18** | - | <0.01 | 0.05 | **3.48** |
| **Mortandad below Effluent Canyon** | M-2W | WS | Unfiltered | **12.5** | **0.36** | **4.22** | - | **3.94** | - | **0.18** | 0.03 | **0.29** | - | <0.01 | <0.01 | 0.05 | **0.161** | **0.15** | - | <0.01 | 0.01 | **21.9** |
| **Mortandad below Effluent Canyon** | M-2W | WS | Filtered | **1.35** | 0.08 | **0.28** | - | **0.63** | - | **0.15** | - | 0.08 | - | - | - | - | - | <0.01 | - | - | <0.01 | **2.57** |
| **MO-24791** | M-2E | WS | Unfiltered | **0.82** | 0.05 | **0.18** | - | **0.42** | - | - | - | **1.10** | <0.01 | - | - | - | <0.01 | 0.03 | - | - | <0.01 | **2.60** |
| **MO-24791** | M-2E | WS | Filtered | **0.53** | - | **0.13** | <0.01 | **0.33** | - | - | - | **1.04** | - | - | - | - | - | 0.03 | - | - | <0.01 | **2.06** |
| **MO-24792** | TS-1C | WS | Unfiltered | **0.17** | - | **1.12** | **0.66** | **0.32** | - | - | - | **0.17** | - | - | - | - | <0.01 | 0.01 | - | - | <0.01 | **2.45** |
| MO-24792 | TS-1C | WS | Filtered | 0.03 | - | 0.14 | - | 0.06 | - | - | - | 0.23 | <0.01 | <0.01 | - | <0.01 | <0.01 | <0.01 | - | - | <0.01 | 0.47 |
| MO-24793 | TS-2E | WS | Unfiltered | - | - | 0.04 | - | - | - | - | - | 0.53 | - | - | - | - | <0.01 | 0.01 | - | - | 0.01 | 0.60 |
| MO-24793 | TS-2E | WS | Filtered | - | - | - | <0.01 | - | - | - | - | 0.48 | - | - | - | - | - | 0.01 | - | - | 0.01 | 0.50 |
| MO-24794 | TS-1E | WS | Unfiltered | - | - | 0.08 | - | - | - | - | - | - | - | - | - | - | - | 0.01 | - | - | 0.01 | 0.10 |
| MO-24795 | TS-2C | WS | Unfiltered | - | - | 0.04 | - | - | - | - | - | - | - | - | - | - | - | <0.01 | - | - | <0.01 | 0.05 |
| Mortandad at Rio Grande (A-11) | none | WS | Unfiltered | 0.03 | - | - | - | - | - | 0.34 | - | <0.01 | - | - | - | - | <0.01 | 0.02 | - | - | <0.01 | 0.40 |
| Rio Grande at Mortandad | none | WS | Unfiltered | - | - | - | - | - | - | - | - | - | - | - | - | - | <0.01 | - | - | - | - | <0.01 |
| Rio Grande at Mortandad | none | WS | Filtered | - | - | - | - | - | - | - | - | <0.01 | - | - | <0.01 | - | - | 0.03 | - | - | 0.01 | 0.06 |

*Note:* Ratios in bold and gray shading show where the SOFrad>1 and the ratio is >0.1.

[a] Plutonium-239 DCG.

[b] Uranium-235 DCG.

[c] DCG (Derived Concentration Guide) based on committed effective dose equivalent of 4 mrem/yr, all values in pCi/L.

**Table 8.2-7**
**Reaches Evaluated for Water, Sediment, and Multimedia Exposure**

| Endpoint | Reach | Water | Sediment | Multimedia |
|---|---|---|---|---|
| Carcinogen | M-1W | x | x | yes |
| | M-1E | | x | |
| | E-1FW | x | x | yes |
| | E-1W | x | x | yes |
| | E-1E | | x | |
| | M-2W | x | x | |
| | M-3 | | x | |
| | TS-1W | | x | |
| | TS-1C | x | x | yes |
| | TS-1E | | x | |
| | TS-2E | | x | |
| | M-4 | | x | |
| Non-carcinogen | M-1W | x | | |
| | M-1E | x | x | yes |
| | E-1FW | x | x | yes |
| | E-1W | x | x | yes |
| | E-1E | x | x | yes |
| | M-2W | x | x | yes |
| | M-2E | x | | |
| | TS-1W | | x | |
| | TS-1C | x | x | yes |
| | TS-2E | x | x | yes |
| Radionuclide | E-1W | | x | |
| | E-1E | x | x | yes |
| | M-2W | x | x | yes |
| | M-2E | x | x | yes |
| | M-3 | | x | |
| | TS-1W | | x | |
| | TS-1C | x | x | yes |
| | TS-1E | | x | |
| | TS-2W | | x | |
| | TS-2C | | x | |
| | TS-2E | | x | |
| | M-4 | | x | |

**Table 8.2-8**
**Site-Specific Exposure Scenarios and Complete Exposure Pathways**

| | Exposure Scenarios | |
|---|---|---|
| **Exposure Pathways** | **Trail User** | **Residential** |
| Incidental ingestion of soil | X | X |
| Inhalation of dust | X | X |
| Dermal contact with soil | X | X |
| Ingestion of fruits and vegetables | —* | X |
| Ingestion of meat | — | — |
| Ingestion of groundwater | — | — |
| Dermal contact with groundwater | — | — |
| Ingestion of surface water | X | — |
| Dermal contact with surface water | X | — |
| External irradiation | X | X |

* — = Incomplete pathway.

**Table 8.2-9**
**Media-Specific Risk-Based Screening Levels (MSSL) for the Trail User Scenario**

| Medium | COPC | CAS ID | Units | Endpoint | Target Adverse-Effect Level | Recreational MSSL | Reference |
|---|---|---|---|---|---|---|---|
| Sediment | Aluminum | 7429-90-5 | mg/kg | nc | HQ=1 | 100000 | LANL (2004, 87800) |
| Sediment | Antimony | 7440-36-0 | mg/kg | nc | HQ=1 | 317 | LANL (2004, 87800) |
| Sediment | Aroclor-1254 | 11097-69-1 | mg/kg | ca | 1E-5 risk | 10.5 | LANL (2004, 87800) |
| Sediment | Aroclor-1254-nc | 11097-69-1 | mg/kg | nc | HQ=1 | 6.65 | LANL (2004, 87800) |
| Sediment | Aroclor-1260 | 11096-82-5 | mg/kg | ca | 1E-5 risk | 10.5 | LANL (2004, 87800) |
| Sediment | Aroclors (Mixed) | 1336-36-3 | mg/kg | ca | 1E-5 risk | 10.5 | LANL (2004, 87800) |
| Sediment | Arsenic | 7440-38-2 | mg/kg | ca | 1E-5 risk | 27.7 | LANL (2004, 87800) |
| Sediment | Arsenic-nc | 7440-38-2 | mg/kg | nc | HQ=1 | 183 | LANL (2004, 87800) |
| Sediment | Benzo(a)anthracene | 56-55-3 | mg/kg | ca | 1E-5 risk | 30.1 | LANL (2004, 87800) |
| Sediment | Benzo(a)pyrene | 50-32-8 | mg/kg | ca | 1E-5 risk | 3.01 | LANL (2004, 87800) |
| Sediment | Benzo(b)fluoranthene | 205-99-2 | mg/kg | ca | 1E-5 risk | 30.1 | LANL (2004, 87800) |
| Sediment | Chromium | 7440-47-3 | mg/kg | ca | 1E-5 risk | 100000 | LANL (2004, 87800) |
| Sediment | Chromium-nc | 7440-47-3 | mg/kg | nc | HQ=1 | 14300 | LANL (2004, 87800) |
| Sediment | Copper | 7440-50-8 | mg/kg | nc | HQ=1 | 31700 | LANL (2004, 87800) |
| Sediment | Indeno(1,2,3-cd)pyrene | 193-39-5 | mg/kg | ca | 1E-5 risk | 30.1 | LANL (2004, 87800) |
| Sediment | Iron | 7439-89-6 | mg/kg | nc | HQ=1 | 100000 | LANL (2004, 87800) |
| Sediment | Lead | 7439-92-1 | mg/kg | nc | HQ=1 | 560 | LANL (2004, 87800) |
| Sediment | Manganese | 7439-96-5 | mg/kg | nc | HQ=1 | 15800 | LANL (2004, 87800) |
| Sediment | Mercury | 7487-94-7 | mg/kg | nc | HQ=1 | 238 | LANL (2004, 87800) |
| Sediment | Thallium | 7440-28-0 | mg/kg | nc | HQ=1 | 52.3 | LANL (2004, 87800) |
| Sediment | Uranium | 7440-61-1 | mg/kg | nc | HQ=1 | 2380 | LANL (2004, 87800) |
| Sediment | Vanadium | 7440-62-2 | mg/kg | nc | HQ=1 | 5550 | LANL (2004, 87800) |
| Sediment | Americium-241 | 86954-36-1 | pCi/g | rad | 15 mrem/yr | 280 | LANL (2005, 88493) |
| Sediment | Cesium-137 | 10045-97-3 | pCi/g | rad | 15 mrem/yr | 210 | LANL (2005, 88493) |
| Sediment | Cobalt-60 | 10198-40-0 | pCi/g | rad | 15 mrem/yr | 46 | LANL (2005, 88493) |
| Sediment | Europium-152 | 14683-23-9 | pCi/g | rad | 15 mrem/yr | 100 | LANL (2005, 88493) |
| Sediment | Plutonium-238 | 13981-16-3 | pCi/g | rad | 15 mrem/yr | 330 | LANL (2005, 88493) |
| Sediment | Plutonium-239 | 15117-48-3 | pCi/g | rad | 15 mrem/yr | 300 | LANL (2005, 88493) |
| Sediment | Sodium-22 | 13966-32-0 | pCi/g | rad | 15 mrem/yr | 58 | LANL (2005, 88493) |
| Sediment | Strontium-90 | 10098-97-2 | pCi/g | rad | 15 mrem/yr | 5600 | LANL (2005, 88493) |
| Sediment | Thorium-228 | 14274-82-9 | pCi/g | rad | 15 mrem/yr | 77 | LANL (2005, 88493) |
| Sediment | Thorium-230 | 14269-63-7 | pCi/g | rad | 15 mrem/yr | 150 | LANL (2005, 88493) |
| Sediment | Thorium-232 | 7440-29-1 | pCi/g | rad | 15 mrem/yr | 40 | LANL (2005, 88493) |
| Sediment | Tritium | 10028-17-8 | pCi/g | rad | 15 mrem/yr | 5100000 | LANL (2005, 88493) |
| Sediment | Uranium-238 | 7440-61-1 | pCi/g | rad | 15 mrem/yr | 2100 | LANL (2005, 88493) |

**Table 8.2-9 (continued)**

| Medium | COPC | CAS ID | Units | Endpoint | Target Adverse-Effect Level | Recreational MSSL | Reference |
|---|---|---|---|---|---|---|---|
| Surface water | Arsenic | 7440-38-2 | ug/L | ca | 1E-5 risk | 98.3 | LANL (2004, 87390) |
| Surface water | Arsenic-nc | 7440-38-2 | ug/L | nc | HQ=1 | 1900 | LANL (2004, 87390) |
| Surface water | Aroclor-1260 | 11096-82-5 | ug/L | ca | 1E-5 risk | 74.5 | LANL (2004, 87390)* |
| Surface water | Lead | 7439-92-1 | ug/L | nc | HQ=1 | 65 | LANL (2005, 88493) |
| Surface water | Mercury | 7439-97-6 | ug/L | nc | HQ=1 | 1660 | LANL (2004, 87390)* |
| Surface water | Aluminum | 7429-90-5 | ug/L | nc | HQ=1 | 6320000 | LANL (2004, 87390)* |
| Surface water | Barium | 7440-39-3 | ug/L | nc | HQ=1 | 388000 | LANL (2004, 87390) |
| Surface water | Fluoride | 7782-41-4 | ug/L | nc | HQ=1 | 379000 | LANL (2004, 87390) |
| Surface water | Iron | 7439-89-6 | ug/L | nc | HQ=1 | 1900000 | LANL (2004, 87390) |
| Surface water | Manganese | 7439-96-5 | ug/L | nc | HQ=1 | 706000 | LANL (2004, 87390) |
| Surface water | Molybdenum | 7439-98-7 | ug/L | nc | HQ=1 | 31600 | LANL (2004, 87390) |
| Surface water | Thallium | 7440-28-0 | ug/L | nc | HQ=1 | 506 | LANL (2004, 87390) |
| Surface water | Vanadium | 7440-62-2 | ug/L | nc | HQ=1 | 32000 | LANL (2005, 88493) |
| Surface water | Perchlorate | 14797-73-0 | ug/L | nc | HQ=1 | 632 | LANL (2004, 87390) |
| Surface water | Uranium | 7440-61-1 | ug/L | nc | HQ=1 | 19000 | LANL (2004, 87390) |
| Surface water | Americium-241 | 86954-36-1 | pCi/L | rad | 4 mrem/yr | 275 | LANL (2004, 87390) |
| Surface water | Cesium-137 | 10045-97-3 | pCi/L | rad | 4 mrem/yr | 20000 | LANL (2004, 87390)* |
| Surface water | Plutonium-238 | 13981-16-3 | pCi/L | rad | 4 mrem/yr | 313 | LANL (2004, 87390)* |
| Surface water | Plutonium-239 | 15117-48-3 | pCi/L | rad | 4 mrem/yr | 282 | LANL (2004, 87390) |
| Surface water | Plutonium-239/240 | 15117-48-3 | pCi/L | rad | 4 mrem/yr | 282 | LANL (2004, 87390) |
| Surface water | Potassium-40 | 13966-00-2 | pCi/L | rad | 4 mrem/yr | 53800 | LANL (2004, 87390)* |
| Surface water | Radium-226 | 13982-63-3 | pCi/L | rad | 4 mrem/yr | 758 | LANL (2004, 87390)* |
| Surface water | Strontium-90 | 10098-97-2 | pCi/L | rad | 4 mrem/yr | 6540 | LANL (2004, 87390) |
| Surface water | Tritium | 10028-17-8 | pCi/L | rad | 4 mrem/yr | 15600000 | LANL (2004, 87390)* |
| Surface water | Uranium-234 | 13966-29-5 | pCi/L | rad | 4 mrem/yr | 3530 | LANL (2004, 87390) |

*Additional documentation of this MSSL is provided in Appendix E.

**Table 8.2-10**
**Toxicity Values that Differed Between Sources**

| Chemical | Chemical Abstract System ID | Parameter | Value | Source |
|---|---|---|---|---|
| Aroclor-1254 | 11097-69-1 | SFi | 3.50E-01 | LANL (2004, 87800) |
| | | | No value | LANL (2004, 87390) |
| | | | **2.00E+00** | NMED (2006, 92513) |
| | | | **2.00E+00** | EPA (2005, 91002) |
| Barium | 7440-39-3 | RfDo | **7.00E-02** | LANL (2004, 87800) |
| | | | **7.00E-02** | LANL (2004, 87390) |
| | | | 2.00E-01 | NMED (2006, 92513) |
| | | | 2.00E-01 | EPA (2005, 91002) |
| | | RfDi | **1.43E-04** | LANL (2004, 87800) |
| | | | 7.00E-02 | LANL (2004, 87390) |
| | | | 2.00E-01 | NMED (2006, 92513) |
| | | | 2.00E-01 | EPA (2005, 91002) |
| Copper | 7440-50-8 | RfDo | 4.00E-02 | LANL (2004, 87800) |
| | | | **3.70E-02** | LANL (2004, 87390) |
| | | | 4.00E-02 | NMED (2006, 92513) |
| | | | **3.70E-02** | EPA (2005, 91002) |
| Manganese | 7439-96-5 | RfDo | **2.00E-02** | LANL (2004, 87800) |
| | | | 1.40E-01 | LANL (2004, 87390) |
| | | | 4.70E-02 | NMED (2006, 92513) |
| | | | 4.70E-02 | EPA (2005, 91002) |
| Thallium | 7440-28-0 | RfDo | **6.60E-05** | LANL (2004, 87800) |
| | | | 8.00E-05 | LANL (2004, 87390) |
| | | | **6.60E-05** | NMED (2006, 92513) |
| | | | 7.00E-05 | EPA (2005, 91002) |
| Vanadium | 7440-62-2 | RfDo | 7.00E-03 | LANL (2004, 87800) |
| | | | 7.00E-03 | LANL (2004, 87390) |
| | | | **1.00E-03** | NMED (2006, 92513) |
| | | | **1.00E-03** | EPA (2005, 91002) |

*Notes:* More protective values are in bold type. CSFi = inhalation cancer slope factor, RFDo = oral reference dose, RFDi = inhalation reference dose.

**Table 8.2-11**
**Summary of Trail User Risk Assessment Results**

| Endpoint | Reach | Sediment | Surface Water | Multimedia Sum |
|---|---|---|---|---|
| Non-carcinogen HI | M-1W | 0.016 | 0.446 | 0.46 |
| | M-1E | 0.397 | 0.055 | 0.45 |
| | E-1FW | 0.429 | 0.060 | 0.49 |
| | E-1W | 0.304 | 0.042 | 0.35 |
| | E-1E | 0.063 | 0.040 | 0.10 |
| | M-2W | 0.116 | 0.206 | 0.32 |
| | M-2E | | 0.003 | |
| | M-3 | 0.011 | | |
| | TS-1W | 0.091 | | |
| | TS-1C | 0.113 | 0.549 | 0.66 |
| | TS-2E | 0.184 | 0.030 | 0.21 |
| | M-4 | 0.012 | | |
| Carcinogen risk | M-1W | 5.5E-06 | 6.6E-07 | 6.2E-06 |
| | M-1E | 1.9E-06 | | |
| | E-1FW | 3.5E-06 | 7.7E-07 | 4.3E-06 |
| | E-1W | 2.4E-06 | 6.7E-07 | 3.0E-06 |
| | E-1E | 1.6E-06 | | |
| | M-2W | 2.0E-06 | 7.6E-07 | 2.8E-06 |
| | M-3 | 8.6E-07 | | |
| | TS-1W | 1.4E-06 | | |
| | TS-1C | 2.7E-06 | 9.1E-07 | 3.6E-06 |
| | TS-1E | 2.3E-06 | | |
| | TS-2E | 1.2E-06 | | |
| | M-4 | 7.8E-07 | | |
| Radionuclide dose (mrem/yr) | E-1W | 1.60 | | |
| | E-1E | **43.7** | 0.25 | **44.0** |
| | M-2W | 10.4 | 0.33 | 10.7 |
| | M-2E | 10.2 | 0.05 | 10.3 |
| | M-3 | 9.08 | | |
| | TS-1W | 0.43 | | |
| | TS-1C | 3.39 | 0.04 | 3.43 |
| | TS-1E | 3.98 | | |
| | TS-2W | 0.05 | | |
| | TS-2C | 0.01 | | |
| | TS-2E | 0.30 | | |
| | M-4 | 2.75 | | |

**Table 8.2-12**
**Risk Ratios based on Representative Concentrations for Sediment, Trail User Scenario**

| Non-carcinogen COPCs - Ratios | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Reach** | **Aluminum** | **Antimony** | **Aroclor-1254** | **Arsenic** | **Chromium** | **Copper** | **Iron** | **Lead** | **Manganese** | **Mercury** | **Thallium** | **Uranium** | **Vanadium** | **SOFnc** | **HI** |
| MSSL | 1E+05 | 317 | 6.65 | 183 | 14300 | 31700 | 1E+05 | 560 | 15800 | 238 | 52.3 | 2380 | 5550 | | |
| M-1W | - | - | - | 0.016~~4~~ | - | - | - | - | - | - | - | - | - | 0.02~~1~~ | 0.02~~1~~ |
| M-1E | 0.156~~2~~ | - | - | 0.029~~2~~ | - | - | 0.151~~2~~ | - | 0.057~~45~~ | - | - | - | 0.005~~4~~ | 0.40~~31~~ | 0.40~~31~~ |
| E-1FW | 0.106~~091~~ | - | 0.021 | 0.040~~35~~ | 0.057~~48~~ | 0.004~~3~~ | 0.112 | 0.053~~45~~ | 0.031~~29~~ | - | - | - | 0.005~~4~~ | 0.43~~38~~ | 0.43~~38~~ |
| E-1W | 0.093~~59~~ | - | - | 0.023~~18~~ | 0.001~~3~~ | - | 0.123~~087~~ | - | 0.059~~41~~ | - | - | 0.001 | 0.003~~2~~ | 0.30~~21~~ | 0.30~~21~~ |
| E-1E | - | - | 0.011~~-~~ | 0.011 | - | - | - | 0.017 | 0.020~~1~~ | <0.001 | 0.003 | 0.002 | - | 0.06 | 0.06 |
| M-2W | - | ~~9E-04~~<0.001 | 0.023~~-~~ | 0.009~~11~~ | - | - | 0.066~~8~~ | 0.015 | - | - | 0.002 | - | - | 0.12~~1~~ | 0.12~~1~~ |
| M-2E | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| M-3 | - | - | - | 0.011 | - | - | - | - | - | - | - | - | - | 0.01 | 0.01 |
| TS-1W | - | - | 0.086~~-~~ | - | - | - | - | - | - | - | 0.002 | - | 0.002 | 0.09~~0~~ | 0.09~~05~~ |
| TS-1C | - | 0.002 | - | - | - | - | 0.106~~1~~ | - | - | - | 0.002 | - | 0.003 | 0.11~~2~~ | 0.11~~2~~ |
| TS-1E | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TS-2W | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TS-2C | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| TS-2E | 0.073~~66~~ | - | - | 0.014~~2~~ | - | - | 0.094~~87~~ | - | - | - | - | - | 0.003 | 0.18~~7~~ | 0.18~~7~~ |
| M-4 | - | - | - | 0.012~~1~~ | - | - | - | - | - | - | - | - | - | 0.01 | 0.01 |

## Table 8.2-12 (continued)

| Carcinogen COPCs - Ratios | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Reach** | **Aroclor-1254** | **Aroclor-1260** | **Arsenic** | **Benzo(a)anthracene** | **Benzo(a)pyrene** | **Benzo(b)fluoranthene** | **Chromium** | **Indeno(1,2,3-cd)pyrene** | **SOFca** | **Carcinogenic risk** |
| MSSL | 10.5 | 10.5 | 27.7 | 30.1 | 3.01 | 30.1 | 1E+05 | 30.1 | | |
| M-1W | - | - | 0.**107**~~092~~ | 0.0**40**~~33~~ | 0.**351**~~286~~ | 0.0**42**~~35~~ | - | 0.01**4**~~2~~ | 0.**55**~~46~~ | **5.5**~~4.6~~E-06 |
| M-1E | - | - | 0.1**90**~~47~~ | - | - | - | - | - | 0.1**9**~~5~~ | 1.**9**~~5~~E-06 |
| E-1FW | 0.013 | - | 0.2**67**~~3~~ | - | 0.0**60**~~5~~ | - | 0.00**8**~~7~~ | - | 0.3**5**~~0~~ | 3.**5**~~0~~E-06 |
| E-1W | - | - | 0.1**51**~~17~~ | - | 0.086 | - | ~~4E-04~~**<0.001** | - | 0.2**4**~~0~~ | 2.**4**~~0~~E-06 |
| E-1E | 0.007 | - | 0.0**67**~~74~~ | - | 0.083 | - | - | - | 0.16 | 1.6E-06 |
| M-2W | 0.014 | 0.004 | 0.0**61**~~73~~ | - | 0.123 | - | - | - | 0.2**0**~~1~~ | 2.**0**~~1~~E-06 |
| M-2E | - | - | - | - | - | - | - | - | - | - |
| M-3 | - | 0.014 | 0.072 | - | - | - | - | - | 0.09 | 8.6E-07 |
| TS-1W | 0.054 | **0.044**~~-~~ | - | - | 0.03**5**~~4~~ | **0.004**~~-~~ | - | - | 0.1**4**~~09~~ | **1.4**~~8.8~~E-0**6**~~7~~ |
| TS-1C | - | 0.0**45**~~34~~ | - | 0.0**21**~~17~~ | 0.1**67**~~36~~ | 0.0**23**~~19~~ | - | 0.011 | 0.2**7**~~2~~ | 2.**7**~~2~~E-06 |
| TS-1E | - | - | - | 0.0**20**~~16~~ | 0.1**7**~~3~~7 | 0.02**8**~~3~~ | - | - | 0.**23**~~18~~ | **2.3**~~1.8~~E-06 |
| TS-2W | - | - | - | - | - | - | - | - | - | - |
| TS-2C | - | - | - | - | - | - | - | - | - | - |
| TS-2E | - | 0.03**0** | 0.0**90**~~81~~ | - | - | - | - | - | 0.1**2**~~1~~ | 1.**2**~~1~~E-06 |
| M-4 | - | - | 0.07**8**~~3~~ | - | - | - | - | - | 0.0**8**~~7~~ | 7.**8**~~3~~E-07 |

**Table 8.2-12 (continued)**

| Radionuclide COPCs - Ratios | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reach | Americium-241 | Cesium-137 | Cobalt-60 | Plutonium-238 | Plutonium-239 | Sodium-22 | Strontium-90 | Thorium-228 | Thorium-230 | Thorium-232 | Tritium | Uranium-238 | SOFrad | Radionuclide dose (mrem/yr) |
| MSSL | 280 | 210 | 46 | 330 | 300 | 58 | 5600 | 77 | 150 | 40 | 5E+06 | 2100 | | |
| M-1W | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| M-1E | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| E-1FW | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| E-1W | - | 0.005 | - | - | 0.1 | - | - | - | - | - | - | - | 0.11 | 1.58 |
| E-1E | ~~0.38~~0.281 | ~~2.58~~2.321 | 0.016~~22~~ | 0.048~~57~~ | ~~0.37~~0.245 | 0.002~~1~~ | 0.002 | - | - | - | ~~2E-07~~<0.001 | - | ~~3.42~~2.91 | ~~51.2~~43.7 |
| M-2W | 0.148~~69~~ | 0.305 | 0.010~~07~~ | 0.085~~107~~ | 0.140~~51~~ | - | <0.001~~1E-03~~ | - | - | - | - | <0.001~~7E-04~~ | 0.69~~74~~ | 10.4~~1.1~~ |
| M-2E | 0.086 | 0.467 | 0.004 | 0.049 | 0.076 | - | <0.001~~6E-04~~ | - | - | - | - | - | 0.68 | 10.2 |
| M-3 | 0.099 | 0.388 | 0.004 | 0.028 | 0.085~~91~~ | - | <0.001~~7E-04~~ | - | - | - | - | - | 0.61 | 9.08~~16~~ |
| TS-1W | 0.003 | 0.003 | - | 0.016~~4~~ | 0.006 | - | <0.001~~1E-04~~ | - | - | - | - | - | 0.03 | 0.43~~39~~ |
| TS-1C | - | 0.009 | - | 0.071~~58~~ | 0.029 | - | - | 0.033 | 0.025 | 0.05~~7~~9 | - | - | 0.23 | 3.30~~50~~ |
| TS-1E | - | - | - | 0.235 | 0.031 | - | - | - | - | - | - | - | 0.27 | 3.98 |
| TS-2W | - | - | - | - | - | - | 0.0034~~4E-04~~ | - | - | - | - | - | 0.00 | 0.005~~7~~ |
| TS-2C | - | - | - | - | - | - | <0.001~~4E-04~~ | - | - | - | - | - | 0.00 | 0.006 |
| TS-2E | - | - | - | - | 0.017 | - | 0.003~~1~~ | - | - | - | - | - | 0.02 | 0.30~~28~~ |
| M-4 | 0.034 | 0.137~~8~~ | 0.002~~1~~ | 0.010 | - | - | <0.001~~6E-04~~ | - | - | - | - | - | 0.18 | 2.75~~6~~ |

**Table 8.2-13**
**Risk Ratios based on Representative Concentrations for Surface Water, Trail User Scenario**

| Non-carcinogen COPCs – Ratios | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reach | Aluminum | Arsenic-nc | Barium | Fluoride | Iron | Lead | Manganese | Mercury | Molybdenum | Perchlorate | Thallium | Uranium | Vanadium | SOFnc | HI |
| MSSL | 6E+06 | 1900 | 4E+05 | 4E+05 | 2E+06 | 65 | 7E+05 | 1660 | 31600 | 632 | 506 | 19000 | 31700 | | |
| M-1W | 0.007 | 0.003 | | 0.002 | 0.014 | 0.415 | | 4E-05 | 0.004 | | | | 0.002 | 0.45 | 0.45 |
| M-1E | 0.001 | | | 0.001 | 0.002 | 0.048 | 0.003 | | | | | | 2E-04 | 0.06 | 0.06 |
| east of E-1FW | | 0.004 | | 9E-04 | 0.002 | 0.048 | 0.001 | | 0.003 | | 4E-04 | | 3E-04 | 0.06 | 0.06 |
| E-1W | | 0.003 | | 0.002 | 0.003 | 0.029 | 0.001 | | 0.002 | | | | 2E-04 | 0.04 | 0.04 |
| E-1E | | | | 0.002 | 0.001 | 0.035 | | | 0.001 | | 1E-03 | | | 0.04 | 0.04 |
| M-2W | 7E-04 | 0.004 | | | 0.001 | 0.042 | | 5E-05 | 2E-04 | 0.157 | 1E-03 | | 7E-05 | 0.21 | 0.21 |
| M-2E | | | | 0.002 | | | | | 1E-03 | | | | | 0.00 | 0.00 |
| TS-2E | | | | 8E-04 | 6E-04 | 0.026 | 0.001 | | 0.001 | | | 4E-05 | 1E-04 | 0.03 | 0.03 |
| TS-1C | 0.006 | | 9E-04 | 6E-04 | 0.02 | 0.517 | 0.002 | | | | 0.001 | 2E-04 | 0.001 | 0.55 | 0.55 |

**Table 8.2-13 (continued)**

| Reach | Carcinogen COPCs - Ratios | | | | Radionuclide COPCs - Ratios | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Aroclor-1260 | Arsenic | SOFca | Carcinogenic risk | Americium-241 | Cesium-137 | Plutonium-238 | Plutonium-239/240 | Potassium-40 | Radium-226 | Strontium-90 | Tritium | Uranium-234 | SOFrad | Radionuclide dose (mrem/yr) |
| MSSL | 74.5 | 98.3 | | | 275 | 20000 | 313 | 282 | 53800 | 758 | 6540 | 15600000 | 3530 | | |
| M-1W | | 0.066 | 0.07 | 6.6E-07 | | | | | | | | | | | |
| M-1E | | | | | | | | | | | | | | | |
| east of E-1FW | | 0.077 | 0.08 | 7.7E-07 | | | | | | | | | | | |
| E-1W | | 0.067 | 0.07 | 6.7E-07 | | | | | | | | | | | |
| E-1E | | | | | 0.0314 | 0.0018 | 0.0101 | 0.0172 | 0.0012 | 0.0003 | 0.0006 | | | 0.063 | 0.25 |
| M-2W | | 0.076 | 0.08 | 7.6E-07 | 0.0463 | 0.0016 | 0.016 | 0.0147 | | 0.0007 | 0.0017 | 0.002272 | 0.0004 | 0.084 | 0.33 |
| M-2E | | | | | 0.0036 | | 0.0009 | 0.0018 | | | 0.0067 | | | 0.013 | 0.05 |
| TS-2E | | | | | | | | | | | | | | | |
| TS-1C | 0.015 | 0.076 | 0.09 | 9.1E-07 | | | 0.0057 | 0.0028 | | | 0.001 | | | 0.01 | 0.04 |

**Table 8.2-14**
**Representative Concentrations for Sediment COPCs, Trail User Scenario (Surface Area Weighted)**

| Reach | COPC | UCL | Mean | Number of Samples | Number of Detects | Maximum Detect |
|---|---|---|---|---|---|---|
| E-1E | Americium-241 | ~~107.45~~**78.6** | 36.**1**~~05~~ | 31 | 30 | 642 |
| **E-1E** | **Aroclor-1254** | **0.07** | **0.016** | **16** | **1** | **0.07 *** |
| E-1E | Arsenic | ~~2.04811~~**1.85** | 1.6**8**~~772~~ | 32 | 31 | 6.1 |
| **E-1E** | **Benzo(a)pyrene** | **0.25** | **0.205** | **16** | **1** | **0.25 *** |
| E-1E | Cesium-137 | ~~542.15~~**487** | 18**7**~~6.79~~ | 31 | 31 | 2530 |
| E-1E | Cobalt-60 | 0.**73**~~9935~~ | 0.**33**~~43307~~ | 31 | 16 | 4.35 |
| E-1E | Lead | 9.63~~17~~ | 8.3**7**~~673~~ | 32 | 32 | 50 |
| E-1E | Manganese | ~~331.94~~**309** | 27**2**~~1.84~~ | 32 | 32 | 1700 |
| E-1E | Mercury | 0.2**2**~~59~~ | 0.12~~05~~ | 32 | 29 | 0.39 |
| E-1E | Plutonium-238 | ~~18.892~~**15.8** | 9.4**6**~~569~~ | 31 | 30 | 88.7 |
| E-1E | Plutonium-239 | ~~110.5~~**73.4** | 34.**2**~~177~~ | 31 | 30 | 1110 |
| E-1E | Sodium-22 | 0.**14**~~08~~ | 0.0**66**~~5088~~ | 31 | 3 | 0.49 |
| E-1E | Strontium-90 | 13.8~~09~~ | 8.2**8**~~762~~ | 31 | 19 | 273 |
| E-1E | Thallium | 0.14~~97~~ | 0.09~~421~~ | 32 | 6 | 1.6 |
| E-1E | Tritium | ~~1.0007~~**0.96** | 0.58~~14~~ | 15 | 8 | 2.4 |
| E-1E | Uranium | 4.14 | 2.63~~2~~ | 5 | 5 | 4.14 |
| E-1FW | Aluminum | ~~9126.9~~**10611** | 8004 | 16 | 16 | 21300 |
| E-1FW | Aroclor-1254 | 0.1**4**~~398~~ | 0.11~~108~~ | 8 | 5 | 0.16 |
| E-1FW | Arsenic | ~~6.3618~~**7.39** | 5.6**3**~~298~~ | 16 | 16 | 16.6 |
| E-1FW | Benzo(a)pyrene | 0.1**8**~~519~~ | 0.12~~288~~ | 16 | 11 | 0.5 |
| E-1FW | Chromium | ~~690.81~~**811** | 45**3**~~2.91~~ | 16 | 16 | 2210 |
| E-1FW | Copper | 1**30**~~08.83~~ | 79~~.415~~ | 16 | 16 | 383 |
| E-1FW | Iron | ~~9955.6~~**11246** | 987**7**~~6.6~~ | 16 | 16 | 18300 |
| E-1FW | Lead | ~~24.925~~**29.8** | 24.**1**~~078~~ | 16 | 16 | 56.8 |
| E-1FW | Manganese | 4**86**~~62.3~~ | 3**80**~~79.86~~ | 16 | 16 | 1040 |
| E-1FW | Vanadium | 2**5.8**~~1.66~~ | 19.**9**~~888~~ | 16 | 16 | 53.1 |
| E-1W | Aluminum | ~~5897.9~~**9332** | 78**20**~~91.9~~ | 22 | 22 | 19000 |
| E-1W | Arsenic | ~~3.2493~~**4.17** | 3.31~~12~~ | 22 | 21 | 11 |
| **E-1W** | **Benzo(a)pyrene** | **0.26** | **0.30** | **12** | **1** | **0.26 *** |
| E-1W | Cesium-137 | 1.**37**~~0536~~ | 0.8**2**~~1755~~ | 11 | 7 | 2.14 |
| E-1W | Chromium | ~~40.773~~**18.0** | 13.**9**~~894~~ | 22 | 22 | 50 |
| E-1W | Iron | ~~8727.6~~**12314** | 10751 | 22 | 22 | 25000 |
| E-1W | Manganese | ~~642.34~~**933** | 64**3**~~2.5~~ | 22 | 22 | 2500 |
| E-1W | Plutonium-239 | 30.1 | 2.19~~368~~ | 8 | 7 | 30.1 |
| E-1W | Uranium | 3.39~~43~~ | 2.084 | 5 | 5 | 4.32 |
| E-1W | Vanadium | ~~12.018~~**17.4** | 14.**9**~~894~~ | 22 | 22 | 30 |
| M-1E | Aluminum | 1**5579**~~1961~~ | 12972 | 21 | 21 | 26000 |
| M-1E | Arsenic | ~~4.065~~**5.26** | 4.5**1**~~09~~ | 21 | 21 | 8.4 |
| M-1E | Iron | 1**5129**~~1962~~ | 13660 | 21 | 21 | 21000 |
| M-1E | Manganese | ~~704.27~~**894** | 714~~.48~~ | 21 | 21 | 1640 |

**Table 8.2-14 (continued)**

| Reach | COPC | UCL | Mean | Number of Samples | Number of Detects | Maximum Detect |
|---|---|---|---|---|---|---|
| M-1E | Vanadium | 25.90.13 | 22.6561 | 21 | 21 | 37 |
| M-1W | Arsenic | 2.965527 | 2.38785 | 16 | 14 | 4.4 |
| M-1W | Benzo(a)anthracene | 0.98011.21 | 0.62494 | 16 | 10 | 2.71 |
| M-1W | Benzo(a)pyrene | 0.86231.06 | 0.54029 | 16 | 8 | 2.11 |
| M-1W | Benzo(b)fluoranthene | 1.270678 | 0.576874 | 16 | 7 | 2.51 |
| M-1W | Indeno(1,2,3-cd)pyrene | 0.433636 | 0.19041 | 16 | 5 | 1.23 |
| M-2E | Americium-241 | 24.03.982 | 17.323 | 36 | 34 | 211 |
| M-2E | Cesium-137 | 98.143 | 81.947 | 36 | 36 | 557 |
| M-2E | Cobalt-60 | 0.194 | 0.176677 | 36 | 20 | 0.47 |
| M-2E | Plutonium-238 | 16.1073 | 12.9864 | 36 | 36 | 113 |
| M-2E | Plutonium-239 | 22.737 | 17.6567 | 36 | 36 | 157 |
| M-2E | Strontium-90 | 3.1602 | 2.77663 | 36 | 35 | 20 |
| M-2W | Americium-241 | 47.18941.5 | 24.7688 | 53 | 47 | 524 |
| M-2W | Antimony | 0.29853 | 0.265509 | 48 | 25 | 0.65 |
| **M-2W** | **Aroclor-1254** | **0.15** | **0.017** | **21** | **1** | **0.015 *** |
| M-2W | Aroclor-1260 | 0.04032 | 0.02508 | 21 | 9 | 0.21 |
| M-2W | Arsenic | 2.01191.70 | 1.55455 | 54 | 51 | 4.3 |
| **M-2W** | **Benzo(a)pyrene** | **0.37** | **0.29** | **21** | **2** | **0.37 *** |
| M-2W | Cesium-137 | 64.1061 | 54.6577 | 53 | 53 | 850 |
| M-2W | Cobalt-60 | 0.483364 | 0.3226596 | 53 | 33 | 2.45 |
| M-2W | Iron | 7967.36626 | 616470.9 | 54 | 54 | 14000 |
| M-2W | Lead | 8.5311 | 8.02198 | 54 | 54 | 18 |
| M-2W | Plutonium-238 | 35.18528.1 | 15.216 | 53 | 51 | 203 |
| M-2W | Plutonium-239 | 41.95.28 | 24.119 | 53 | 53 | 596 |
| M-2W | Strontium-90 | 5.383.60 | 3.0123 | 53 | 51 | 35.9 |
| M-2W | Thallium | 0.1009 | 0.098676 | 54 | 12 | 0.8 |
| M-2W | Uranium-238 | 2.45551.56 | 1.073226 | 16 | 16 | 10.7 |
| M-3 | Americium-241 | 27.8795 | 20.917 | 76 | 70 | 223 |
| M-3 | Aroclor-1260 | 0.1548 | 0.07698 | 15 | 13 | 0.39 |
| M-3 | Arsenic | 1.9829 | 1.8303 | 65 | 65 | 4 |
| M-3 | Cesium-137 | 81.6557 | 72.2188 | 76 | 76 | 298 |
| M-3 | Cobalt-60 | 0.17684 | 0.13276 | 74 | 43 | 1.47 |
| M-3 | Plutonium-238 | 9.3315 | 7.9833 | 76 | 74 | 40.9 |
| M-3 | Plutonium-239 | 27.15325.6 | 18.2154 | 76 | 76 | 123 |
| M-3 | Strontium-90 | 3.91094 | 3.5116 | 76 | 71 | 8.6 |
| M-4 | Americium-241 | 9.55695 | 7.7023 | 65 | 59 | 112 |
| M-4 | Arsenic | 2.150265 | 1.92372 | 63 | 62 | 4.6 |
| M-4 | Cesium-137 | 28.7951 | 23.8989 | 65 | 65 | 276 |
| M-4 | Cobalt-60 | 0.080586 | 0.053457 | 64 | 14 | 0.44 |

## Table 8.2-14 (continued)

| Reach | COPC | UCL | Mean | Number of Samples | Number of Detects | Maximum Detect |
|---|---|---|---|---|---|---|
| M-4 | Plutonium-238 | 3.28719 | 2.67901 | 65 | 64 | 32.2 |
| M-4 | Strontium-90 | 3.52443 | 2.88102 | 65 | 60 | 9.64 |
| TS-1C | Antimony | 0.4931 | 0.476543 | 19 | 3 | 0.63 |
| TS-1C | Aroclor-1260 | 0.47359 | 0.298663 | 19 | 18 | 1.3 |
| TS-1C | Benzo(a)anthracene | 0.635231 | 0.28428 | 19 | 11 | 1.86 |
| TS-1C | Benzo(a)pyrene | 0.504095 | 0.27689 | 19 | 13 | 2.04 |
| TS-1C | Benzo(b)fluoranthene | 0.705792 | 0.343632 | 19 | 8 | 2.53 |
| TS-1C | Cesium-137 | 1.9247 | 0.83 | 4 | 3 | 2.19 |
| TS-1C | Indeno(1,2,3-cd)pyrene | 0.3339 | 0.176673 | 19 | 10 | 1.45 |
| TS-1C | Iron | 106271007 | 9093.1 | 19 | 19 | 28800 |
| TS-1C | Plutonium-238 | 19.05823.5 | 12.1 | 18 | 18 | 314.07 |
| TS-1C | Plutonium-239 | 8.6642 | 4.6879 | 18 | 18 | 35.19 |
| TS-1C | Thallium | 0.1104 | 0.10289 | 19 | 8 | 0.18 |
| TS-1C | Thorium-228 | 2.54368 | 1.6239 | 14 | 14 | 15.2 |
| TS-1C | Thorium-230 | 3.807975 | 1.99887 | 14 | 14 | 28.51 |
| TS-1C | Thorium-232 | 3.15832.35 | 1.5906 | 14 | 14 | 13.55 |
| TS-1C | Vanadium | 14.87315.9 | 13.8752 | 19 | 19 | 25.9 |
| TS-1E | Benzo(a)anthracene | 0.604958 | 0.332692 | 17 | 11 | 0.72 |
| TS-1E | Benzo(a)pyrene | 0.534122 | 0.38296 | 17 | 14 | 0.85 |
| TS-1E | Benzo(b)fluoranthene | 0.867002 | 0.46484 | 17 | 8 | 1.6 |
| TS-1E | Plutonium-238 | 77.436 | 29.308 | 16 | 16 | 338.33 |
| TS-1E | Plutonium-239 | 9.1811 | 3.81059 | 16 | 16 | 37.91 |
| TS-1W | Americium-241 | 0.7702 | 0.50495 | 8 | 5 | 1.53 |
| **TS-1W** | **Aroclor-1254** | **0.57** | **0.051** | **14** | **1** | **0.57 *** |
| TS-1W | Aroclor-1260 | 0.47671 | 0.29443 | 8 | 5 | 1.37 |
| TS-1W | Benzo(a)pyrene | 0.11028 | 0.07544 | 14 | 12 | 0.32 |
| TS-1W | Benzo(b)fluoranthene | 0.11073 | 0.07437 | 14 | 12 | 0.87 |
| TS-1W | Cesium-137 | 0.65484 | 0.49896 | 8 | 8 | 1.15 |
| TS-1W | Plutonium-238 | 4.69895.34 | 3.73253 | 14 | 14 | 14.3 |
| TS-1W | Plutonium-239 | 1.667494 | 1.54374 | 14 | 14 | 4.06 |
| **TS-1W** | **Strontium-90** | **0.62** | **0.19** | **8** | **1** | **0.62 *** |
| TS-1W | Thallium | 0.13206 | 0.10237 | 14 | 7 | 0.24 |
| TS-1W | Vanadium | 12.4563.5 | 12.1086 | 14 | 14 | 23 |
| TS-2C | Strontium-90 | 2.267141 | 1.9972 | 28 | 24 | 5.61 |
| TS-2E | Aluminum | 6584.27346 | 6043.1 | 14 | 14 | 16100 |
| TS-2E | Aroclor-1260 | 0.31 | 0.076962 | 8 | 5 | 0.31 |
| TS-2E | Arsenic | 2.492453 | 2.1303 | 14 | 14 | 4.43 |
| TS-2E | Iron | 8703.99437 | 81310.9 | 14 | 14 | 13900 |
| TS-2E | Plutonium-239 | 5.23 | 2.59261 | 8 | 7 | 5.23 |

**Table 8.2-14 (continued)**

| Reach | COPC | UCL | Mean | Number of Samples | Number of Detects | Maximum Detect |
|---|---|---|---|---|---|---|
| TS-2E | Strontium-90 | ~~14.533~~**15,4** | 5.0**8**~~773~~ | 14 | 9 | 8.3 * |
| TS-2E | Vanadium | ~~15.038~~**16,4** | 14.**2**~~187~~ | 14 | 14 | 27.1 |
| TS-2W | Strontium-90 | ~~2.4796~~**17.2** | ~~1.5442~~**4.77** | 26 | 10 | 6.7 |

*Used maximum detect as representative concentration; calculated UCL > maximum.

## Table 8.2-15
## Representative Concentrations for Surface Water COPCs, Trail User Scenario

| Reach | COPC | UCL | Mean | Number of Samples | Number of Detects | Maximum Detect |
|---|---|---|---|---|---|---|
| E-1E | Americium-241 | 8.64 | 6.71~~333~~ | 3 | 3 | 8.64 |
| E-1E | Cesium-137 | 35.6 | 27.7 | 2 | 2 | 35.6 * |
| E-1E | Fluoride | 607~~.091~~ | 444 | 4 | 4 | 620 |
| E-1E | Iron | 2080 | 1246~~.33~~ | 3 | 3 | 2080 |
| E-1E | Lead | 2.3 | 1.49~~333~~ | 3 | 3 | 2.3 |
| E-1E | Molybdenum | 34.8 | 28.8~~75~~ | 2 | 2 | 34.8 * |
| E-1E | Plutonium-238 | 3.15 | 2.53~~333~~ | 3 | 3 | 3.15 |
| E-1E | Plutonium-239/240 | 4.85 | 3.89~~333~~ | 3 | 3 | 4.85 |
| E-1E | Potassium-40 | 63.6 | 35.3~~255~~ | 2 | 1 | 63.6 * |
| E-1E | Strontium-90 | 3.97 | 3.13 | 2 | 2 | 3.97 * |
| E-1W | Arsenic | 6.6 | 3.9 | 4 | 1 | 6.6 |
| E-1W | Fluoride | 760 | 611~~0.8~~ | 5 | 5 | 760 |
| E-1W | Iron | 6250 | 42633~~2.5~~ | 4 | 4 | 6250 |
| E-1W | Lead | 1.9 | 1.70~~69636~~ | 4 | 3 | 1.9 |
| E-1W | Manganese | 1035~~.14~~ | 590~~89.5~~ | 4 | 4 | 1080 |
| E-1W | Molybdenum | 64.5 | 52.~~666~~7 | 3 | 3 | 64.5 |
| E-1W | Vanadium | 6.2 | 4.9~~267~~3 | 4 | 3 | 6.2 |
| east of E-1FW | Arsenic | 7.6 | 5.3 | 2 | 1 | 7.6 * |
| east of E-1FW | Fluoride | 349 | 2122~~1.667~~ | 3 | 3 | 349 |
| east of E-1FW | Iron | 4200 | 3965 | 2 | 2 | 4200 * |
| east of E-1FW | Lead | 3.1 | 1.68~~75~~ | 2 | 1 | 3.1 * |
| east of E-1FW | Manganese | 873 | 63~~4.~~5 | 2 | 2 | 873 * |
| east of E-1FW | Molybdenum | 93.5 | 56.0~~5.95~~ | 2 | 2 | 93.5 * |
| east of E-1FW | Vanadium | 8.3 | 4.4 | 2 | 1 | 8.3 * |
| M-1E | Aluminum | 7400 | 4655 | 2 | 2 | 7400 * |
| M-1E | Fluoride | 500 | 2922~~1.667~~ | 3 | 3 | 500 |
| M-1E | Iron | 4230 | 3095 | 2 | 2 | 4230 * |
| M-1E | Lead | 3.1 | 1.945 | 2 | 2 | 3.1 * |
| M-1E | Manganese | 2010 | 1081~~0.5~~ | 2 | 2 | 2010 * |
| M-1E | Vanadium | 7.6 | 6.1 | 2 | 2 | 7.6 * |
| M-1W | Aluminum | 43700 | 31033~~.3~~ | 3 | 3 | 43700 |
| M-1W | Arsenic | 6.5 | 4.1~~666~~7 | 3 | 1 | 6.5 |
| M-1W | Fluoride | 672~~.121~~ | ~~399.5~~400 | 4 | 4 | 720 |
| M-1W | Iron | 25700 | 1733~~6.~~7 | 3 | 3 | 25700 |
| M-1W | Lead | 27 | 19.0~~333~~ | 3 | 3 | 27 |
| M-1W | Mercury | 0.07 | 0.0483~~3~~ | 3 | 2 | 0.07 |
| M-1W | Molybdenum | 121 | 83.6~~55~~ | 2 | 2 | 121 * |

**Table 8.2-15 (continued)**

| Reach | COPC | UCL | Mean | Number of Samples | Number of Detects | Maximum Detect |
|---|---|---|---|---|---|---|
| M-1W | Vanadium | 48.3 | 35.1~~0667~~ | 3 | 3 | 48.3 |
| M-2E | Americium-241 | 0.985 | 0.89 | 2 | 2 | 0.985 * |
| M-2E | Fluoride | 628 | 502 | 3 | 3 | 628 |
| M-2E | Molybdenum | 30.9 | 29.7 | 2 | 2 | 30.9 * |
| M-2E | Plutonium-238 | 0.287 | 0.277~~65~~ | 2 | 2 | 0.287 * |
| M-2E | Plutonium-239/240 | 0.508 | 0.482 | 2 | 2 | 0.508 * |
| M-2E | Strontium-90 | 43.9 | 41.7~~65~~ | 2 | 2 | 43.9 * |
| M-2W | Aluminum | 4410 | 1971~~0.67~~ | 3 | 3 | 4410 |
| M-2W | Americium-241 | 12.7~~148~~ | 6.36~~5501~~ | 10 | 10 | 15.1 |
| M-2W | Cesium-137 | 32.9~~25~~ | 25.8~~775~~ | 8 | 8 | 42.6 |
| M-2W | Iron | 2460 | 1118 | 3 | 3 | 2460 |
| M-2W | Lead | 2.7 | 1.26~~333~~ | 3 | 3 | 2.7 |
| M-2W | Mercury | 0.08 | 0.0451~~3~~ | 10 | 1 | 0.08 |
| M-2W | Perchlorate | 99.5 | 14.1~~489~~ | 10 | 5 | 99.5 |
| M-2W | Plutonium-238 | 5.00~~321~~ | 3.55~~384~~ | 10 | 10 | 7.57 |
| M-2W | Plutonium-239/240 | 4.14~~226~~ | 2.98~~443~~ | 10 | 10 | 6.7543 |
| M-2W | Radium-226 | 0.5122~~154~~ | 0.373 | 8 | 2 | 0.709 |
| M-2W | Strontium-90 | 11.2~~143~~ | 7.60~~309~~ | 8 | 7 | 14.5 |
| M-2W | Tritium | 35500 | 9888~~.1~~ | 8 | 8 | 35500 |
| M-2W | Uranium-234 | 1.363~~23~~ | 0.739~~14~~ | 10 | 10 | 2.93 |
| M-2W | Vanadium | 2.1 | 2.28~~333~~ | 3 | 2 | 2.1 |
| TS-1C | Aluminum | 37700 | 20920 | 3 | 3 | 37700 |
| TS-1C | Aroclor-1260 | 1.1 | 0.573~~25~~ | 2 | 1 | 1.1 * |
| TS-1C | Arsenic | 7.5 | 6 | 3 | 1 | 7.5 |
| TS-1C | Barium | 349 | 192~~1.967~~ | 3 | 3 | 349 |
| TS-1C | Fluoride | 227~~6.522~~ | 152~~1.5~~ | 4 | 4 | 228 |
| TS-1C | Iron | 37800 | 16486~~6.~~7 | 3 | 3 | 37800 |
| TS-1C | Lead | 33.6 | 13.9~~333~~ | 3 | 3 | 33.6 |
| TS-1C | Manganese | 1690 | 598~~.167~~ | 3 | 3 | 1690 |
| TS-1C | Plutonium-238 | 1.79 | 1.106 | 3 | 3 | 1.79 |
| TS-1C | Plutonium-239/240 | 0.79 | 0.453~~33~~ | 3 | 3 | 0.79 |
| TS-1C | Strontium-90 | 6.63 | 5.57 | 2 | 2 | 6.63 * |
| TS-1C | Thallium | 0.73 | 0.47~~66~~7 | 3 | 1 | 0.73 |
| TS-1C | Vanadium | 36.4 | 17.8~~7667~~ | 3 | 2 | 36.4 |
| TS-1C | Uranium | 2.9 | 2.9 | 1 | 1 | 2.9 * |
| TS-1E | Fluoride | 322 | 322 | 1 | 1 | 322 * |
| TS-2C | Fluoride | 430 | 430 | 1 | 1 | 430 * |
| TS-2C | Lead | 1.6 | 1.6 | 1 | 1 | 1.6 * |

**Table 8.2-15 (continued)**

| Reach | COPC | UCL | Mean | Number of Samples | Number of Detects | Maximum Detect |
|---|---|---|---|---|---|---|
| TS-2E | Fluoride | 316 | 269~~.333~~ | 3 | 3 | 316 |
| TS-2E | Iron | 1120 | 909~~8.5~~ | 2 | 2 | 1120 * |
| TS-2E | Lead | 1.7 | 1.21 | 2 | 2 | 1.7 * |
| TS-2E | Manganese | 887 | 463~~2.75~~ | 2 | 2 | 887 * |
| TS-2E | Molybdenum | 36.6 | 21.2 | 2 | 2 | 36.6 * |
| TS-2E | Uranium | 0.77 | 0.77 | 1 | 1 | 0.77 * |
| TS-2E | Vanadium | 4.4 | 4.05 | 2 | 2 | 4.4 * |

*Maximum detect used as the representative concentration.