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RCRA Facility Investigation-Remedial Investigation/ Corrective Measures Study-Feasibility Study Report for the Rocky Flats Environmental Technology Site Appendix A – Comprehensive Risk Assessment

Volume 3 of 15
Risk Assessment for the West Area Exposure Unit

This Draft was prepared by Kaiser-Hill Company, L.L.C.
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Volume 3 of 15

West Area Exposure Unit

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ACRONYMS AND ABBREVIATIONS

µg/kg	microgram per kilogram
µg/L	microgram per liter
AEU	Aquatic Exposure Unit
AI	adequate intake
bgs	below ground surface
BZ	Buffer Zone
CAD/ROD	Corrective Action Decision/Record of Decision
CD	compact disc
CDH	Colorado Department of Health
CDPHE	Colorado Department of Public Health and Environment
CMS	Corrective Measures Study
CNHP	Colorado Natural Heritage Program
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
DQA	data quality assessment
DQO	data quality objective
DRI	dietary reference intake
ECOI	ecological contaminant of interest
ECOPC	ecological contaminant of potential concern
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	Ecological Risk Assessment

ESL	ecological screening level
EU	Exposure Unit
HHRA	Human Health Risk Assessment
HRR	Historical Release Report
IA	Industrial Area
IAG	Interagency Agreement
IDEU	Inter-Drainage Exposure Unit
IHSS	Individual Hazardous Substance Site
MDC	maximum detected concentration
mg	milligram
mg/day	milligram per day
N/A	not applicable or not available
NFA	No Further Action
NFAA	No Further Accelerated Action
NOAEL	no observed adverse effect level
OU	Operable Unit
PAC	Potential Area of Concern
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCOC	potential contaminant of concern
PMJM	Preble's meadow jumping mouse
PRG	preliminary remediation goal
QA/QC	quality assurance/quality control
QAPjP	Quality Assurance Project Plan
RCEU	Rock Creek Drainage Exposure Unit
RCRA	Resource Conservation and Recovery Act

RDA	recommended daily allowance
RDI	recommended daily intake
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SCM	Site Conceptual Model
SEP	Solar Evaporation Ponds
tESL	threshold ESL
UBC	Under Building Contamination
UCL	upper confidence limit
UL	upper limit daily intake
UT	uncertain toxicity
UTL	upper tolerance limit
VOC	volatile organic compound
WAEU	West Area Exposure Unit
WRS	Wilcoxon Rank Sum
WRV	wildlife refuge visitor
WRW	wildlife refuge worker

EXECUTIVE SUMMARY

This report presents the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the 468-acre West Area Exposure Unit (EU) (WAEU) at the Rocky Flats Environmental Technology Site (RFETS). The purpose of this report is to assess potential risks to human health and ecological receptors posed by exposure to contaminants of concern (COCs) and ecological contaminants of potential concern (ECOPCs) remaining at the WAEU after completion of accelerated actions at RFETS.

Results of the COC selection process for the HHRA indicate that no COCs were selected and there are no significant human health risks from RFETS-related operations at the WAEU. As a result, potential health risks for the wildlife refuge worker (WRW) and wildlife refuge visitor (WRV) are expected to be within the range of background risks. The estimated cancer risks for the WRW and WRV associated with potential exposure to background levels of naturally occurring metals in surface soil/surface sediment are both approximately 2E-06. The estimated noncancer hazard indices associated with potential exposure to background levels of metals in surface soil/surface sediment are approximately 0.3 for the WRW and 0.1 for the WRV.

In addition, no ECOPCs were selected in the ERA. The ECOPC identification process constitutes a screening level risk assessment. Because this process did not identify any ECOPCs in the WAEU, risks to ecological receptors from site-related contaminants are likely to be negligible in this EU.

1.0 WEST AREA EXPOSURE UNIT

This volume of the Comprehensive Risk Assessment (CRA) presents the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the West Area Exposure Unit (EU) (WAEU) at Rocky Flats Environmental Technology Site (RFETS) (Figure 1.1).

The HHRA and ERA methods and selection of receptors are described in detail in the Final CRA Work Plan and Methodology (DOE 2005a), hereafter referred to as the CRA Methodology. A summary of the risk assessment methods, including updates made in consultation with the regulatory agencies, are summarized in Appendix A, Volume 2, Section 2.0 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation (RI)/Corrective Measures Study (CMS)-Feasibility Study (FS) Report (hereafter referred to as the RI/FS Report). The anticipated future land use of RFETS is a wildlife refuge. Consequently, two human receptors, a wildlife refuge worker (WRW) and a wildlife refuge visitor (WRV), are evaluated in this risk assessment consistent with this land use. A variety of representative terrestrial and aquatic receptors are evaluated in the ERA. The assessment of the WAEU includes all terrestrial receptors named in the CRA Methodology, with the exception of the Preble's meadow jumping mouse (PMJM), a federally listed threatened species present at RFETS. The limited PMJM habitat within the WAEU boundary is assessed with the more extensive habitat that occurs in the Rock Creek Drainage EU (RCEU) and Inter Drainage Exposure Unit (IDEU) (see Appendix A, Volumes 4 and 5 of the RI/FS Report).

1.1 West Area Exposure Unit Description

This section provides a brief description of the WAEU, including its location at RFETS, historical activities in the area, topography, surface water features, vegetation, and ecological resources. A more detailed description of these features and additional information regarding the geology, hydrology, and soil types at RFETS is included in Section 2.0, Physical Characteristics of the Study Area, of the RI/FS Report.

The Historical Release Report (HRR) and its annual updates provide descriptions of known or suspected releases of hazardous substances that occurred at RFETS. The original HRR (DOE 1992a) organized these known or suspected historical sources of contamination as Individual Hazardous Substance Sites (IHSSs), Potential Areas of Concern (PACs), or Under Building Contamination (UBC) sites (hereafter collectively referred to as historical IHSSs). Individual historical IHSSs and groups of historical IHSSs were also designated as Operable Units (OUs). Over the course of cleanup under the 1991 Interagency Agreement (IAG) and the 1996 Rocky Flats Cleanup Agreement (RFCA), the U.S. Department of Energy (DOE) has thoroughly investigated and characterized contamination associated with these historical IHSSs. Historical IHSSs have been dispositioned through appropriate remedial actions or by determining that No Further Accelerated Action (NFAA) is required, pursuant to the applicable IAG and

RFCA requirements. Some OUs have also been dispositioned in accordance with an OU-specific Corrective Action Decision/Record of Decision (CAD/ROD).

A more detailed description of the regulatory agreements and the investigation and cleanup history under these agreements is contained in Section 1.0 of the RI/FS Report. Section 1.4.3 of the RI/FS Report describes the accelerated action process, while the disposition of all historic IHSSs at RFETs is summarized in Table 1.4 of the RI/FS Report. The 2005 Annual Update to the HRR (DOE 2005b) provides a description of the potential contaminant releases for each IHSS, and any interim response to the releases; identification of potential contaminants based on process knowledge and site data; data collection activities; accelerated action activities (if any); and the basis for recommending no further accelerated action.

The WAEU is located within the Buffer Zone (BZ) OU, west of the Industrial Area (IA), which was used for RFETS operations (Figure 1.1). There are no known sources of groundwater or soil contamination within the WAEU based on the 2005 Annual Update to the HRR (DOE 2005b). No historical IHSSs or PACs are designated in the WAEU (Figure 1.2). The only potential nearby source area, located in the Inter-Drainage EU (IDEU) (Appendix A, Volume 5 of the RI/FS Report), is IHSS 168, the West Spray Field, which is located east of the WAEU. Excess water from the Solar Evaporation Ponds (SEP) (IHSS 101) was periodically sprayed within IHSS 168 between April 1982 and October 1985 (DOE 1992b). A Colorado Department of Public Health and Environment (CDPHE) risk-based conservative screen was conducted for IHSS 168 by DOE (1995). A No Further Action (NFA) CAD/ROD was approved for IHSS 168 (also designated in the IAG of 1991 as OU 11) in October 1995 (Administrative Record reference OU11-A-000184). It is unlikely that IHSS 168, located outside and downgradient of the WAEU, is a source of contaminants for the WAEU.

1.1.1 Exposure Unit Characteristics and Location

The 468-acre WAEU is located on the western perimeter of RFETS (Figure 1.1) and has several distinguishing features:

- The WAEU is located within the BZ OU and is outside areas that were used historically for operation of the RFETS;
- Sources of contamination are not present within the WAEU boundaries;
- The WAEU is a functionally distinct exposure area due to large areas with disturbed soil (gravel mining), sparse vegetation, and relative scarcity of water and wetland habitat; and
- The WAEU is part of two watersheds: the Rock Creek and Walnut Creek Drainages.

The WAEU is bounded by the RCEU and IDEU to the east and DOE's National Wind Technology Center to the north. Land to the west and south of the WAEU, outside the RFETS boundary, is privately owned. Highway 93, which runs north-south and connects

the cities of Boulder and Golden, Colorado, is located approximately 1,500 feet west of the WAEU boundary.

1.1.2 Topography and Surface Water Hydrology

A recent aerial photograph of the WAEU shows that soil in the northern and southern portions of the EU has been disturbed by gravel mining unrelated to RFETS activities (Figure 1.3). The disturbed areas include a majority of the surface area of the WAEU and consist of excavations, ponds, soil piles, and roads.

The WAEU is relatively level compared to the rest of RFETS, which is located on a broad, eastward-sloping pediment that is deeply transected by several stream valleys (eastern portion of RFETS). Although several ephemeral or intermittent creeks originate just west of and within the WAEU (Figure 1.3) and traverse the EU in a west to east-northeast direction, the channels are shallow. Named creeks in the WAEU include the Mahonia, Snowberry, and Lindsay branches of Rock Creek and portions of the Upper Church and McKay ditches (Figure 1.4). Groundwater in the EU originates upgradient of RFETS and is not affected by RFETS activities.

The WAEU contains several water bodies, most of which are a result of mining activities (Figure 1.3). Ponds created as a result of mining activities exist in the mining areas in the northern and southern portions of the EU. These ponds are transient in nature and not related to RFETS activities. A large pond near the southern boundary of the EU is also related to mining activities, but it is not transient. The pond has been present in various configurations prior to 1990. Its steep walled banks and constant water level fluctuation make this pond poor aquatic habitat. A small natural pond is also located in the southern portion of the WAEU. The other water bodies visible in the aerial photograph are a result of mining activities.

Two small ponds exist at the upper ends of the Rock Creek tributaries located in the center of the EU. One pond is in the Mahonia branch and the other in the Lindsay branch. Both ponds are man-made and are unrelated to and pre-date mining activities. They are small on-channel dugouts likely made for stock ponds prior to acquisition by DOE, and are related to ranching activities, not RFETS activities. The pond on the Lindsay branch is only 6 feet in diameter and surrounded by cattails. It is ephemeral but has surface water for the majority of the year, even during dry years. The Mahonia branch pond is larger (8 feet in diameter) and has a combination of cattails and Baltic rush vegetation. This pond is ephemeral, and only holds water during spring runoff and during significant summer storm events.

1.1.3 Flora and Fauna

A vegetation map for the WAEU is shown on Figure 1.4. Areas that have not been disturbed by mining are characterized predominantly by xeric tallgrass prairie on the plains, and wetland and mesic mixed grassland in and adjacent to the drainages. Small areas of tall upland shrubland, Ponderosa pine woodland, and short upland shrubland also exist. The xeric tallgrass prairie is distinguished at RFETS by such plant species as big

bluestem (*Andropogon gerardii*), little bluestem (*Andropogon scoparius*), indian grass (*Sorghastrum nutans*), prairie dropseed (*Sporobolus heterolepis*), porter aster (Aster porerid), mountain muhly (*Muhlenhogia montana*), and switchgrass (*Panicum virgatum*), essentially the same species that dominate the plant community on the eastern edge of the Great Plains.

Land within the WAEU was heavily grazed during past land use. However, since the purchase of the land by DOE, grazing within the EU has not occurred in decades and plant communities have nearly returned to pre-grazed conditions. The Colorado Natural Heritage Program (CNHP) (1994) classifies the xeric tallgrass prairie plant community as very rare. Portions of this plant community in the Rock Creek drainage along with other areas within RFETS and surrounding lands comprise the largest remnants of xeric tallgrass prairie.

The WAEU contains a plant recognized by CNHP as rare or imperiled. Forktip three-awn (*Aristada basiramea*) occurs within the xeric tallgrass prairie in areas that have been disturbed and vegetation has been removed. Few locations are known in Colorado that support forktip three-awn, but RFETS has several sites.

Numerous animal species have been observed at RFETS and the more common ones are also expected to be present in the WAEU. Common large and medium-sized mammals likely to live at or frequent the WAEU include mule deer (*Odocoileus hemionus*), coyotes (*Canis latrans*), raccoons (*Procyon lotor*), desert cottontails (*Sylvilagus audubonii*), and white-tailed jackrabbit (*Lepus townsendii*). The western prairie rattlesnake (*Crotalis viridus*) occurs on the xeric tallgrass prairie and the boreal chorus frog (*Pseudacris tryseriatus*) occurs in wetland areas, especially in the spring. Common birds include meadow lark (*Sturnella neglecta*), vesper sparrow (*Pooecetes gramineus*), and mourning dove (*Zenaida macroura*). The most common small mammal species include deer mice (*Peromyscus maniculatus*), prairie voles (*Microtus ochrogaster*), meadow voles (*Microtus pennsylvanicus*), and different species of harvest mice (*Reithrodontomys sp.*). More information on the species that exist within RFETS is provided in Section 2.0 of the RI/FS Report.

The WAEU also acts as a travel corridor for large mammals connecting Coal Creek and the foothills to the west of RFETS. Despite mining activities in the EU, elk (*Cervus canadensis*) and mule deer travel through this corridor to calve and fawn in upper Rock Creek in late spring. Black bear (*Ursus americanus*) also use this corridor to access RFETS, and several individuals have been observed in recent years.

The preferred habitat for the PMJM (*Zapus hudsonius preblei*) is the riparian corridors bordering RFETS streams, ponds, and wetlands. Small areas designated as PMJM habitat occur along three drainages in the WAEU as shown on Figure 1.5. No PMJM have ever been captured in the WAEU. More information on the species that use the habitats at RFETS is provided in Section 2.0 of the RI/FS Report.

1.1.4 Data Description

Data have been collected at RFETS under regulatory agency-approved Work Plans, Sampling and Analysis Plans (SAPs), and Quality Assurance Project Plans (QAPjPs) to meet data quality objectives (DQOs) and appropriate U.S. Environmental Protection Agency (EPA) and CDPHE guidance. Surface soil, subsurface soil, surface sediment, subsurface sediment, and groundwater samples were collected from the WAEU. Surface soil/surface sediment, subsurface soil/subsurface sediment, surface soil, and subsurface soil are the media evaluated in the HHRA and ERA (Table 1.1). The sampling locations for these media are shown on Figures 1.6 and 1.7, and data summaries for detected analytes in each medium are provided in Tables 1.2 through 1.5. Potential contaminants of concern (PCOCs) and ecological contaminants of interest (ECOIs) that were analyzed for but not detected, or were detected in less than 5 percent of the samples are presented in Attachment 1. Detection limits for those PCOCs and ECOPCs are compared to preliminary remediation goals (PRGs) and ecological screening levels (ESLs) and discussed in Attachment 1 (Tables A1.1 through A1.4). Only data from June 1991 to the present are used in the CRA because these data meet the approved analytical quality assurance/quality control (QA/QC) requirements.

In accordance with the CRA Methodology, only data collected on or after June 28, 1991, and data for subsurface soil and subsurface sediment samples with a start depth less than or equal to 8 feet below ground surface (bgs) are used in the CRA. Subsurface soil and subsurface sediment data are limited to this depth because it is not anticipated that the WRW or burrowing animals will dig to deeper depths. A detailed description of data storage and processing methods is provided in Appendix A, Volume 2 of the RI/FS Report. The CRA analytical data set for the WAEU is provided on a compact disc (CD) presented in Attachment 4. The CD in Attachment 4 includes the data used in the CRA as well as data not considered useable based on criteria presented in Appendix A, Volume 2 of the RI/FS Report.

The sampling data used for the WAEU HHRA and ERA are as follows:

- Combined surface soil/surface sediment data (HHRA);
- Combined subsurface soil/subsurface sediment data (HHRA);
- Surface soil data (ERA); and,
- Subsurface soil data (ERA).

The data for these media are briefly described below.

Surface water and sediment are assessed for ecological receptors on an Aquatic Exposure Unit (AEU) basis in Appendix A, Volume 15 of the RI/FS Report. An assessment of the surface water, groundwater-to-surface water, and volatilization pathways for human health are presented in Appendix A, Volume 2 of the RI/FS Report.

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Surface Soil/Surface Sediment

The combined surface soil/surface sediment data set for the WAEU consists of up to 20 samples that were analyzed for inorganics (20 samples), organics (10 samples), and radionuclides (18 samples) (Table 1.1). The data include sediment samples collected to depths down to 0.5 feet bgs. The sampling locations for surface soil and surface sediment are shown on Figure 1.6. Surface soil/surface sediment samples were collected in the WAEU for several months from August 1991 through March 1993, and then again in March 2004. The samples collected in 2004 were located on a 30-acre grid, as described in CRA SAP Addendum #04-01 (DOE 2004). For the grid sampling, five individual samples were collected from each 30-acre cell, one from each quadrant and one in the center, as described in the addendum (DOE 2004). Most of the evenly spaced surface soil sampling locations on Figure 1.6 represent the 30-acre grid samples.

The data summary for detected analytes in surface soil/surface sediment for the WAEU is presented in Table 1.2. Detected analytes include representatives from the inorganics, organics, and radionuclides analyte groups. A summary of analytes that were not detected in, or detected in less than 5 percent of, surface soil/surface sediment samples collected in the WAEU is presented and discussed in Attachment 1.

Subsurface Soil/Subsurface Sediment

Subsurface soil samples used in the CRA are defined in the CRA Methodology as soil samples with a starting depth less than or equal to 8 feet bgs and an ending depth below 0.5 feet bgs. Subsurface sediment samples (sediment samples with a start depth less than or equal to 8 feet bgs and an ending depth below 0.5 feet were not collected in the WAEU. The combined subsurface soil/subsurface sediment data set for the WAEU consists of up to seven samples that were analyzed for inorganics (seven samples), organics (five samples), and radionuclides (seven samples) (Table 1.1). The sampling locations for subsurface soil are shown on Figure 1.7. Subsurface soil samples were collected in the WAEU in July 1992 and August 1994.

The data summary for detected analytes in subsurface soil/subsurface sediment for the WAEU is presented in Table 1.3. Detected analytes include representatives from the inorganics, organics, and radionuclides analyte groups. A summary of analytes that were not detected in, or detected in less than 5 percent of, subsurface soil/subsurface sediment samples collected in the WAEU is presented and discussed in Attachment 1.

Surface Soil

Data meeting the CRA requirements are available for up to 10 surface soil samples collected in the WAEU that were analyzed for inorganics (10 samples) and radionuclides (10 samples) (Table 1.1). The surface soil sampling locations for the WAEU are shown on Figure 1.6. Surface soil samples were collected in the WAEU in March 2004. The samples collected in 2004 were located on a 30-acre grid, as described in CRA SAP Addendum #04-01 (DOE 2004). For the grid sampling, five individual samples were collected from each 30-acre cell, one from each quadrant and one in the center, as described in the addendum (DOE 2004). Most of the evenly spaced surface soil sampling locations on Figure 1.6 represent the 30-acre grid samples.

The data summary for detected analytes in WAEU surface soil is presented in Table 1.4. Radionuclides and inorganics were detected. A summary of analytes that were not detected in, or detected in less than 5 percent of, surface soil samples collected in the WAEU is presented and discussed in Attachment 1.

Subsurface Soil

Subsurface soil samples used in the CRA are defined in the CRA Methodology as soil samples with a starting depth less than or equal to 8 feet bgs and an ending depth below 0.5 feet. The subsurface soil data set for the WAEU consists of up to seven samples that were analyzed for organics (five samples), inorganics (seven samples), and radionuclides (seven samples) (Table 1.1). Subsurface soil sampling locations are shown on Figure 1.7. Subsurface soil samples were collected in the WAEU in July 1992 and August 1994.

The data summary for detected analytes in subsurface soil for the WAEU is presented in Table 1.5. Subsurface soil samples were analyzed for inorganics, organics, and radionuclides, and representatives from all three analyte groups were detected. A summary of analytes that were not detected in, or detected in less than 5 percent of, subsurface soil samples collected in the WAEU is presented and discussed in Attachment 1.

1.2 Data Adequacy Assessment

A data adequacy assessment was performed to determine whether the available data set discussed in the previous section is adequate for risk assessment purposes. The data adequacy assessment rules are presented in the CRA Methodology, and a detailed data adequacy assessment for the data used in the CRA is presented in Appendix A, Volume 2 of the RI/FS Report. The adequacy of the data was assessed by examining the number of available samples for each analyte group in each medium for use in the CRA; the spatial and temporal representativeness of the data; and information on potential historical sources of contamination, migration pathways, and the concentration levels in the media. The assessment concludes that the data are adequate for the purposes of the CRA.

1.3 Data Quality Assessment

A Data Quality Assessment (DQA) of the WAEU data was conducted to determine whether the data were of sufficient quality for risk assessment use. The DQA is presented in Attachment 2, and an evaluation of the entire RFETS data set is presented in Appendix A, Volume 2 of the RI/FS Report. The quality of the laboratory results were evaluated for compliance with the CRA Methodology DQOs through an overall review of precision, accuracy, representativeness, completeness, and comparability (PARCC) parameters. This review concluded that the data are of sufficient quality for use in the CRA and that the CRA DQOs have been met.

2.0 SELECTION OF HUMAN HEALTH CONTAMINANTS OF CONCERN

The human health contaminant of concern (COC) screening process is described in Section 4.4 of the CRA Methodology and summarized in Appendix A, Volume 2 of the RI/FS Report (Section 2.2).

The human health COC selection process was conducted for surface soil/surface sediment and subsurface soil/subsurface sediment in the WAEU. Results of the COC selection process are summarized below.

2.1 Contaminant of Concern Selection for Surface Soil/Surface Sediment

Detected PCOCs in surface soil/surface sediment samples (Table 1.2) are screened in accordance with the CRA Methodology to identify the COCs.

2.1.1 Surface Soil/Surface Sediment Cation/Anion and Essential Nutrient Screen

The major cations and anions that do not have toxicity criteria are eliminated from assessments in surface soil/surface sediment in accordance with the CRA Methodology.

The essential nutrient screen for analytes detected in surface soil/surface sediment is presented in Table 2.1. The screen includes PCOCs that are essential for human health and do not have toxicity criteria available. Table 2.1 shows the maximum detected concentrations (MDCs) for essential nutrients, daily intake estimates based on the MDCs, and dietary reference intakes (DRIs). The DRIs are identified in the table as recommended daily allowances (RDAs), recommended daily intakes (RDIs), adequate intakes (AIs), and upper limit daily intakes (ULs). The estimated daily maximum intakes based on the nutrients' MDCs and a surface soil/surface sediment ingestion rate of 100 milligrams per day (mg/day) are less than the DRIs. Therefore, these PCOCs were not further evaluated as COCs for surface soil/surface sediment.

2.1.2 Surface Soil/Surface Sediment Preliminary Remediation Goals Screen

Table 2.2 compares the MDCs and upper confidence limits on the means (UCLs) to the WRW PRGs for each PCOC. If the MDC and the UCL are greater than the PRG, the PCOC is retained for further screening; otherwise, it is not further evaluated. Arsenic, cesium-137, and radium-228 in surface soil/surface sediment had MDCs and UCLs that exceeded the PRGs and were retained as PCOCs. Cesium-134 was also retained as a PCOC because the MDC exceeded the PRG. A comparison of the UCL for cesium-134 could not be performed because a UCL could not be calculated based on the number of samples.

PRGs were not available for several PCOCs in surface soil/surface sediment. Analytes without PRGs are listed on Table 2.2 and their effect on the conclusions of the risk assessment results is discussed in the uncertainty section (Section 6.0).

2.1.3 Surface Soil/Surface Sediment Detection Frequency Screen

Arsenic was detected in more than 5 percent of surface soil/surface sediment samples and, therefore, was retained for further evaluation in the COC screen (Table 1.2). A detection frequency screen was not performed for cesium-134, cesium-137, and radium-228 in surface soil/surface sediment because all reported values for radionuclides are considered detects.

2.1.4 Surface Soil/Surface Sediment Background Analysis

Results of the background statistical comparison for arsenic is presented in Table 2.3 and discussed in Attachment 3. Box plots for arsenic (both WAEU and background) are provided in Attachment 3. Arsenic is the only PCOC that was statistically greater than background at the 0.1 significance level, and it is evaluated further in the professional judgment section.

The PRG exceedances seen for cesium-134, cesium-137, and radium-228 were from samples that are part of the background data set and were not carried forward through the formal statistical analysis. Therefore, these analytes were not further evaluated as PCOCs in surface soil/surface sediment in the WAEU.

2.1.5 Surface Soil/Surface Sediment Professional Judgment Evaluation

Based on the weight of available evidence evaluated by professional judgment, PCOCs will either be included for further evaluation as COCs or excluded as COCs. The professional judgment evaluation takes into account process knowledge, spatial trends, and pattern recognition. As discussed in Section 1.2 and Attachment 2, the sample results are adequate for use in the professional judgment because they are of sufficient quality for use in the CRA.

Based on the weight of evidence described in Attachment 3, arsenic in surface soil/surface sediment in the WAEU is not considered a COC because the weight of evidence supports the conclusion that arsenic concentrations in surface soil/surface sediment in the WAEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations.

2.2 Contaminant of Concern Selection for Subsurface Soil/Subsurface Sediment

Detected PCOCs in subsurface soil/subsurface sediment samples (Table 1.3) are screened in accordance with the CRA Methodology to identify the COCs.

2.2.1 Subsurface Soil/Subsurface Sediment Cation/Anion and Essential Nutrient Screen

The major cations and anions that do not have toxicity criteria were eliminated from assessments in subsurface soil/subsurface sediment in accordance with the CRA Methodology.

Essential nutrients without toxicity criteria that were detected in subsurface soil/subsurface sediment in the WAEU are compared to DRIs in Table 2.4. The estimated daily maximum intakes for these PCOCs, based on the nutrients' MDCs and a subsurface soil/subsurface sediment ingestion rate of 100 mg/day, are less than the DRIs. Therefore, these PCOCs were not further evaluated as COCs for subsurface soil/subsurface sediment.

2.2.2 Subsurface Soil/Subsurface Sediment Preliminary Remediation Goal Screen

The PRG screen for detected analytes in subsurface soil/subsurface sediment is presented in Table 2.5. The MDC for all PCOCs were less than the PRGs and, therefore, the UCLs were not compared to the PRGs. No detected PCOCs in subsurface soil/subsurface sediment in the WAEU were retained for further evaluation in the COC selection process.

PRGs were not available for several PCOCs in subsurface soil/subsurface sediment. Analytes without PRGs are listed on Table 2.5 and their effect on the conclusions of the risk assessment results is discussed in the uncertainty section (Section 6.0).

2.2.3 Subsurface Soil/Subsurface Sediment Detection Frequency Screen

The detection frequency screen was not performed for subsurface soil/subsurface sediment because there were no PCOCs with concentrations greater than the PRGs.

2.2.4 Subsurface Soil/Subsurface Sediment Background Analysis

The background analysis was not performed for subsurface soil/subsurface sediment because there were no PCOCs with concentrations greater than the PRGs.

2.2.5 Subsurface Soil/Subsurface Sediment Professional Judgment Evaluation

The professional judgment step was not performed for subsurface soil/subsurface sediment because there were no PCOCs with concentrations greater than the PRGs.

2.3 Contaminant of Concern Selection Summary

A summary of the results of the COC screening process is presented in Table 2.6. No COCs were selected for any of the media at the WAEU.

3.0 HUMAN HEALTH EXPOSURE ASSESSMENT

The Site Conceptual Model (SCM), presented in Figure 2.1 of the CRA Methodology and discussed in Appendix A, Volume 2 of the RI/FS Report, provides an overview of potential human exposures at RFETS for reasonably anticipated land use. However, all PCOCs were eliminated from further consideration as human health COCs for the WAEU based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). A quantitative risk characterization is not necessary for the WAEU and, therefore, an exposure assessment was not conducted.

4.0 HUMAN HEALTH TOXICITY ASSESSMENT

Procedures and assumptions for the toxicity assessment are presented in the CRA Methodology. All PCOCs were eliminated from further consideration as human health COCs for the WAEU based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). A quantitative risk characterization is not necessary for the WAEU and therefore, a toxicity assessment was not conducted.

5.0 HUMAN HEALTH RISK CHARACTERIZATION

Information from the exposure assessment and the toxicity assessment is integrated in this section to characterize risk to the WRW and WRV receptors. However, all PCOCs were eliminated from further consideration as human health COCs based on comparisons of MDCs and UCLs to PRGs, background comparisons, or professional judgment (see Section 2.0). Therefore, a quantitative risk characterization was not performed for the WAEU.

6.0 UNCERTAINTIES ASSOCIATED WITH THE HUMAN HEALTH RISK ASSESSMENT

There are various types of uncertainties associated with steps of an HHRA. General uncertainties common to the EUs are discussed in Appendix A, Volume 2, of the RI/FS Report. Uncertainties specific to the EU are described below.

6.1 Uncertainties Associated With the Data

Data adequacy for this CRA is evaluated and discussed in Appendix A, Volume 2 of the RI/FS Report. Although there are some uncertainties associated with the sampling and analyses conducted for surface soil/surface sediment and subsurface soil/subsurface sediment at the WAEU, data are considered adequate for the characterization of risk at the EU. The environmental samples for the WAEU were collected from 1991 through 2004. The CRA sampling and analysis requirements for the BZ (DOE 2004, 2005a) specify that the minimum sampling density requirement for surface soil/surface sediment is one five-sample composite for every 30-acre grid cell. In surface soil/surface sediment, there are up to 20 samples in the WAEU. Although there are no data for organics in surface soil/surface sediment, no known or suspected sources for organic contaminants in the WAEU. In subsurface soil/subsurface sediment, there are up to seven samples in the WAEU.

Another source of uncertainty in the data is the relationship of detection limits to the PRGs for analytes eliminated as COCs because they were either not detected or had a low detection frequency (i.e., less than five percent). The detection limits were appropriate for the analytical methods used, and this is examined in greater detail in Attachment 1.

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6.2 Uncertainties Associated With Screening Values

The COC screening analyses utilized RFETS-specific PRGs based on a WRW scenario. The assumptions used in the development of these values were conservative. For example, it is assumed that a future WRW will consume 100 mg of surface soil/surface sediment for 230 days per year for a period of 18.7 years. In addition, a WRW is assumed to be dermally exposed to and inhale surface soil and surface sediment particles in the air. These assumptions are likely to overestimate actual exposures to surface soil for WRWs in the WAEU because a WRW will not spend 100 percent of his or her time in this area. Exposure to subsurface soil and subsurface sediment is assumed to occur 20 days per year. The WRW PRGs for subsurface soil/subsurface sediment are also expected to conservatively estimate potential exposures because it is unlikely a WRW will excavate extensively in the WAEU.

6.2.1 Uncertainties Associated with Potential Contaminants of Concern without Preliminary Remediation Goals

PCOCs for the WAEU for which PRGs are not available are listed in Table 6.1.

Uncertainties associated with the lack of PRGs for analytes listed in Table 6.1 are considered small. The listed inorganics are not usually included in HHRAs because they are not expected to result in significant human health impacts. Radionuclide PRGs are available for all detected individual radionuclides. Therefore, the lack of PRGs for the gross alpha and gross beta activities is not expected to affect the results of the HHRA.

6.3 Uncertainties Associated with Eliminating Potential Contaminants of Concern Based on Professional Judgment

Arsenic in surface soil/surface sediment was eliminated as a COC based on professional judgment. There is no identified source or pattern of release in the WAEU and the slightly elevated median value of arsenic in the WAEU is most likely due to natural variation. The weight of evidence presented in Attachment 3, Section 4.0 supports the conclusion that concentrations of arsenic are naturally occurring and not due to site activities. Uncertainty associated with the elimination of this chemical as a COC is low.

No PCOCs were eliminated in subsurface soil/subsurface sediment based on professional judgment in the WAEU.

6.4 Uncertainties Evaluation Summary

Evaluation of the uncertainties associated with the data and the COC screening process indicates there is reasonable confidence in the conclusions of the WAEU risk characterization.

7.0 IDENTIFICATION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN

The ecological contaminant of potential concern (ECOPC) identification process streamlines the ecological risk characterization for each EU by focusing the assessment on ECOIs that are present in the WAEU. ECOIs are defined as any chemical detected in the WAEU and are assessed for surface soils and subsurface soils. ECOIs for sediments and surface water are assessed in Appendix A, Volume 15 of the RI/FS Report. The ECOPC process is described in the CRA Methodology and additional details are provided in Appendix A, Volume 2 of the RI/FS Report.

The process is based on the site conceptual model (SCM) presented in the CRA Methodology and described in detail in Appendix A, Volume 2 of the RI/FS Report. The SCM presents the pathways of potential exposure from documented historical source areas (IHSSs and PACs) to the receptors of concern. Generally the most significant exposure pathways for wildlife at the WAEU are the ingestion of plant, invertebrate, or animal tissue that could have accumulated ECOIs from the source areas through direct uptake or dietary routes, as well as the direct ingestion of potentially contaminated media. For terrestrial plans and invertebrates, the most significant exposure pathway is direct contact with potentially contaminated soil.

The receptors of concern that were selected for assessment are listed in Table 7.1 and discussed in detail in Appendix A, Volume 2 of the RI/FS Report, and include representative birds and mammals in addition to the general plant and terrestrial invertebrate communities. The receptors were selected based on several criteria, including their potential to be found in the various habitats present within RFETS , their potential to come into contact with ECOIs, and the amount of life history and behavioral information available.

The ECOPC process consists of two separate evaluations, one for the PMJM receptor and one for non-PMJM receptors. The ECOPC identification process for the PMJM is conducted separately from non-PMJM receptors because the PMJM is a federally listed threatened species under the Endangered Species Act (63 FR 26517). The assessment of risk to the PMJM is addressed in the RCEU and IDEU because habitat for the PMJM within the WAEU is a small subset of the larger PMJM habitat areas in the RCEU and IDEU (Figure 1.5)

7.1 Data Used in the Ecological Risk Assessment

The following WAEU data are used in the CRA:

- A total of 10 surface soil samples were collected and analyzed for inorganics (10 samples) and radionuclides (10 samples) (Table 1.1).

- A total of seven subsurface soil samples were collected and analyzed for inorganics (seven samples), organics (five samples), and radionuclides (seven samples) (Table 1.1).

A data summary is provided in Table 1.4 for surface soil and Table 1.5 for subsurface soil.

Sediment and surface water data for the WAEU were collected (Section 1.2) and are evaluated for the ERA in Appendix A, Volume 15 of the RI/FS Report.

7.2 Identification of Surface Soil Ecological Contaminants of Potential Concern

ECOPCs for surface soil were identified for non-PMJM receptors in accordance with the sequence presented in the CRA Methodology.

7.2.1 Comparison to No Observed Adverse Effect Level Ecological Screening Levels

In the first step of the ECOPC identification process, the MDCs of ecological contaminants of interest (ECOIs) in surface soil were compared to receptor-specific no observed adverse effect level (NOAEL) ESLs. NOAEL ESLs for surface soil were developed in the CRA Methodology for three receptor groups: terrestrial vertebrates, terrestrial invertebrates, and terrestrial plants.

Non-PMJM Receptors

The NOAEL ESLs for non-PMJM receptors are compared to MDCs in surface soil in Table 7.1. The results of the NOAEL ESL screening analyses for all receptor types are summarized in Table 7.2. Analytes with a "Yes" in any of the "Exceedance" columns in Table 7.2 are evaluated further.

NOAEL ESLs were not available for several ECOI/receptor pairs (Tables 7.1 and 7.2). These ECOI/receptor pairs are discussed as ECOIs with uncertain toxicity in Section 10.0, along with the potential impacts to the risk assessment.

PMJM Receptors

No screening for PMJM receptors was conducted in the WAEU.

7.2.2 Surface Soil Frequency of Detection Evaluation

The ECOPC identification process for non-PMJM receptors includes an evaluation of detection frequency for each ECOI retained after the NOAEL screening step. If the detection frequency is less than 5 percent, then population-level risks are considered highly unlikely and the ECOI is not further evaluated. The detection frequencies for chemicals in surface soil are presented in Table 7.3. None of the chemicals in surface soil at the WAEU that were retained after the NOAEL ESL screening step had a detection frequency of less than 5 percent. Therefore, no ECOIs were excluded based on the detection frequency evaluation for surface soil in the WAEU.

7.2.3 Surface Soil Background Comparisons

The ECOIs retained after the NOAEL ESL screening and the detection frequency evaluation were compared to site-specific background concentrations where available. The background comparison is presented in Table 7.3 and discussed in Attachment 3. The statistical methods used for the background comparison are summarized in Appendix A, Volume 2 of the RI/FS Report.

Non-PMJM Receptors

The results of the background comparisons for the non-PMJM receptors are presented in Table 7.3 and discussed in Attachment 3. Aluminum, arsenic, boron, chromium, lithium, and thallium are retained as ECOIs and are evaluated further using upper-bound EPCs in the following section.

PMJM Receptors

No background analysis was conducted for PMJM receptors in the WAEU.

7.2.4 Upper-Bound Exposure Point Concentration Comparisons to Threshold ESLs (tESLs)

The ECOIs retained after completion of all previous evaluations for non-PMJM receptors were compared to threshold ESLs (tESLs) using upper-bound EPCs specific to small and large home-range receptors. The calculation of EPCs is discussed in Appendix A, Volume 2 of the RI/FS Report.

Statistical concentrations for each ECOI retained for the tESL screen are presented in Table 7.4. The EPC for the small home-range receptors is the 95 percent UCL of the 90th percentile (upper tolerance limit [UTL]), or the MDC in the event that the UTL is greater than the MDC. The EPC for large home-range receptors is the UCL, or the MDC in the event that the UCL is greater than the MDC.

Small home-range receptors include terrestrial plants, terrestrial invertebrates, mourning dove, American kestrel, deer mouse, and black-tailed prairie dog. These receptors are evaluated by comparing the small home-range EPC (UTL) for each ECOI to the limiting (or lowest) small home-range receptor tESL (if available). In the event that tESLs are not available, the limiting NOAEL ESL is used in accordance with the CRA Methodology.

Large home-range receptors, such as the coyote and mule deer are evaluated by comparing the large home-range EPC (UCL) for each ECOI to the limiting large home-range receptor tESL (if available). In the event that tESLs are not available, the limiting NOAEL ESL is used in accordance with the CRA Methodology.

The EPC comparison to limiting tESLs for small and large home-range receptors is presented in Table 7.5. Analytes exceeding the limiting tESLs for small home-range receptors are compared to receptor-specific tESLs in Table 7.6. No analytes exceeded the limiting tESLs for large home-range receptors.

Chemicals that exceed any tESLs (if available) are assessed in the professional judgment evaluation. Any analyte/receptor pairs that are retained through professional judgment are identified as ECOPCs and are carried forward in the risk characterization.

7.2.5 Surface Soil Professional Judgment Evaluation

Non-PMJM Receptors

Based on the weight-of-evidence, professional judgment described in Attachment 3, aluminum, arsenic, boron, chromium, lithium, and thallium in surface soil in the WAEU were not considered ECOPCs for non-PMJM receptors and are not further evaluated quantitatively.

PMJM Receptors

No professional judgment evaluation was conducted for PMJM receptors in the WAEU.

7.2.6 Summary of Surface Soil Ecological Contaminants of Potential Concern

The ECOPC screening process for surface soil is summarized below for non-PMJM receptors and PMJM receptors.

Non-PMJM Receptors

All surface soil ECOIs for non-PMJM receptors in the WAEU were eliminated from further consideration as ECOPCs based on one of the following: 1) the MDC of the ECOI was less than the lowest ESL; 2) no ESLs were available (these ECOIs are discussed in Section 10.0); 3) the concentration of the ECOI in WAEU surface soil was not statistically greater than background surface soils; 4) the upper-bound EPC did not exceed the limiting tESL; or 5) the weight-of-evidence, professional judgment evaluation indicated that the ECOI was not a site-related contaminant of potential concern. No chemicals were retained as ECOPCs.

A summary of the ECOPC screening process for non-PMJM receptors is presented in Table 7.7.

PMJM Receptors

No ECOPC identification for PMJM receptors was conducted in the WAEU.

7.3 Identification of Subsurface Ecological Contaminants of Potential Concern

Subsurface soil sampling locations for soil collected at a starting depth of 0.5 to 8 feet bgs in the WAEU are identified on Figure 1.7. A data summary for subsurface soil less than 8 feet bgs is presented in Table 1.5.

7.3.1 Comparison to No Observed Adverse Effect Level Ecological Screening Levels

The CRA Methodology indicates subsurface soil is evaluated for those ECOIs that have greater concentrations in the subsurface than in surface soil. As a conservative screening step, subsurface soil is evaluated for all EUs regardless of the presence/absence of a change in concentrations from surface soil and subsurface soil. The MDCs of ECOIs in subsurface soil were compared to NOAEL ESLs for burrowing receptors (Table 7.8). There were no ECOIs with MDCs greater than the NOAEL ESL for the prairie dog; therefore, no analytes were further evaluated in the ECOPC identification process.

NOAEL ESLs are not available for some analytes, and these are identified as "N/A" in Table 7.8. These constituents are considered ECOIs with uncertain toxicity (UT) and are discussed in the uncertainty section (Section 10.0).

7.3.2 Subsurface Soil Detection Frequency Evaluation

All ECOIs were eliminated from further consideration as ECOPCs in the WAEU subsurface soils in the preceding step. Therefore, no detection frequency evaluation is necessary.

7.3.3 Subsurface Soil Background Comparison

All ECOIs were eliminated from further consideration as ECOPCs in the WAEU subsurface soils in the preceding steps. Therefore, no subsurface soil background comparison is necessary.

7.3.4 Upper-Bound Exposure Point Concentration Comparisons to Threshold ESLs

All ECOIs were eliminated from further consideration as ECOPCs in the WAEU subsurface soils in the preceding steps. Therefore, no EPC comparisons to tESLs are necessary.

7.3.5 Subsurface Soil Professional Judgment

All ECOIs were eliminated from further consideration as ECOPCs in the WAEU subsurface soils in the preceding steps. Therefore, no professional judgment evaluation is necessary.

7.3.6 Summary of Subsurface Soil Ecological Contaminants of Potential Concern

All subsurface soil ECOIs for burrowing receptors in the WAEU were eliminated from further consideration as ECOPCs. These ECOIs were eliminated during the first step of the ECOPC identification process because the MDC of the ECOI was less than the NOAEL ESL for the burrowing receptor. The results of the subsurface soil ECOPC identification process for burrowing receptors are summarized in Table 7.9.

7.4 Summary of Ecological Contaminants of Potential Concern

ECOIs in surface and subsurface soil in the WAEU were evaluated in the ECOPC identification process for non-PMJM receptors and burrowing receptors. No ECOPCs were identified in surface (Table 7.7) or subsurface soil (Table 7.9) for non-PMJM or burrowing receptors.

8.0 ECOLOGICAL EXPOSURE ASSESSMENT

The ECOPC identification steps did not identify any ECOPCs for either surface or subsurface soil in the WAEU. Therefore, no exposure assessment for the WAEU was performed.

9.0 ECOLOGICAL TOXICITY ASSESSMENT

The ECOPC identification steps did not identify any ECOPCs for either surface or subsurface soil in the WAEU. Therefore, no toxicity assessment for the WAEU was performed.

10.0 ECOLOGICAL RISK CHARACTERIZATION

Risk characterization includes risk estimation and risk description. Details of these components are described in the CRA Methodology and in Appendix A, Volume 2 of the RI/FS Report. Predicted risks should be viewed in terms of the potential for the assumptions used in the risk characterization to occur in nature, the uncertainties associated with the assumptions, and of the potential for effects on the population of receptors that could inhabit the WAEU. Because no ECOPCs were identified for either surface or subsurface soils in the WAEU, no risk characterization is necessary. The ECOPC identification process constitutes a screening level risk assessment. Because this process did not identify any ECOPCs in the WAEU, risks to ecological receptors from site-related contaminants are likely to be negligible in this EU.

10.1 General Uncertainty Analysis

Quantitative evaluation of ecological risks is limited by uncertainties regarding the assumptions used to predict risk and the data available for quantifying risk. These limitations are usually addressed by making estimates based on the data available or by making assumptions based on professional judgment when data are limited. Because of these assumptions and estimates, the results of the risk calculations themselves are uncertain, and it is important for risk managers and the public to view the results of the risk assessment with this in mind. A full discussion of categories of general uncertainty that are not specific to the WAEU are presented in Appendix A, Volume 2 of the RI/FS Report. The following sections are potential sources of general uncertainty that are specific to the WAEU ERA. No ECOPCs were identified for any receptor in either

surface or subsurface soil in the WAEU. The ECOPC identification procedure constitutes a screening level risk assessment. Because the procedure did not identify any ECOPCs, risks to ecological receptors from site-related contaminants are likely to be negligible in the WAEU.

10.1.1 Uncertainties Associated With Data Adequacy and Quality

Sections 1.2 and 1.3 summarize the general data adequacy and data quality for the WAEU, respectively. A more detailed discussion is presented in Attachment 2 and Appendix A, Volume 2 of the RI/FS. The data adequacy assessment indicates that the data are adequate for the CRA. Data of sufficient quality for ERA purposes were collected in surface and subsurface soils.

10.1.2 Uncertainties Associated with the Lack of Toxicity Data for Ecological Contaminant of Interest Detected at the West Area Exposure Unit

Several ECOIs detected in the WAEU do not have adequate toxicity data for the derivation of ESLs (CRA Methodology). These ECOIs are listed in Tables 7.1, 7.2, and 7.8 with a "UT" designation. Appendix B of the CRA Methodology outlines a detailed search process that was intended to provide high-quality toxicological information for a large proportion of the chemicals detected at RFETS. Although the toxicity is uncertain for those ECOIs that do not have ESLs calculated due to a lack of identified toxicity data, the overall effect on the risk assessment is small because the primary chemicals historically used at RFETS have adequate toxicity data for use in the CRA.

10.1.3 Uncertainties Associated With Eliminating Ecological Contaminants of Interest Based on Professional Judgment

Aluminum, arsenic, boron, chromium, lithium, and thallium were eliminated as ECOIs in surface soil based on professional judgment. The professional judgment evaluation is intended to identify those ECOIs that have a limited potential for contamination in the WAEU. The weight-of-evidence supports the conclusion that there is no identified source or pattern of release in the WAEU, and the slightly elevated values of the WAEU data for these ECOIs are most likely due to natural variation. The professional judgment evaluation has little effect on the overall risk calculations because the ECOIs eliminated from further consideration are not related to site-activities in the WAEU and have very low potential to be transported from historical sources to the WAEU.

10.2 Summary of Significant Sources of Uncertainty

The preceding discussion outlined the significant sources of uncertainty in the CRA process for assessing ecological risk. While some of the sources of uncertainty discussed tend to either underestimate or overestimate risk, this may result in an unknown effect on the potential risks. However, the CRA process was designed to be of a conservative nature, which should be taken into consideration when reviewing the conclusions of the risk assessment.

11.0 SUMMARY AND CONCLUSIONS

A summary of the results of this CRA for human health and ecological receptors in the WAEU is presented below.

11.1 Human Health

The COC screening analyses compared MDCs and UCLs of chemicals and radionuclides in WAEU media to PRGs for the WRW receptor. PCOCs with UCLs greater than the PRGs were statistically compared to the background concentration data set. Inorganic analytes that were statistically greater than background at the 0.1 significance level, and organics with UCL concentrations greater than the PRG were carried forward to professional judgment evaluation. Based on the COC selection process, no COCs were selected for surface soil/surface sediment and subsurface soil/subsurface sediment in the WAEU and a risk characterization was not performed for the WAEU.

11.2 Ecological Risk

All ECOIs were eliminated from further consideration as ECOPCs based on comparisons of MDCs to NOAEL ESLs, background comparisons, tESL comparisons, or professional judgment evaluations. Therefore, a risk characterization was not performed for the WAEU and potential risks to ecological receptors in the WAEU are likely to be negligible.

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TABLES

Table 1.1
Number of Samples in Each Medium by Analyte Suite

Analyte Suite	Surface Soil/Surface Sediment[a]	Subsurface Soil/Subsurface Sediment[a]	Surface Soil[b]	Subsurface Soil[b]
Inorganics	20	7	10	7
Organics	10	5	0	5
Radionuclides	18	7	10	7

[a] Used in the HHRA.

[b] Used in the ERA.

Note: The total number of results (samples) for the analytes listed in Tables 1.2 to 1.5 may differ from the number of samples presented in Table 1.1 because not all analyses are necessarily performed for each sample.

Table 1.2
Summary of Detected Analytes in Surface Soil/Surface Sediment

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Inorganics (mg/kg)							
Aluminum	4.8 - 40	20	100	2,390	19,400	11,521	5,128
Antimony[b]	0.3 - 12	20	20	0.340	12.4	2.67	3.71
Arsenic	0.27 - 2	20	100	1.40	22.0	5.83	4.57
Barium	0.39 - 40	20	100	22.2	244	106	51.7
Beryllium	0.11 - 1	20	50	0.250	1.40	0.415	0.285
Boron	1.1 - 1.2	10	100	2.80	7.10	5.11	1.20
Cadmium	0.069 - 1.3	20	15	0.410	1.30	0.298	0.345
Calcium	6.2 - 2,000	20	100	530	4,800	2,489	1,242
Cesium[b]	107 - 275	10	10	4.90	4.90	24.1	42.9
Chromium	0.16 - 2	20	100	2.10	24.8	11.9	5.30
Cobalt	0.19 - 10	20	100	2.60	10.1	5.73	1.97
Copper	0.048 - 5	20	95	4.30	25.9	11.8	6.45
Iron	1.5 - 20	20	100	4,440	23,400	13,142	4,549
Lead	0.29 - 2.5	20	100	2.80	48.0	22.3	12.7
Lithium	0.52 - 20	20	100	2.70	20.3	8.82	4.29
Magnesium	7.1 - 2,000	20	100	662	4,330	2,055	934
Manganese	0.18 - 3	20	100	101	470	249	92.8
Mercury	0.0073 - 0.21	20	50	0.020	0.030	0.045	0.026
Molybdenum	0.31 - 40	20	65	0.320	2.40	0.934	0.596
Nickel	0.21 - 8	20	95	3.10	17.6	9.10	3.70
Nitrate / Nitrite	0.02 - 2.8	10	60	0.300	76.0	15.1	29.2
Potassium	38 - 2,000	20	100	423	2,890	1,679	711
Silica	4.6 - 5.2	10	100	670	790	735	42.5
Silicon[b]	5 - 9.8	2	100	187	252	220	46.0
Silver	0.083 - 2	19	10.5	0.120	2.00	0.323	0.454
Sodium	36.8 - 2,000	20	60	75.2	559	176	132
Strontium	0.062 - 400	20	100	4.10	41.2	21.4	9.45
Thallium[b]	0.41 - 2	20	10	0.400	1.30	0.409	0.257
Tin	0.89 - 40	20	15	3.60	17.5	3.97	5.99
Titanium[b]	0.093 - 0.1	10	100	150	320	236	58.2
Vanadium	0.49 - 10	20	100	8.00	51.9	27.0	9.88
Zinc	0.48 - 4	20	100	21.0	720	129	202
Organics (ug/kg)							
2-Butanone	10 - 29	9	11.1	3	3	7.67	3.05
4-Methylphenol	330 - 950	10	10	95	95	394	184
Benzoic Acid	1,600 - 4,800	10	30	380	480	1,442	937
bis(2-ethylhexyl)phthalate	330 - 950	10	30	69	250	377	201
Di-n-butylphthalate	330 - 950	10	40	52	150	289	186
Fluoranthene	330 - 950	10	10	88	88	411	180
Pyrene	330 - 950	10	10	61	61	409	186
Toluene	5 - 14	10	10	2	2	4.00	1.29
Radionuclides (pCi/g)							
Americium-241	0 - 0.296	18	N/A	-0.016	0.087	0.023	0.032
Cesium-134	0.079 - 0.087	2	N/A	0.079	0.087	0.083	0.006
Cesium-137	0.05 - 0.48	8	N/A	0.002	1.50	0.382	0.507
Gross Alpha	1.8 - 3.4	8	N/A	15.3	72.0	35.0	19.7
Gross Beta	2.4 - 5.2	8	N/A	35.0	59.0	43.3	7.41
Plutonium-239/240	0.002 - 0.275	18	N/A	-0.078	0.250	0.044	0.073
Radium-226	0.19 - 1	4	N/A	0.390	1.80	1.06	0.693
Radium-228	0.33 - 1.76	4	N/A	0.940	4.10	2.41	1.39
Strontium-89/90	0.04 - 0.4	8	N/A	0.080	0.319	0.217	0.091
Uranium-233/234	0.014 - 0.423	18	N/A	0.630	3.08	1.28	0.745
Uranium-235	0 - 0.482	18	N/A	-0.011	0.189	0.076	0.067
Uranium-238	0.008 - 0.423	18	N/A	0.65	2.81	1.29	0.716

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[c] All radionuclide values are considered detects.

N/A = Not applicable; not calculated. Only one sample was collected.

Table 1.3
Summary of Detected Analytes in Subsurface Soil/Subsurface Sediment

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Inorganics (mg/kg)							
Aluminum	40 - 40	7	100	3,130	15,400	9,153	4,749
Arsenic	2 - 2	7	100	2.40	5.90	3.36	1.25
Barium	40 - 40	7	100	21.9	64.0	45.1	14.3
Beryllium	1 - 1	7	100	0.270	1.20	0.656	0.357
Calcium	1,000 - 1,000	7	100	347	3,160	1,237	995
Cesium[b]	200 - 200	7	28.6	1.20	1.70	3.49	1.40
Chromium	2 - 2	7	100	13.1	22.8	15.7	3.60
Cobalt	10 - 10	7	100	3.50	13.7	7.17	3.29
Copper	5 - 5	7	100	4.80	12.5	8.63	2.93
Iron	20 - 20	7	100	6,830	18,100	10,736	4,093
Lead[b]	0.6 - 1	7	100	2.80	13.9	6.91	3.97
Lithium[b]	20 - 20	7	100	2.00	7.80	5.20	2.27
Magnesium	1,000 - 1,000	7	100	308	3,160	1,223	954
Manganese	3 - 3	7	100	90.5	295	151	67.5
Mercury[b]	0.1 - 0.1	7	14.3	0.100	0.100	0.048	0.025
Nickel	8 - 8	7	85.7	5.70	12.6	7.89	2.81
Nitrate / Nitrite[b]	0.1 - 0.1	5	100	0.100	1.00	0.380	0.356
Potassium	1,000 - 1,000	7	100	318	1,010	780	249
Selenium	1 - 1	7	14.3	0.390	0.390	0.204	0.093
Sodium	1,000 - 1,000	7	100	30.3	559	152	202
Strontium	40 - 40	7	100	7.10	45.0	17.0	13.8
Tin[b]	40 - 40	7	28.6	32.9	33.9	10.4	15.7
Vanadium	10 - 10	7	100	9.10	36.1	20.9	9.19
Zinc	4 - 4	7	57.1	14.3	26.9	12.5	9.23
Organics (ug/kg)							
Acetone	10 - 10	1	100	2.00	2.00	2.00	N/A
bis(2-ethylhexyl)phthalate	330 - 330	5	80.0	38.0	93.0	86.8	51.3
Diethylphthalate	330 - 330	5	20.0	130	130	163	18.9
Di-n-butylphthalate	330 - 330	5	100	240	410	350	66.7
Fluoranthene	330 - 330	5	20.0	48.0	48.0	146	54.7
Toluene	5 - 5	4	50.0	2.00	3.00	2.50	0.408
Radionuclides (pCi/g)[c]							
Americium-241	0.008 - 0.02	5	N/A	0.002	0.013	0.006	0.004
Gross Alpha	2.2 - 2.2	2	N/A	13.9	21.1	17.5	5.09
Gross Beta	4.6 - 4.8	2	N/A	18.1	20.6	19.4	1.77
Plutonium-239/240	0.011 - 0.026	5	N/A	-0.002	0.032	0.007	0.014
Strontium-89/90	0.3 - 0.3	2	N/A	-0.030	0.133	0.052	0.115
Uranium-233/234	0.065 - 0.14	5	N/A	0.840	2.30	1.57	0.541
Uranium-235	0.046 - 0.12	5	N/A	0.033	0.100	0.063	0.026
Uranium-238	0.074 - 0.16	5	N/A	0.710	2.30	1.52	0.607

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[c] All radionuclide values are considered detects.

N/A = Not applicable.

Table 1.4
Summary of Detected Analytes in Surface Soil

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Inorganics (mg/kg)							
Aluminum	5.2 - 5.8	10	100	8,200	18,000	13,520	3,168
Antimony[b]	0.3 - 0.34	10	20	0.340	0.600	0.219	0.146
Arsenic	0.86 - 0.97	10	100	3.60	22.0	8.48	5.07
Barium	0.39 - 0.44	10	100	68.0	140	109	24.5
Beryllium[b]	0.11 - 0.12	10	40	0.250	0.520	0.358	0.099
Boron	1.1 - 1.2	10	100	2.80	7.10	5.11	1.20
Calcium	7.4 - 8.4	10	100	880	4,600	2,308	943
Chromium	0.16 - 0.18	10	100	8.10	17.0	13.3	2.65
Cobalt	0.19 - 0.22	10	100	3.80	6.40	5.04	0.934
Copper	0.048 - 0.054	10	100	5.20	13.0	9.77	2.20
Iron	1.5 - 1.7	10	100	8,900	16,000	13,190	2,414
Lead	0.29 - 0.32	10	100	9.90	48.0	30.5	11.3
Lithium[b]	0.52 - 0.58	10	100	5.70	12.0	9.28	1.74
Magnesium	8 - 9	10	100	1,000	2,500	1,920	432
Manganese	0.18 - 0.21	10	100	150	320	260	55.8
Mercury	0.0073 - 0.0083	10	100	0.020	0.030	0.025	0.003
Molybdenum	0.31 - 0.35	10	100	0.320	0.910	0.613	0.200
Nickel	0.21 - 0.23	10	100	4.90	11.0	8.79	1.62
Potassium	38 - 43	10	100	1,200	2,800	2,050	455
Silica[b]	4.6 - 5.2	10	100	670	790	735	42.5
Silver	0.083 - 0.093	10	10	0.120	0.120	0.086	0.052
Sodium	140 - 150	10	20	140	200	91.5	43.8
Strontium	0.062 - 0.07	10	100	9.60	24.0	20.3	4.20
Thallium[b]	0.96 - 1.1	10	10	1.30	1.30	0.571	0.256
Titanium	0.093 - 0.1	10	100	150	320	236	58.2
Vanadium	0.49 - 0.55	10	100	19.0	34.0	28.0	5.06
Zinc	0.48 - 0.54	10	100	21.0	50.0	37.0	9.01
Radionuclides (pCi/g)[c]							
Americium-241	0.131 - 0.296	10	N/A	-0.016	0.080	0.028	0.034
Plutonium-239/240	0.0582 - 0.275	10	N/A	-0.078	0.250	0.066	0.094
Uranium-233/234	0.136 - 0.423	10	N/A	0.710	1.27	0.888	0.203
Uranium-235	0.214 - 0.482	10	N/A	-0.011	0.189	0.084	0.084
Uranium-238	0.194 - 0.423	10	N/A	0.678	1.70	0.985	0.331

[a] For inorganics, statistics are computed using one-half the reported value for nondetects.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument

[c] All radionuclide values are considered detects.

N/A = Not applicable.

Table 1.5
Summary of Detected Analytes in Subsurface Soil

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Inorganics (mg/kg)							
Aluminum	40 - 40	7	100	3,130	15,400	9,153	4,749
Arsenic	2 - 2	7	100	2.40	5.90	3.36	1.25
Barium	40 - 40	7	100	21.9	64.0	45.1	14.3
Beryllium	1 - 1	7	100	0.270	1.20	0.656	0.357
Calcium	1,000 - 1,000	7	100	347	3,160	1,237	995
Cesium[b]	200 - 200	7	28.6	1.20	1.70	3.49	1.40
Chromium	2 - 2	7	100	13.1	22.8	15.7	3.60
Cobalt	10 - 10	7	100	3.50	13.7	7.17	3.29
Copper	5 - 5	7	100	4.80	12.5	8.63	2.93
Iron	20 - 20	7	100	6,830	18,100	10,736	4,093
Lead[b]	0.6 - 1	7	100	2.80	13.9	6.91	3.97
Lithium[b]	20 - 20	7	100	2.00	7.80	5.20	2.27
Magnesium	1,000 - 1,000	7	100	308	3,160	1,223	954
Manganese	3 - 3	7	100	90.5	295	151	67.5
Mercury[b]	0.1 - 0.1	7	14.3	0.100	0.100	0.048	0.025
Nickel	8 - 8	7	85.7	5.70	12.6	7.89	2.81
Nitrate / Nitrite[b]	0.1 - 0.1	5	100	0.100	1.00	0.380	0.356
Potassium	1,000 - 1,000	7	100	318	1,010	780	249
Selenium	1 - 1	7	14.3	0.390	0.390	0.204	0.093
Sodium	1,000 - 1,000	7	100	30.3	559	152	202
Strontium	40 - 40	7	100	7.10	45.0	17.0	13.8
Tin[b]	40 - 40	7	28.6	32.9	33.9	10.4	15.7
Vanadium	10 - 10	7	100	9.10	36.1	20.9	9.19
Zinc	4 - 4	7	57.1	14.3	26.9	12.5	9.23
Organics (ug/kg)							
Acetone	10 - 10	1	100	2.00	2.00	2.00	N/A
bis(2-ethylhexyl)phthalate	330 - 330	5	80.0	38.0	93.0	86.8	51.3
Diethylphthalate	330 - 330	5	20.0	130	130	163	18.9
Di-n-butylphthalate	330 - 330	5	100	240	410	350	66.7
Fluoranthene	330 - 330	5	20.0	48.0	48.0	146	54.7
Toluene	5 - 5	4	50.0	2.00	3.00	2.50	0.408
Radionuclides (pCi/g)[c]							
Americium-241	0.008 - 0.02	5	N/A	0.002	0.013	0.006	0.004
Gross Alpha	2.2 - 2.2	2	N/A	13.9	21.1	17.5	5.09
Gross Beta	4.6 - 4.8	2	N/A	18.1	20.6	19.4	1.77
Plutonium-239/240	0.011 - 0.026	5	N/A	-0.002	0.032	0.007	0.014
Strontium-89/90	0.3 - 0.3	2	N/A	-0.030	0.133	0.052	0.115
Uranium-233/234	0.065 - 0.14	5	N/A	0.840	2.30	1.57	0.541
Uranium-235	0.046 - 0.12	5	N/A	0.033	0.100	0.063	0.026
Uranium-238	0.074 - 0.16	5	N/A	0.710	2.30	1.52	0.607

[a] For inorganics and organics, statistics are computed using one-half the reported value for nondetects.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

[c] All radionuclide values are considered detects.

N/A = Not applicable.

Table 2.1
Essential Nutrient Screen for Surface Soil/Surface Sediment

Analyte	MDC (mg/kg)	Estimated Maximum Daily Intake[a] (mg/day)	RDA/RDI/AI[b] (mg/day)	UL[b] (mg/day)	Retain for PRG Screen?
Calcium	4,800	0.480	500-1,200	2,500	No
Magnesium	4,330	0.433	80-420	65-110	No
Potassium	2,890	0.289	2,000-3,500	N/A	No
Sodium	559	0.056	500-2,400	N/A	No

[a] Based on the MDC and a 100 mg/day soil ingestion rate for a WRW.

[b] RDA/RDI/AI/UL taken from NAS 2000, 2002.

N/A = Not available.

Table 2.2
PRG Screen for Surface Soil/Surface Sediment

Analyte	PRG[a]	MDC	MDC Greater Than PRG?	UCL[b]	UCL Greater Than PRG?	Retain for Detection Frequency Screen?
Inorganics (mg/kg)						
Aluminum	24,774	19,400	No	--	--	No
Antimony	44.4	12.4	No	--	--	No
Arsenic	**2.41**	**22.0**	**Yes**	**11.6**	**Yes**	**Yes**
Barium	2,872	244	No	--	--	No
Beryllium	100	1.40	No	--	--	No
Boron	9,477	7.10	No	--	--	No
Cadmium	91.4	1.30	No	--	--	No
Cesium	N/A	4.90	UT	--	--	UT
Chromium[c]	28.4	24.8	No	--	--	No
Cobalt	122	10.1	No	--	--	No
Copper	4,443	25.9	No	--	--	No
Iron	33,326	23,400	No	--	--	No
Lead	1,000	48.0	No	--	--	No
Lithium	2,222	20.3	No	--	--	No
Manganese	419	470	Yes	292	--	No
Mercury	32.9	0.030	No	--	--	No
Molybdenum	555	2.40	No	--	--	No
Nickel	2,222	17.6	No	--	--	No
Nitrate / Nitrite[d]	177,739	76.0	No	--	--	No
Silica	N/A	790	UT	--	--	UT
Silicon	N/A	252	UT	--	--	UT
Silver	555	2.00	No	--	--	No
Strontium	66,652	41.2	No	--	--	No
Thallium	7.78	1.30	No	--	--	No
Tin	66,652	17.5	No	--	--	No
Titanium	169,568	320	No	--	--	No
Vanadium	111	51.9	No	--	--	No
Zinc	33,326	720	No	--	--	No
Organics (mg/kg)						
2-Butanone	4.64E+07	3.00	No	--	--	No
4-Methylphenol	400,718	95.0	No	--	--	No
Benzoic Acid	3.21E+08	480	No	--	--	No
bis(2-ethylhexyl)phthalate	213,750	250	No	--	--	No
Di-n-butylphthalate	8.01E+06	150	No	--	--	No
Fluoranthene	2.96E+06	88.0	No	--	--	No
Pyrene	2.22E+06	61.0	No	--	--	No
Toluene	3.09E+06	2.00	No	--	--	No
Radionuclides (pCi/g)						
Americium-241	7.69	0.087	No	--	--	No
Cesium-134	**0.080**	**0.087**	**Yes**	**N/A**	**N/A**	**Yes**
Cesium-137	**0.221**	**1.50**	**Yes**	**1.22**	**Yes**	**Yes**
Gross alpha	N/A	72.0	UT	--	--	UT
Gross beta	N/A	59.0	UT	--	--	UT
Plutonium-239/240	9.80	0.250	No	--	--	No
Radium-226	2.69	1.80	No	--	--	No
Radium-228	**0.111**	**4.10**	**Yes**	**4.04**	**Yes**	**Yes**
Strontium-89/90	13.2	0.319	No	--	--	No
Uranium-233/234	25.3	3.08	No	--	--	No
Uranium-235	1.05	0.189	No	--	--	No
Uranium-238	29.3	2.81	No	--	--	No

[a] The value shown is equal to the most stringent of the PRGs based on a risk of 1E-06 or an HQ of 0.1.

[b] UCL = Upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.

[c] The PRG for chromium (VI) is used in the PRG screen because it is more conservative than the PRG for chromium (III).

[d] The PRG for nitrate is used.

N/A = Not available.

UT = Uncertain toxicity; no PRG available (assessed in Section 6.0).

-- = Screen not performed because analyte was eliminated from further consideration in a previous step.

Bold = Analyte retained for further consideration in the next COC selection step.

Table 2.3

Statistical Distributions and Comparison to Background for the WAEU[a]

	Statistical Distribution Testing Results						Background Comparison		
	Background			WAEU					
Analyte	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Retain as PCOC?
Surface Soil/Surface Sediment									
Arsenic	**73**	**GAMMA**	**91.8**	**10**	**GAMMA**	**100**	**WRS**	**7.00E-05**	**Yes**

[a]EU data used for background comparisons do not include data from background locations.

Bold = Analyte retained for further consideration in the next COC selection step.

Table 2.4

Essential Nutrient Screen for Subsurface Soil/Subsurface Sediment[a]

Analyte	MDC (mg/kg)	Estimated Maximum Daily Intake[b] (mg/day)	RDA/RDI/AI[c] (mg/day)	UL[c] (mg/day)	Retain for PRG Screen?
Calcium	3,160	0.3160	500-1,200	2,500	No
Magnesium	3,160	0.3160	80-420	65-110	No
Potassium	1,010	0.1010	2,000-3,500	N/A	No
Sodium	559	0.0559	500-2,400	N/A	No

[a] Sediment greater than 0.5 feet deep was not sampled at the WAEU. Data in this table are for subsurface soil only.

[b] Based on the MDC and a 100 mg/day soil ingestion rate for a WRW.

[c] RDA/RDI/AI/UL taken from NAS 2000, 2002.

N/A = Not available.

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Table 2.5

PRG Screen for Subsurface Soil/Subsurface Sediment[a]

Analyte	PRG[b]	MDC	MDC Greater Than PRG?	UCL[c]	UCL Greater Than PRG?	Retain for Detection Frequency Screen?
Inorganics (mg/kg)						
Aluminum	284,902	15,400	No	--	--	No
Arsenic	27.7	5.90	No	--	--	No
Barium	33,033	64.0	No	--	--	No
Beryllium	1,151	1.20	No	--	--	No
Cesium	N/A	1.70	UT	--	--	UT
Chromium[d]	327	22.8	No	--	--	No
Cobalt	1,401	13.7	No	--	--	No
Copper	51,100	12.5	No	--	--	No
Iron	383,250	18,100	No	--	--	No
Lead	1,000	13.9	No	--	--	No
Lithium	25,550	7.80	No	--	--	No
Manganese	4,815	295	No	--	--	No
Mercury	379	0.100	No	--	--	No
Nickel	25,550	12.6	No	--	--	No
Nitrate / Nitrite[e]	2.04E+06	1.00	No	--	--	No
Selenium	6,388	0.390	No	--	--	No
Strontium	766,500	45.0	No	--	--	No
Tin	766,500	33.9	No	--	--	No
Vanadium	1,278	36.1	No	--	--	No
Zinc	383,250	26.9	No	--	--	No
Organics (mg/kg)						
Acetone	1.15E+09	2.00	No	--	--	No
bis(2-ethylhexyl)phthalate	2.46E+06	93.0	No	--	--	No
Diethylphthalate	7.37E+08	130	No	--	--	No
Di-n-butylphthalate	9.22E+07	410	No	--	--	No
Fluoranthene	3.40E+07	48.0	No	--	--	No
Toluene	3.56E+07	3.00	No	--	--	No
Radionuclides (pCi/g)						
Americium-241	88.4	0.013	No	--	--	No
Gross alpha	N/A	21.1	UT	--	--	UT
Gross beta	N/A	20.6	UT	--	--	UT
Plutonium-239/240	112	0.032	No	--	--	No
Strontium-89/90	152	0.133	No	--	--	No
Uranium-233/234	291	2.30	No	--	--	No
Uranium-235	12.1	0.100	No	--	--	No
Uranium-238	337	2.30	No	--	--	No

[a] Sediment greater than 0.5 feet deep was not sampled at the WAEU. Data in this table are for subsurface soil only.

[b] The value shown is equal to the most stringent of the PRGs based on a risk of 1E-06 or an HQ of 0.1.

[c] UCL = 95 percent upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.

[d] The PRG for chromium (VI) is used in the PRG screen because it is more conservative than the PRG for chromium (III).

[e] The PRG for nitrate is used.

N/A = Not available.

UT = Uncertain toxicity; no PRG available (assessed in Section 6.0).

-- = Screen not performed because analyte was eliminated from further consideration in a previous step.

Table 2.6
Summary of the COC Selection Process

Analyte	MDC Exceeds PRG?	UCL Exceeds PRG?	Detection Frequency >5%?[a]	Exceeds 30x the PRG?	Exceeds Background?	Professional Judgment - Retain?	Retain as COC?
Surface Soil/Surface Sediment							
Arsenic	Yes	Yes	Yes	N/A	Yes	No	No
Manganese	Yes	No	--	--	--	--	No
Cesium-134	Yes	N/A	N/A	N/A	No[b]	--	No
Cesium-137	Yes	Yes	N/A	N/A	No[b]	--	No
Radium-228	Yes	Yes	N/A	N/A	No[b]	--	No
Subsurface Soil/Subsurface Sediment[c]							
None > PRG	No	--	--	--	--	--	No

[a] All radionuclide values are considered detects.

[b] The radionuclide was only detected in surface sediment at background locations within the EU.

[c] Sediment greater than 0.5 ft deep was not sampled at the WAEU. Data in this table are for subsurface soil only.

N/A = Not applicable or not available.

-- = Screen not performed because analyte was eliminated from further consideration in a previous step.

Table 6.1

Summary of Detected PCOCs Without PRGs[a]

Analyte	Surface Soil/Surface Sediment	Subsurface Soil/Subsurface Sediment
Inorganics		
Cesium	X[b]	X[b]
Silica	X	N/A
Silicon	X[b]	N/A
Radionuclides		
Gross-Alpha	X	X
Gross-Beta	X	X

[a] Does not include essential nutrients. Essential nutrients without PRGs were evaluated by comparing estimated intakes to recommended intakes.

[b] All detections are "J" qualified, signifying that the reported result is below the detection limit, but above the instrument detection limit.

X = PRG is unavailable.

N/A = Not applicable. Analyte not detected or not analyzed.

Table 7.1
Comparison of MDCs in Surface Soil to NOAEL ESLs for Terrestrial Plants, Invertebrates, and Vertebrates (Non-PMJM)

Analyte	MDC	Terrestrial Plants		Terrestrial Invertebrates		Mourning Dove Herbivore		Mourning Dove Insectivore		American Kestrel		Deer Mouse Herbivore		Deer Mouse Insectivore		Prairie Dog		Mule Deer		Coyote Carnivore		Coyote Generalist		Coyote Insectivore		Terrestrial Receptor[a]		Most Sensitive Receptor	Retain for Further Analysis?
		NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	NOAEL	MDC > ESL?	Results	
Inorganics (mg/kg)																												
Aluminum	18,000	50	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Plant	Yes
Antimony	0.600	5	No	78	No	N/A	N/A	N/A	N/A	N/A	N/A	9.89	No	0.905	No	18.7	No	57.6	No	138	No	13.2	No	3.85	No	N/A	N/A	Deer Mouse Insectivore	No
Arsenic	22	10	Yes	60	No	20.0	Yes	164	No	1,028	No	2.57	Yes	51.4	No	9.35	Yes	13.0	Yes	709	No	341	No	293	No	N/A	N/A	Deer Mouse Herbivore	Yes
Barium	140	500	No	330	No	159	No	357	No	1,317	No	930	No	4,427	No	3,224	No	4,766	No	24,896	No	19,838	No	18,369	No	N/A	N/A	Dove Herbivore	No
Beryllium	0.520	10	No	40	No	N/A	N/A	N/A	N/A	N/A	N/A	160	No	6.82	No	211	No	896	No	1,072	No	103	No	29.2	No	N/A	N/A	Deer Mouse Insectivore	No
Boron	7.10	0.500	Yes	N/A	N/A	30.3	No	115	No	167	No	62.1	No	422	No	237	No	314	No	929	No	6,070	No	1,816	No	N/A	N/A	Plant	Yes
Calcium	4,600	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Chromium[b]	17	1	Yes	0.400	Yes	24.6	No	1.34	Yes	14.0	Yes	281	No	15.9	Yes	703	No	1,461	No	4,173	No	250	No	68.5	No	N/A	N/A	Invertebrates	Yes
Cobalt	6.40	13	No	N/A	N/A	278	No	87.0	No	440	No	1,476	No	363	No	2,461	No	7,902	No	3,785	No	2,492	No	1,519	No	N/A	N/A	Dove Insectivore	No
Copper	13	100	No	50	No	28.9	No	8.25	Yes	164	No	295	No	605	No	838	No	4,119	No	5,459	No	3,000	No	4,641	No	N/A	N/A	Dove Insectivore	Yes
Iron	16,000	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Lead	48	110	No	1,700	No	49.9	No	12.1	Yes	95.8	No	1,344	No	242	No	1,850	No	9,798	No	8,927	No	3,066	No	1,393	No	N/A	N/A	Dove Insectivore	Yes
Lithium	12	2	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,882	No	610	No	3,178	No	10,173	No	18,431	No	5,608	No	2,560	No	N/A	N/A	Plant	Yes
Magnesium	2,500	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Manganese	320	500	No	N/A	N/A	1,032	No	2,631	No	9,917	No	486	No	4,080	No	1,519	No	2,506	No	14,051	No	10,939	No	19,115	No	N/A	N/A	Deer Mouse Herbivore	No
Mercury	0.0300	0.300	No	0.100	No	0.197	No	1.00E-04	Yes	1.57	No	0.439	No	0.179	No	3.15	No	7.56	No	8.18	No	8.49	No	37.3	No	N/A	N/A	Dove Insectivore	Yes
Molybdenum	0.910	2	No	N/A	N/A	44.4	No	6.97	No	76.7	No	8.68	No	1.90	No	27.1	No	44.3	No	275	No	28.9	No	8.18	No	N/A	N/A	Deer Mouse Insectivore	No
Nickel	11	30	No	200	No	44.1	No	1.24	Yes	13.1	No	16.4	No	0.431	Yes	38.3	No	124	No	90.9	No	6.02	Yes	1.86	Yes	N/A	N/A	Deer Mouse Insectivore	Yes
Potassium	2,800	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Silica	790	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Silver	0.120	2	No	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Plant	No
Sodium	200	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Strontium	24	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	940	No	13,578	No	3,519	No	4,702	No	584,444	No	144,904	No	57,298	No	N/A	N/A	Deer Mouse Herbivore	No
Thallium	1.30	1	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	180	No	7.24	No	204	No	1,039	No	212	No	81.6	No	30.8	No	N/A	N/A	Plant	Yes
Titanium	320	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	UT
Vanadium	34	2	Yes	N/A	N/A	503	No	274	No	1,514	No	63.7	No	29.9	Yes	83.5	No	358	No	341	No	164	No	121	No	N/A	N/A	Plant	Yes
Zinc	50	50	No	200	No	109	No	0.646	Yes	113	No	171	No	5.29	Yes	1,174	No	2,772	No	16,489	No	3,887	No	431	No	N/A	N/A	Dove Insectivore	Yes
Radionuclides (pCi/g)																													
Americium-241	0.0804	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3,890	No	N/A	No
Plutonium-239/240	0.250	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	6,110	No	N/A	No
Uranium-233/234	1.27	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4,980	No	N/A	No
Uranium-235	0.189	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	2,770	No	N/A	No
Uranium-238	1.70	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1,580	No	N/A	No

[a] Radionuclide ESLs are not receptor-specific. They are considered protective of all terrestrial ecological species.

[b] The ESLs for chromium were developed using toxicity data based on chromium III (birds) and chromium VI (plants, invertebrates, and mammals).

N/A = No ESL was available for that ECOI/receptor pair.

UT = Uncertain toxicity; no ESL available (assessed in Section 10.0).

Bold = MDC exceeds one or more ESLs. Analyte retained for further consideration in the next ECOPC selection step.

Table 7.2
Summary of Non-PMJM NOAEL ESL Screening Results for Surface Soil in the WAEU

Analyte	Terrestrial Plant Exceedance?	Terrestrial Invertebrate Exceedance?	Terrestrial Vertebrate Exceedance?
Inorganics			
Aluminum	**Yes**	UT	UT
Antimony	No	No	No
Arsenic	**Yes**	No	**Yes**
Barium	No	No	No
Beryllium	No	No	No
Boron	**Yes**	UT	No
Calcium	UT	UT	UT
Chromium	**Yes**	**Yes**	**Yes**
Cobalt	No	UT	No
Copper	No	No	**Yes**
Iron	UT	UT	UT
Lead	No	No	**Yes**
Lithium	**Yes**	UT	No
Magnesium	UT	UT	UT
Manganese	No	UT	No
Mercury	No	No	**Yes**
Molybdenum	No	UT	No
Nickel	No	No	**Yes**
Potassium	UT	UT	UT
Silica	UT	UT	UT
Silver	No	UT	UT
Sodium	UT	UT	UT
Strontium	UT	UT	No
Thallium	**Yes**	UT	No
Titanium	UT	UT	UT
Vanadium	**Yes**	UT	**Yes**
Zinc	No	No	**Yes**
Radionuclides			
Americium-241	UT	UT	No
Plutonium-239/240	UT	UT	No
Uranium-233/234	UT	UT	No
Uranium-235	UT	UT	No
Uranium-238	UT	UT	No

UT = Uncertain toxicity; no ESLs available (assessed in Section 10).
Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.3
Statistical Distributions and Comparisons to Background for WAEU Surface Soil

Analyte	Statistical Distribution Testing Results						Background Comparison		
	Background			WAEU					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Retain as ECOI?
Aluminum	**20**	**NORMAL**	**100**	**10**	**NORMAL**	**100**	**t-Test_N**	**0.00649**	**Yes**
Arsenic	**20**	**NORMAL**	**100**	**10**	**GAMMA**	**100**	**WRS**	**0.0673**	**Yes**
Boron	**N/A**	**N/A**	**N/A**	**10**	**NORMAL**	**100**	**N/A**	**N/A**	**N/A**
Chromium	**20**	**NORMAL**	**100**	**10**	**NORMAL**	**100**	**t-Test_N**	**0.0305**	**Yes**
Copper	20	NONPARAMETRIC	100	10	NORMAL	100	WRS	0.999	No
Lead	20	NORMAL	100	10	NORMAL	100	t-Test_N	0.764	No
Lithium	**20**	**NORMAL**	**100**	**10**	**NORMAL**	**100**	**t-Test_N**	**0.0156**	**Yes**
Mercury	20	NONPARAMETRIC	40	10	NORMAL	100	WRS	1.000	No
Nickel	20	NORMAL	100	10	NORMAL	100	t-Test_N	0.812	No
Thallium	**14**	**NORMAL**	**0**	**10**	**NONPARAMETRIC**	**10**	**N/A**	**N/A**	**N/A**
Vanadium	20	NORMAL	100	10	NORMAL	100	t-Test_N	0.461	No
Zinc	20	NORMAL	100	10	NORMAL	100	t-Test_N	0.997	No

N/A = Not applicable. Background comparison was not performed because background data were not available or detection frequency of on analyte in EU or background data set is less 20 percent.
Test: WRS = Wilcoxon Rank Sum, t-Test_N = Student's t-test using normal data, t-Test-LN = Student's t-test using log-transformed data.
Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.4
Statistical Concentrations in WAEU Surface Soil

Analyte	Units	Number of Samples	Mean	Median	75th percentile	95th percentile	UCL[a]	UTL[b]	Maximum[c]
Aluminum	mg/kg	10	13,500	13,500	15,000	18,000	15,400	21,000	18,000
Arsenic	mg/kg	10	8.48	7.60	8.85	16.3	11.6	22	22
Boron	mg/kg	10	5.11	5	5.73	6.79	5.80	7.93	7.10
Chromium	mg/kg	10	13.3	13.5	14.8	16.6	14.8	19.5	17
Lithium	mg/kg	10	9.28	9.40	10	11.6	10.3	13.4	12
Thallium	mg/kg	10	0.571	0.493	0.499	0.940	0.720	1.30	1.30

[a] UCL = Upper confidence limit on the mean, unless the MDC < UCL, then the MDC is used as the UCL.

[b] UTL = 95% upper confidence limit on the 90th percentile value, unless the MDC < UCL, then the MDC is used as the UCL.

[c] Maximum = Maximum proxy result; may be MDC or reporting limit greater than MDC.

Table 7.5
Upper-Bound Exposure Point Concentration Comparison to Limiting ESLs

Analyte	Small Home Range Receptors			Large Home Range Receptors		
	EPC (UTL)	Limiting ESL[a]	EPC>ESL?	EPC (UCL)	Limiting ESL[b]	EPC>ESL?
Inorganics (mg/kg)						
Aluminum	**21,000**	**50**	**Yes**	15,400	N/A	N/A
Arsenic	**22**	**9.87**	**Yes**	11.6	49.9	No
Boron	**7.93**	**0.500**	**Yes**	5.80	314	No
Chromium[c]	**19.5**	**0.400**	**Yes**	14.8	68.5	No
Lithium	**13.4**	**2**	**Yes**	10.3	2,560	No
Thallium	**1.30**	**1**	**Yes**	0.720	53.3	No

[a]Lowest ESL (threshold if available) for the plant, invertebrate, deer mouse, prairie dog, dove, or kestrel receptors.

[b]Lowest ESL (threshold if available) for the coyote and mule deer receptors.

[c]The ESLs for chromium (VI) are used.

N/A = Not applicable; ESL not available (assessed in Section 10).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.6
Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Small Home Range Receptors

Analyte	Small Home Range Receptor UTL	Receptor-Specific ESLs[a]							
		Terrestrial Plant	Terrestrial Invertebrate	American Kestrel	Mourning Dove (herbivore)	Mourning Dove (insectivore)	Deer Mouse (herbivore)	Deer Mouse (insectivore)	Prairie Dog
Inorganics (mg/kg)									
Aluminum	21,000	N/A	**50**	N/A	N/A	N/A	N/A	N/A	N/A
Arsenic	22	**10**	60	1,028	**20**	164	**2.57**	51.4	**9.35**
Boron	7.93	**0.500**	N/A	167	30.3	115	62.1	422	237
Chromium[b]	19.5	**1**	**0.400**	**14.2**	24.6	**1.34**	281	**15.9**	703
Lithium	13.4	**2**	N/A	N/A	N/A	N/A	1,880	610	3,180
Thallium	1.30	**1**	N/A	N/A	N/A	N/A	312	12.5	350

[a]Lowest ESL (threshold if available) for that receptor.

[c] The ESLs for chromium (VI) are used.

N/A = Not applicable; ESL not available (assessed in Section 10).

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.7
Summary of ECOPC Screening Steps for Surface Soil Non-PMJM Receptors

Analyte	Exceeds Any NOAEL ESL?	Detection Frequency >5%?	Exceeds Background?[a]	Upper Bound EPC > Limiting tESL?	Professional Judgment - Retain?	Retain as ECOPC?	Receptor(s) of Potential Concern
Inorganics							
Aluminum	Yes	Yes	Yes	Yes	No	No	--
Antimony	No	--	--	--	--	No	--
Arsenic	Yes	Yes	Yes	Yes	No	No	--
Barium	No	--	--	--	--	No	--
Beryllium	No	--	--	--	--	No	--
Boron	Yes	Yes	N/A	Yes	No	No	--
Calcium	UT	--	--	--	--	No	--
Chromium	Yes	Yes	Yes	Yes	No	No	--
Cobalt	No	--	--	--	--	No	--
Copper	Yes	Yes	No	--	--	No	--
Iron	UT	--	--	--	--	No	--
Lead	Yes	Yes	No	--	--	No	--
Lithium	Yes	Yes	Yes	Yes	No	No	--
Magnesium	UT	--	--	--	--	No	--
Manganese	No	--	--	--	--	No	--
Mercury	Yes	Yes	No	--	--	No	--
Molybdenum	No	--	--	--	--	No	--
Nickel	Yes	Yes	No	--	--	No	--
Potassium	UT	--	--	--	--	No	--
Silica	UT	--	--	--	--	No	--
Silver	No	--	--	--	--	No	--
Sodium	UT	--	--	--	--	No	--
Strontium	No	--	--	--	--	No	--
Thallium	Yes	Yes	N/A	Yes	No	No	--
Titanium	UT	--	--	--	--	No	--
Vanadium	Yes	Yes	No	--	--	No	--
Zinc	Yes	Yes	No	--	--	No	--
Radionuclides							
Americium-241	No	--	--	--	--	No	--
Plutonium-239/240	No	--	--	--	--	No	--
Uranium-233	No	--	--	--	--	No	--
Uranium-235	No	--	--	--	--	No	--
Uranium-238	No	--	--	--	--	No	--

[a] Based on results of statistical analysis at the 0.1 level of significance.

-- = Screen not performed because analyte was eliminated from further consideration in a previous ECOPC selection step.

UT = Uncertain toxicity; ESL not available (assessed in Section 10.0).

N/A = Not applicable.

Table 7.8
Comparison of MDCs in WAEU Subsurface Soil to NOAEL ESLs for Burrowing Receptors

Analyte	MDC	Prairie Dog NOAEL ESL	MDC > ESL?
Inorganics (mg/kg)			
Aluminum	15,400	N/A	UT
Arsenic	5.90	9.35	No
Barium	64	3,220	No
Beryllium	1.20	211	No
Calcium	3,160	N/A	UT
Cesium	1.70	N/A	UT
Chromium[b]	22.8	703	No
Cobalt	13.7	2,461	No
Copper	12.5	838	No
Iron	18,100	N/A	UT
Lead	13.9	1,850	No
Lithium	7.80	3,180	No
Magnesium	3,160	N/A	UT
Manganese	295	1,519	No
Mercury	0.100	3.15	No
Nickel	12.6	38.3	No
Nitrate / Nitrite	1	16,200	No
Potassium	1,010	N/A	UT
Selenium	0.390	2.80	No
Sodium	559	N/A	UT
Strontium	45	3,519	No
Tin	33.9	80.6	No
Vanadium	36.1	83.5	No
Zinc	26.9	1,170	No
Organics (ug/kg)			
Acetone[a]	2	248	No
bis(2-Ethylhexyl)phthalate[a]	93	2,760	No
Diethylphthalate[a]	130	221,000	No
Di-nbutylphthalate	410	40,600	No
Fluoranthene	48	N/A	UT
Toluene[a]	3	1,220	No
Radionuclides (pCi/g)			
Americium-241	0.0130	3,890	No
Gross Alpha	21.1	N/A	UT
Gross Beta	20.6	N/A	UT
Plutonium-239/240	0.0320	6,110	No
Strontium-89/90	0.133	22.5	No
Uranium-233/234	2.30	4,980	No
Uranium-235	0.100	2,770	No
Uranium-238	2.30	1,580	No

[a] All detections are "J" qualified, signifying that the reported result is an estimated value that is below the method detection limit, but above the instrument detection limit.

[b] The ESL for chromium (VI) is used.

N/A = ESL not available.

UT = Uncertain toxicity; ESL not available (assessed in Section 10).

Table 7.9
Summary of ECOPC Screening Steps for Subsurface Soil

Analyte	Exceeds Any NOAEL ESL?	Frequency of Detection >5%	Exceeds Background?[a]	Upper Bound EPC > Limiting ESL?	Professional Judgment Retain?	Retain as ECOPC?	Receptor(s) of Potential Concern
Inorganics							
Aluminum	UT	--	--	--	--	No	--
Arsenic	No	--	--	--	--	No	--
Barium	No	--	--	--	--	No	--
Beryllium	No	--	--	--	--	No	--
Calcium	UT	--	--	--	--	No	--
Cesium	UT	--	--	--	--	No	--
Chromium	No	--	--	--	--	No	--
Cobalt	No	--	--	--	--	No	--
Copper	No	--	--	--	--	No	--
Iron	UT	--	--	--	--	No	--
Lead	No	--	--	--	--	No	--
Lithium	No	--	--	--	--	No	--
Magnesium	UT	--	--	--	--	No	--
Manganese	No	--	--	--	--	No	--
Mercury	No	--	--	--	--	No	--
Nickel	No	--	--	--	--	No	--
Nitrate / Nitrite	No	--	--	--	--	No	--
Potassium	UT	--	--	--	--	No	--
Selenium	No	--	--	--	--	No	--
Sodium	UT	--	--	--	--	No	--
Strontium	No	--	--	--	--	No	--
Tin	No	--	--	--	--	No	--
Vanadium	No	--	--	--	--	No	--
Zinc	No	--	--	--	--	No	--
Organics							
Acetone	No	--	--	--	--	No	--
bis(2-Ethylhexyl)phthalate	No	--	--	--	--	No	--
Diethylphthalate	No	--	--	--	--	No	
Di-nbutylphthalate	No	--	--	--	--	No	--
Fluoranthene	UT	--	--	--	--	No	--
Toluene	No	--	--	--	--	No	--
Radionuclides							
Americium-241	No	--	--	--	--	No	--
Gross Alpha	UT	--	--	--	--	No	--
Gross Beta	UT	--	--	--	--	No	--
Plutonium-239/240	No	--	--	--	--	No	--
Strontium-89/90	No	--	--	--	--	No	--
Uranium-233/234	No	--	--	--	--	No	--
Uranium-235	No	--	--	--	--	No	--
Uranium-238	No	--	--	--	--	No	--

[a] Based on results of statistical analysis at the 0.1 level of significance.

'--' = Screen not performed because analyte was eliminated from further consideration in a previous ECOPC selection step.

UT = Uncertain toxicity; ESL not available (assessed in Section 10).

FIGURES

40

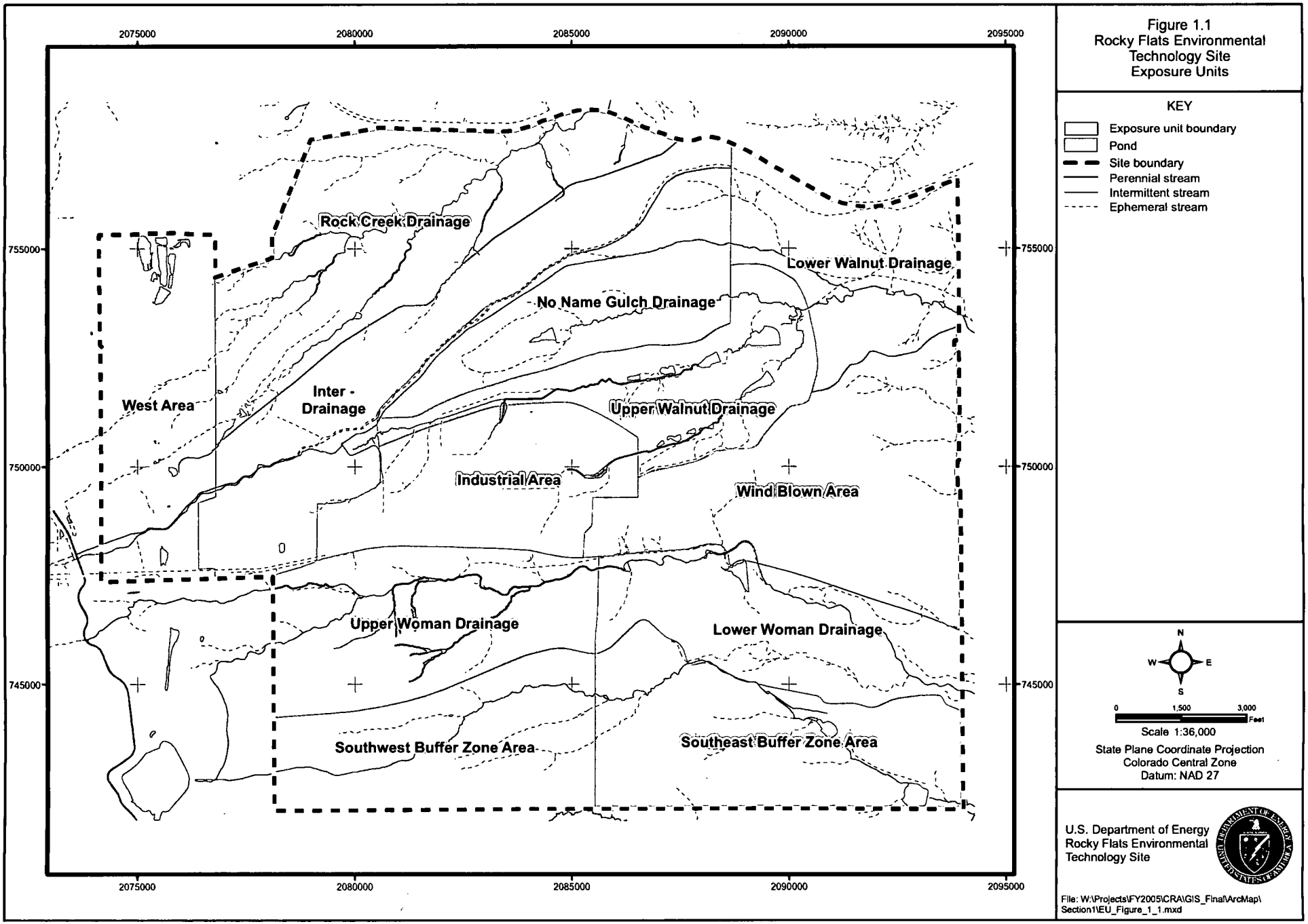

Figure 1.1
Rocky Flats Environmental Technology Site
Exposure Units

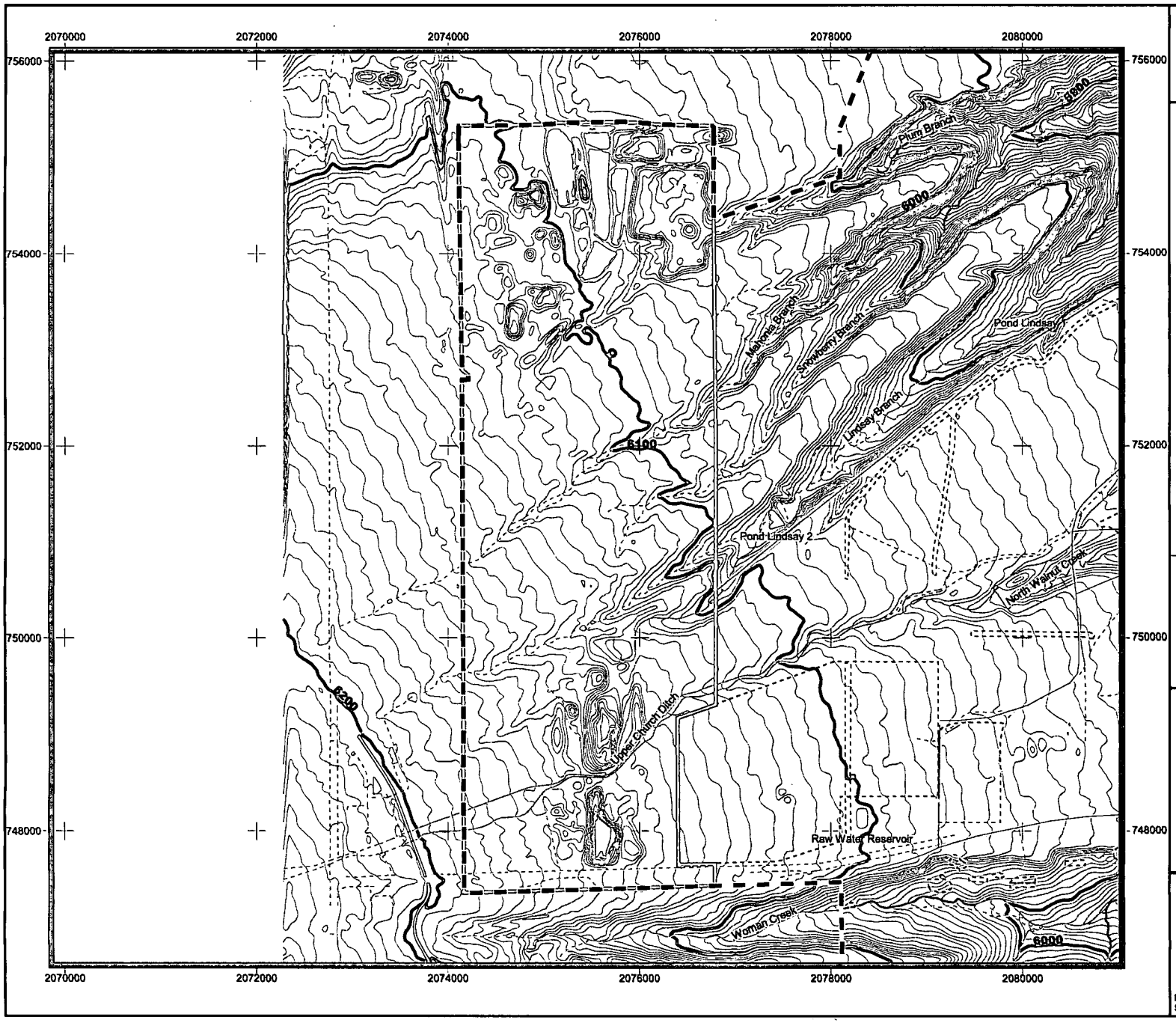

Figure 1.2
Topography and Historical IHSS Locations in the West Area Exposure Unit

KEY

- West Area EU
- Historical IHSS/PAC
- Topographic contour interval = 5 ft.

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W
E
S

0 750 1500 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\Section1\WestArea.apr

Figure 1.3
Aerial Photograph of the
West Area Exposure Unit
July 2005

KEY

West Area EU

Standard Map Features

- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W
E
S

0 750 1500 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
Rocky Flats Environmental
Technology Site

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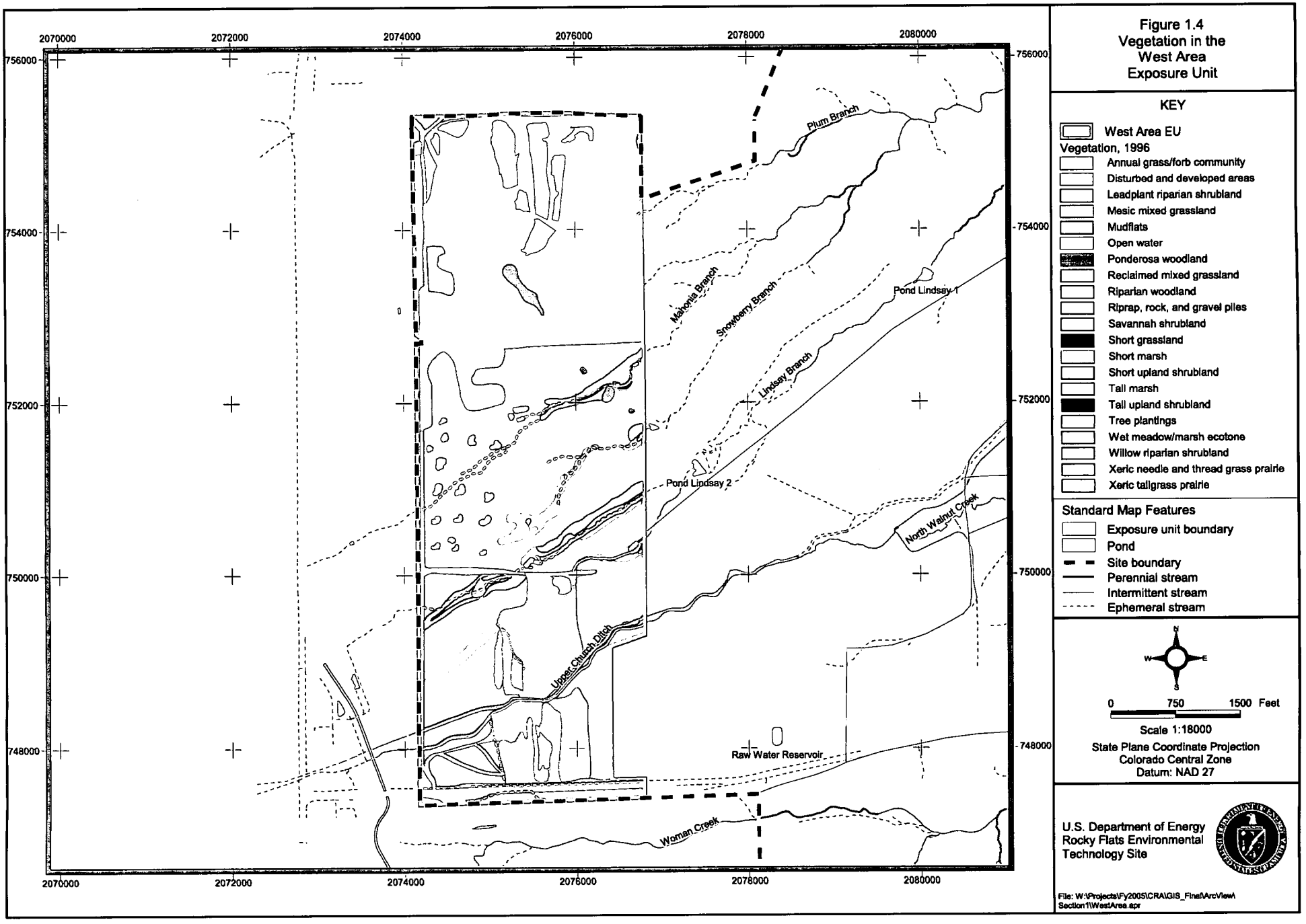
Section1\WestArea.apr


2070000
2072000
2074000
2076000
2078000
2080000
756000
754000
752000
750000
748000
Plum Branch
Mahonia Branch
Snowberry Branch
Pond Lindsay 1
Lindsay Branch
Pond Lindsay 2
North Walnut Creek
Upper Church Ditch
Raw Water Reservoir
Woman Creek
Figure 1.4
Vegetation in the
West Area
Exposure Unit
KEY
West Area EU
Vegetation, 1996
Annual grass/forb community
Disturbed and developed areas
Leadplant riparian shrubland
Mesic mixed grassland
Mudflats
Open water
Ponderosa woodland
Reclaimed mixed grassland
Riparian woodland
Riprap, rock, and gravel piles
Savannah shrubland
Short grassland
Short marsh
Short upland shrubland
Tall marsh
Tall upland shrubland
Tree plantings
Wet meadow/marsh ecotone
Willow riparian shrubland
Xeric needle and thread grass prairie
Xeric tallgrass prairie
Standard Map Features
Exposure unit boundary
Pond
Site boundary
Perennial stream
Intermittent stream
Ephemeral stream
N
W
E
S
0
750
1500 Feet
Scale 1:18000
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27
U.S. Department of Energy
Rocky Flats Environmental
Technology Site
File: W:\Projects\Fy2005\CRA\GIS_Final\ArcView\
Section1\WestArea.apr

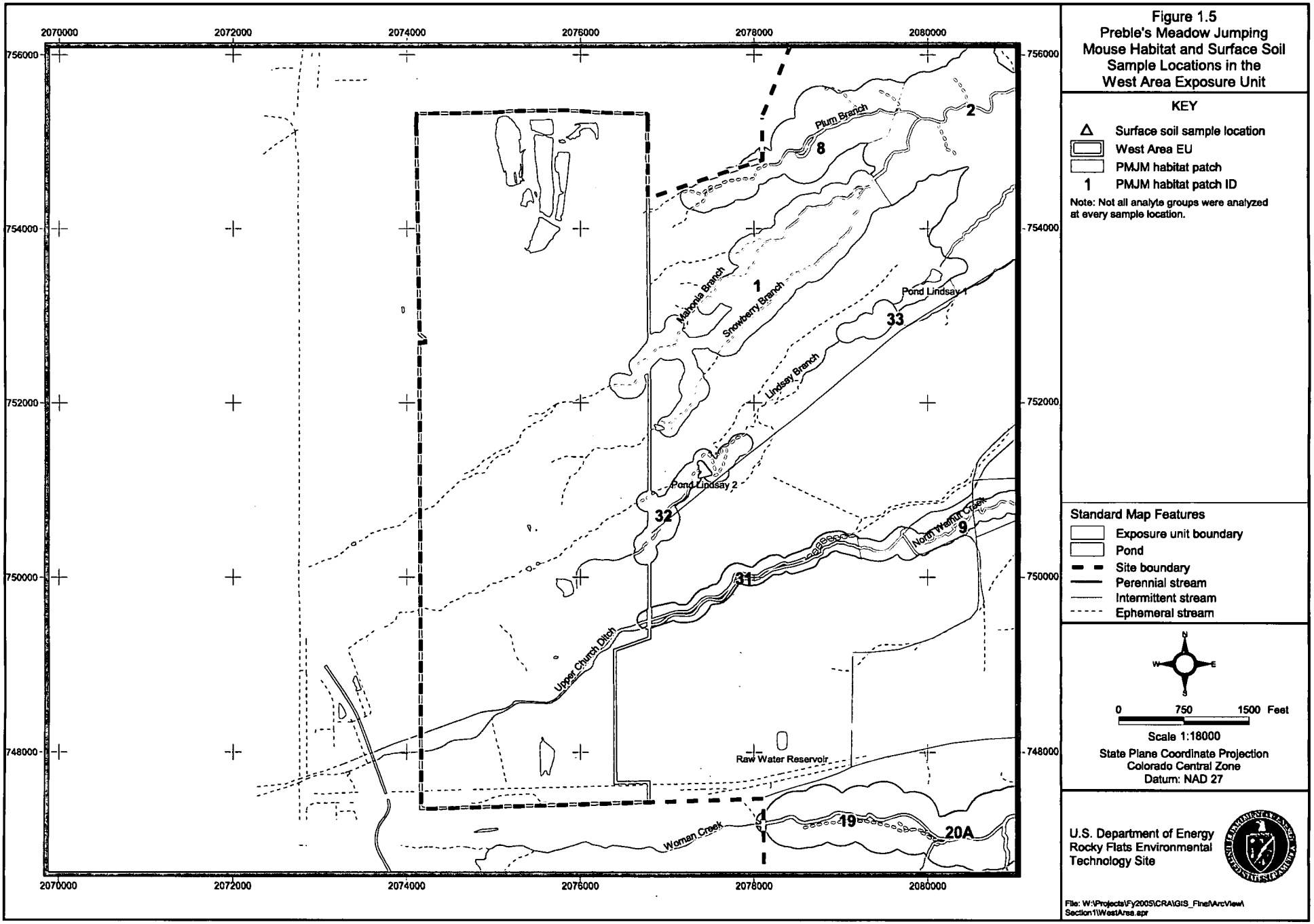


Figure 1.5
Preble's Meadow Jumping Mouse Habitat and Surface Soil Sample Locations in the West Area Exposure Unit

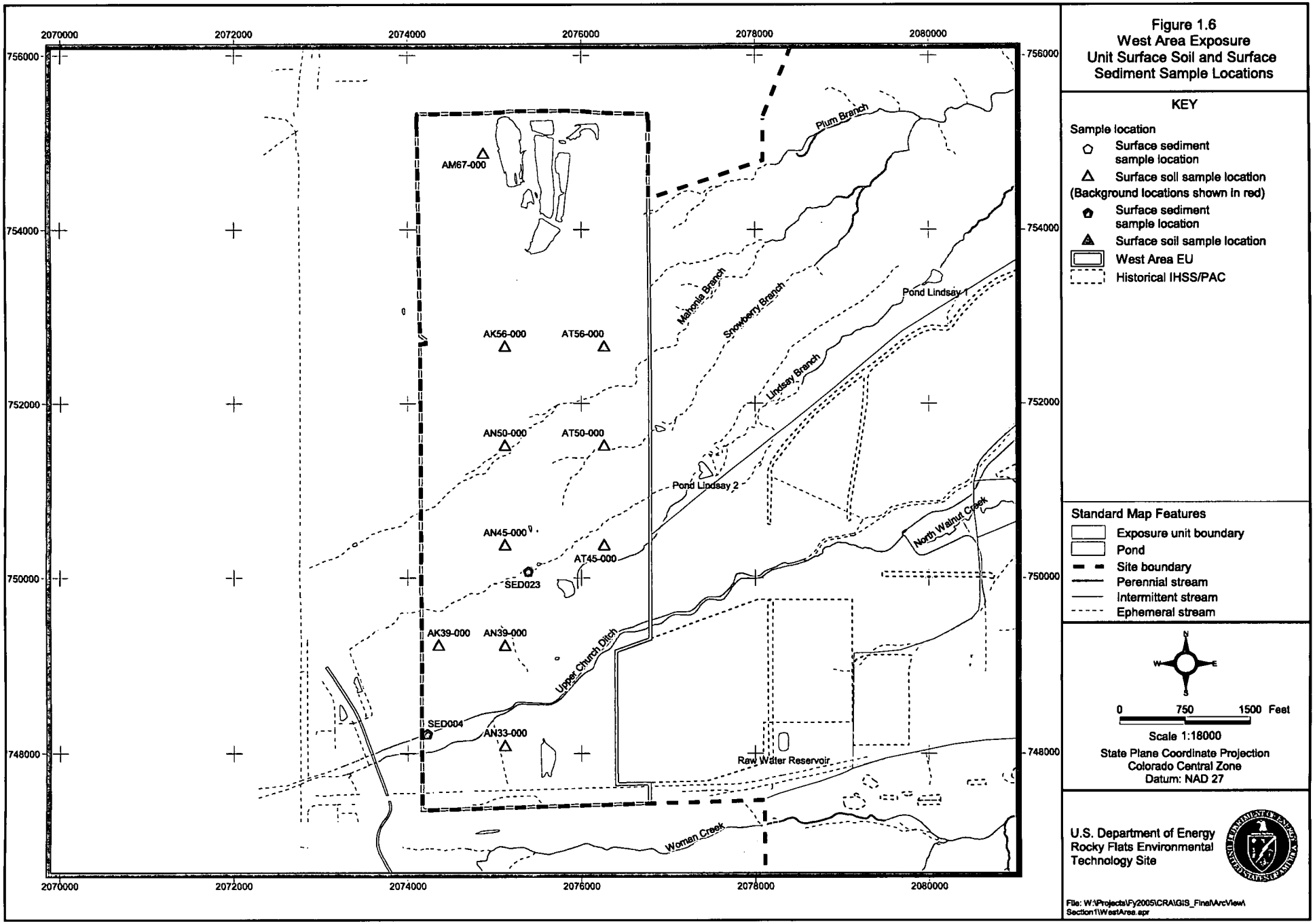


Figure 1.6
West Area Exposure Unit Surface Soil and Surface Sediment Sample Locations

KEY

Sample location
- Surface sediment sample location
- Surface soil sample location

(Background locations shown in red)
- Surface sediment sample location
- Surface soil sample location
- West Area EU
- Historical IHSS/PAC

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W
E
S

0 750 1500 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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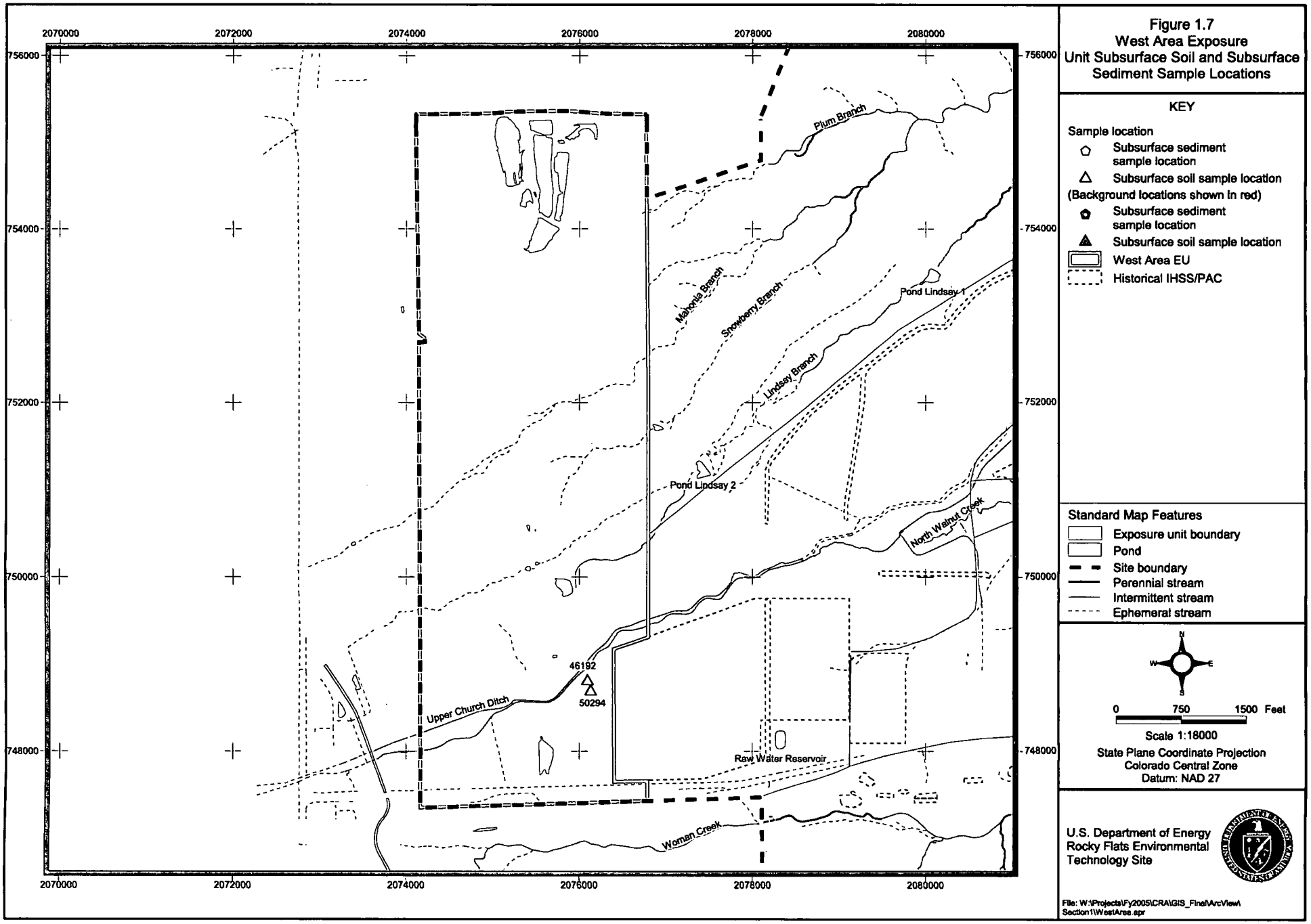

Figure 1.7
West Area Exposure
Unit Subsurface Soil and Subsurface
Sediment Sample Locations

KEY

Sample location
- Subsurface sediment sample location
- Subsurface soil sample location

(Background locations shown in red)
- Subsurface sediment sample location
- Subsurface soil sample location
- West Area EU
- Historical IHSS/PAC

Standard Map Features
- Exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W
E
S

0 750 1500 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Technology Site

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COMPREHENSIVE RISK ASSESSMENT

WEST AREA EXPOSURE UNIT

VOLUME 3: ATTACHMENT 1

Detection Limit Screen

TABLE OF CONTENTS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

µg/kg	micrograms per kilogram
µg/L	micrograms per liter
CD	compact disc
CRA	Comprehensive Risk Assessment
ERA	Ecological Risk Assessment
ESL	ecological screening level
EU	Exposure Unit
HHRA	Human Health Risk Assessment
IHSS	Individual Hazardous Substance Site
mg/kg	milligrams per kilogram
N/A	not available or not applicable
NOAEL	no observed adverse effect level
PAC	Potential Area of Concern
pCi/g	picocuries per gram
PRG	preliminary remediation goal
TIC	tentatively identified compound
VOC	volatile organic compound
WAEU	West Area Exposure Unit
WRW	wildlife refuge worker

1.0 EVALUATION OF DETECTION LIMITS FOR NONDETECTED ANALYTES IN THE WEST AREA EXPOSURE UNIT

The detection limits for analytes that are either not detected or detected in less than 5 percent of the samples collected from the media used in the Human Health Risk Assessment (HHRA) or the Ecological Risk Assessment (ERA) are reviewed in this attachment. The detection limits for surface soil/surface sediment and subsurface soil/subsurface sediment samples are compared to human health preliminary remediation goals (PRGs) for the wildlife refuge worker (WRW). The detection limits for media evaluated in the ERA are compared to the minimum ecological screening level (ESL) for a variety of ecological receptors (surface soil) and the prairie dog no observed effect level (NOAEL) ESL (subsurface soil). The results of these comparisons are presented in Tables A1.1 through A1.4.

Nondetects and the reported detection limits (referred to as "reported result" in the following sections of this attachment) are listed in these tables for each medium in the West Area Exposure Unit (EU) (WAEU) and compared to medium-specific human health PRGs for the WRW and ESLs for a variety of ecological receptors. Detection limits that exceed the respective PRGs and ESLs are noted and discussed.

Analytes that were not detected in any samples collected in each media are referred to as nondetected analytes. The nondetected chemicals are reported in this attachment at the lowest level at which the chemical may be accurately and reproducibly quantified, taking into account the sample characteristics, sample collection, sample preparation, and analytical adjustments.

1.1 Comparison of Maximum Reported Results for Nondetected Analytes to Preliminary Remediation Goals

1.1.1 Surface Soil/Surface Sediment

The maximum reported results for three nondetected analytes in surface soil/surface sediment are greater than the PRG (Table A1.1). Therefore, there is some uncertainty associated with the reported results for these analytes in the WAEU. The minimum reported result for one of the three analytes was below the PRG.

For benzo(a)pyrene and dibenz(a,h)anthracene, all 10 samples exceeded the PRG and were sampled at two locations, SED004 and SED023. These 10 samples were collected from August 1991 through March 1993. For n-nitroso-di-n-propylamine, nine out of 10 samples exceeded the PRG at two sample locations, SED004 and SED023. These nine samples were collected from August 1991 through March 1993.

PRGs were not available for several nondetected organic analytes in surface soil/surface sediment (Table A1.1). Because PRGs were available for most of the nondetected organics in surface soil/surface sediment, and the maximum reported results for these

analytes were much lower than the PRGs, the lack of PRGs for less than half of the organics is unlikely to have a significant effect on the results of the risk assessment. In addition, the fact that no identified source exists for these analytes in the surface soil/surface sediment at the WAEU suggests there is an acceptable level of uncertainty associated with the reported results for these nondetected analytes.

1.1.2 Subsurface Soil/Subsurface Sediment

No nondetected analytes exceeded the PRG in subsurface soil/subsurface sediment (Table A1.2).

PRGs were not available for several nondetected organic analytes in subsurface soil/subsurface sediment (Table A1.2). Because PRGs were available for most of the nondetected organics in subsurface soil/subsurface sediment, and the maximum reported results for these analytes were much lower than the PRGs, the lack of PRGs for less than half of the organics is unlikely to have a significant effect on the results of the risk assessment. In addition, the fact that no identified source exists for these analytes in the subsurface soil/subsurface sediment at the WAEU suggests there is an acceptable level of uncertainty associated with the reported results for these nondetected analytes.

1.2 Comparison of Maximum Reported Results for Analytes Detected in Less than 5 Percent of Samples to Preliminary Remediation Goals

1.2.1 Surface Soil/Surface Sediment

There were no analytes detected in less than 5 percent of samples in surface soil/surface sediment in the WAEU.

1.2.2 Subsurface Soil/Subsurface Sediment

There were no analytes detected in less than 5 percent of samples in subsurface soil/subsurface sediment in the WAEU.

1.3 Comparison of Maximum Reported Results for Nondetected Analytes to Ecological Screening Levels

1.3.1 Surface Soil

In surface soil in the WAEU, the maximum reported results for selenium exceeded the ESL (Table A1.3). Therefore, there is some uncertainty associated with the reported results for nondetected analytes in surface soil in the WAEU.

For selenium, all 10 nondetected samples collected in March 2004 exceeded the ESL at the following locations: AK39-000, AK56-000, AM67-000, AN33-000, AN39-000, AN45-000, AN50-000, AT45-000, AT50-000, and AT56-000.

1.3.2 Subsurface Soil

The minimum and maximum reported results for all nondetected analytes in subsurface soil were below their respective ESLs (Table A1.4).

ESLs were not available for less than half of the organics in subsurface soil (Table A1.4). Because the maximum reported results for nondetected analytes with ESLs available were much lower than the ESLs, the lack of ESLs for less than half of the organics is not likely to have a significant effect on the results of the risk assessment.

1.4 Comparison of Maximum Reported Results for Analytes Detected in Less than 5 Percent of Samples to Ecological Screening Levels

1.4.1 Surface Soil

There were no analytes detected in less than 5 percent of samples in surface soil in the WAEU.

1.4.2 Subsurface Soil

There were no analytes detected in less than 5 percent of samples in subsurface soil in the WAEU.

TABLES

Table A1.1
Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil/Surface Sediment[a]

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result > PRG?
Inorganics (mg/kg)				
Nitrite	0.3 - 0.4	2	11,100	No
Selenium	0.24 - 1.1	20	555	No
Uranium	1.5 - 1.7	10	333	No
Organics (ug/kg)				
1,1,1-Trichloroethane	6 - 14	10	9.18E+06	No
1,1,2,2-Tetrachloroethane	6 - 14	10	10,500	No
1,1,2-Trichloroethane	6 - 14	10	28,000	No
1,1-Dichloroethane	6 - 14	10	2.72E+06	No
1,1-Dichloroethene	6 - 14	10	17,400	No
1,2,4-Trichlorobenzene	390 - 1,200	10	151,000	No
1,2-Dichlorobenzene	390 - 1,200	10	2.89E+06	No
1,2-Dichloroethane	6 - 14	10	13,300	No
1,2-Dichloroethene	6 - 14	10	1.00E+06	No
1,2-Dichloropropane	6 - 14	10	38,400	No
1,3-Dichlorobenzene	390 - 1,200	10	3.33E+06	No
1,4-Dichlorobenzene	390 - 1,200	10	91,300	No
2,4,5-Trichlorophenol	1,900 - 5,900	10	8.01E+06	No
2,4,6-Trichlorophenol	390 - 1,200	10	272,000	No
2,4-Dichlorophenol	390 - 1,200	10	240,000	No
2,4-Dimethylphenol	390 - 1,200	10	1.60E+06	No
2,4-Dinitrophenol	1,900 - 5,900	10	160,000	No
2,4-Dinitrotoluene	390 - 1,200	10	160,000	No
2,6-Dinitrotoluene	390 - 1,200	10	80,100	No
2-Chloronaphthalene	390 - 1,200	10	6.41E+06	No
2-Chlorophenol	390 - 1,200	10	555,000	No
2-Hexanone	13 - 29	9	N/A	UT
2-Methylnaphthalene	390 - 1,200	10	321,000	No
2-Methylphenol	390 - 1,200	10	4.01E+06	No
2-Nitroaniline	1,900 - 5,900	10	192,000	No
2-Nitrophenol	390 - 1,200	10	N/A	UT
3,3'-Dichlorobenzidine	780 - 2,300	7	6,670	No
3-Nitroaniline	1,900 - 5,600	8	N/A	UT
4,4'-DDD	19 - 57	10	15,500	No
4,4'-DDE	19 - 57	10	11,000	No
4,4'-DDT	19 - 57	10	10,900	No
4,6-Dinitro-2-methylphenol	1,900 - 5,900	10	8,010	No
4-Bromophenyl-phenylether	390 - 1,200	10	N/A	UT
4-Chloro-3-methylphenol	390 - 1,200	10	N/A	UT
4-Chloroaniline	390 - 1,200	10	321,000	No
4-Chlorophenyl-phenyl ether	390 - 1,200	10	N/A	UT
4-Methyl-2-pentanone	13 - 29	10	8.32E+07	No
4-Nitroaniline	1,900 - 5,900	8	208,000	No
4-Nitrophenol	1,900 - 5,600	9	641,000	No
Acenaphthene	390 - 1,200	10	4.44E+06	No
Acenaphthylene	390 - 1,200	10	N/A	UT

Table A1.1
Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil/Surface Sediment[a]

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result > PRG?
Acetone	13 - 190	7	1.00E+08	No
Aldrin	9.5 - 29	10	176	No
alpha-BHC	9.5 - 29	10	2,770	No
alpha-Chlordane	95 - 290	10	10,300	No
Anthracene	390 - 1,200	10	2.22E+07	No
Benzene	6 - 14	10	23,600	No
Benzo(a)anthracene	390 - 1,200	10	3,790	No
Benzo(a)pyrene	**390 - 1,200**	**10**	**379**	**Yes**
Benzo(b)fluoranthene	390 - 1,200	10	3,790	No
Benzo(g,h,i)perylene	390 - 1,200	9	N/A	UT
Benzo(k)fluoranthene	390 - 1,200	10	37,900	No
Benzyl Alcohol	390 - 1,200	10	2.40E+07	No
beta-BHC	9.5 - 29	10	2,770	No
beta-Chlordane	95 - 280	4	10,300	No
bis(2-Chloroethoxy) methane	390 - 1,200	10	N/A	UT
bis(2-Chloroethyl) ether	390 - 1,200	10	3,770	No
bis(2-Chloroisopropyl) ether	390 - 1,200	10	59,300	No
Bromodichloromethane	6 - 14	10	67,100	No
Bromoform	6 - 14	10	420,000	No
Bromomethane	13 - 29	9	21,000	No
Butylbenzylphthalate	390 - 1,200	9	1.60E+07	No
Carbon Disulfide	6 - 14	10	1.64E+06	No
Carbon Tetrachloride	6 - 14	10	8,450	No
Chlorobenzene	6 - 14	10	667,000	No
Chloroethane	13 - 29	9	1.43E+06	No
Chloroform	6 - 14	10	7,850	No
Chloromethane	13 - 29	10	115,000	No
Chrysene	390 - 1,200	10	379,000	No
cis-1,3-Dichloropropene	6 - 14	10	19,400	No
delta-BHC	9.5 - 29	10	2,770	No
Dibenz(a,h)anthracene	**390 - 1,200**	**10**	**379**	**Yes**
Dibenzofuran	390 - 1,200	10	222,000	No
Dibromochloromethane	6 - 14	10	49,500	No
Dieldrin	19 - 57	10	187	No
Diethylphthalate	390 - 1,200	10	6.41E+07	No
Dimethylphthalate	390 - 1,200	10	8.01E+08	No
Di-n-octylphthalate	390 - 1,200	10	3.21E+06	No
Endosulfan I	9.5 - 29	10	481,000	No
Endosulfan II	19 - 57	10	481,000	No
Endosulfan sulfate	19 - 57	10	481,000	No
Endrin	19 - 57	10	24,000	No
Endrin ketone	19 - 57	10	24,000	No
Ethylbenzene	6 - 14	10	5.39E+06	No
Fluorene	390 - 1,200	10	3.21E+06	No
gamma-BHC (Lindane)	9.5 - 29	10	2,770	No
gamma-Chlordane	110 - 290	6	10,300	No

Table A1.1
Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil/Surface Sediment[a]

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result > PRG?
Heptachlor	9.5 - 29	10	665	No
Heptachlor epoxide	9.5 - 29	10	329	No
Hexachlorobenzene	390 - 1,200	10	1,870	No
Hexachlorobutadiene	390 - 1,200	10	22,200	No
Hexachlorocyclopentadiene	390 - 1,200	10	380,000	No
Hexachloroethane	390 - 1,200	10	111,000	No
Indeno(1,2,3-cd)pyrene	390 - 1,200	9	3,790	No
Isophorone	390 - 1,200	10	3.16E+06	No
Methoxychlor	95 - 290	10	401,000	No
Methylene Chloride	6 - 63	10	272,000	No
Naphthalene	390 - 1,200	10	1.40E+06	No
Nitrobenzene	390 - 1,200	10	43,200	No
N-Nitroso-di-n-propylamine	**390 - 1,200**	**10**	**429**	**Yes**
N-nitrosodiphenylamine	390 - 1,200	10	612,000	No
PCB-1016	95 - 290	10	1,350	No
PCB-1221	95 - 290	10	1,350	No
PCB-1232	95 - 290	10	1,350	No
PCB-1242	95 - 290	10	1,350	No
PCB-1248	95 - 290	10	1,350	No
PCB-1254	190 - 570	10	1,350	No
PCB-1260	190 - 570	10	1,350	No
Pentachlorophenol	1,900 - 5,900	10	17,600	No
Phenanthrene	390 - 1,200	10	N/A	UT
Phenol	390 - 1,200	10	2.40E+07	No
Styrene	6 - 14	10	1.38E+07	No
Tetrachloroethene	6 - 14	10	6,710	No
Toxaphene	190 - 570	10	2,720	No
trans-1,3-Dichloropropene	6 - 14	10	19,400	No
Trichloroethene	6 - 14	10	1,770	No
Vinyl acetate	13 - 29	10	2.65E+06	No
Vinyl Chloride	13 - 29	10	2,170	No
Xylene	6 - 14	10	1.06E+06	No

N/A = Not Available or Not Applicable.
UT = Uncertain Toxicity.
Bold = Maximum reported result is greater than the PRG.

Table A1.2
Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil/Subsurface Sediment[a]

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result > PRG?
Inorganics (mg/kg)				
Antimony	2.5 - 11.8	7	511	No
Cadmium	0.58 - 1	7	1,050	No
Cyanide	2.5 - 2.7	5	25,600	No
Molybdenum	1.1 - 4.1	7	6,390	No
Silver	0.39 - 0.95	7	6,390	No
Thallium	0.2 - 0.24	7	89.4	No
Organics (ug/kg)				
1,1,1-Trichloroethane	5 - 5	4	1.06E+08	No
1,1,2,2-Tetrachloroethane	5 - 5	4	121,000	No
1,1,2-Trichloroethane	5 - 5	4	322,000	No
1,1-Dichloroethane	5 - 5	4	3.12E+07	No
1,1-Dichloroethene	5 - 5	4	200,000	No
1,2,4-Trichlorobenzene	330 - 350	5	1.74E+06	No
1,2-Dichlorobenzene	330 - 350	5	3.32E+07	No
1,2-Dichloroethane	5 - 5	4	153,000	No
1,2-Dichloroethene	5 - 5	4	1.15E+07	No
1,2-Dichloropropane	5 - 5	4	442,000	No
1,3-Dichlorobenzene	330 - 350	5	3.83E+07	No
1,4-Dichlorobenzene	330 - 350	5	1.05E+06	No
2,4,5-Trichlorophenol	1,600 - 1,800	5	9.22E+07	No
2,4,6-Trichlorophenol	330 - 350	5	3.13E+06	No
2,4-Dichlorophenol	330 - 350	5	2.76E+06	No
2,4-Dimethylphenol	330 - 350	5	1.84E+07	No
2,4-Dinitrophenol	1,600 - 1,800	5	1.84E+06	No
2,4-Dinitrotoluene	330 - 350	5	1.84E+06	No
2,6-Dinitrotoluene	330 - 350	5	922,000	No
2-Butanone	10 - 11	4	5.33E+08	No
2-Chloronaphthalene	330 - 350	5	7.37E+07	No
2-Chlorophenol	330 - 350	5	6.39E+06	No
2-Methylnaphthalene	330 - 350	5	3.69E+06	No
2-Methylphenol	330 - 350	5	4.61E+07	No
2-Nitroaniline	1,600 - 1,800	5	2.21E+06	No
2-Nitrophenol	330 - 350	5	N/A	UT
3,3'-Dichlorobenzidine	660 - 710	5	76,700	No
3-Nitroaniline	1,600 - 1,800	5	N/A	UT
4,6-Dinitro-2-methylphenol	1,600 - 1,800	5	92,200	No
4-Bromophenyl-phenylether	330 - 350	5	N/A	UT
4-Chloro-3-methylphenol	330 - 350	5	N/A	UT
4-Chloroaniline	330 - 350	5	3.69E+06	No
4-Chlorophenyl-phenyl ether	330 - 350	5	N/A	UT
4-Methylphenol	330 - 350	5	4.61E+06	No
4-Nitroaniline	1,600 - 1,800	5	2.39E+06	No
4-Nitrophenol	1,600 - 1,800	5	7.37E+06	No
Acenaphthene	330 - 350	5	5.10E+07	No

Table A1.2
Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil/Subsurface Sediment[a]

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result > PRG?
Acenaphthylene	330 - 350	5	N/A	UT
Anthracene	330 - 350	5	2.55E+08	No
Benzene	5 - 5	4	271,000	No
Benzo(a)anthracene	330 - 350	5	43,600	No
Benzo(a)pyrene	330 - 350	5	4,360	No
Benzo(b)fluoranthene	330 - 350	5	43,600	No
Benzo(g,h,i)perylene	330 - 350	5	N/A	UT
Benzo(k)fluoranthene	330 - 350	5	436,000	No
Benzoic Acid	1,600 - 1,800	5	3.69E+09	No
Benzyl Alcohol	330 - 350	5	2.76E+08	No
bis(2-Chloroethoxy) methane	330 - 350	5	N/A	UT
bis(2-Chloroethyl) ether	330 - 350	5	43,300	No
bis(2-Chloroisopropyl) ether	330 - 350	5	682,000	No
Bromodichloromethane	5 - 5	4	771,000	No
Bromoform	5 - 5	4	4.83E+06	No
Bromomethane	10 - 11	4	241,000	No
Butylbenzylphthalate	330 - 350	5	1.84E+08	No
Carbon Disulfide	5 - 5	4	1.88E+07	No
Carbon Tetrachloride	5 - 5	4	97,100	No
Chlorobenzene	5 - 5	4	7.67E+06	No
Chloroethane	10 - 11	4	1.65E+07	No
Chloroform	5 - 5	4	90,300	No
Chloromethane	10 - 11	4	1.32E+06	No
Chrysene	330 - 350	5	4.36E+06	No
cis-1,3-Dichloropropene	5 - 5	4	223,000	No
Dibenz(a,h)anthracene	330 - 350	5	4,360	No
Dibenzofuran	330 - 350	5	2.56E+06	No
Dibromochloromethane	5 - 5	4	569,000	No
Dimethylphthalate	330 - 350	5	9.22E+09	No
Di-n-octylphthalate	330 - 350	5	3.69E+07	No
Ethylbenzene	5 - 5	4	6.19E+07	No
Fluorene	330 - 350	5	3.69E+07	No
Hexachlorobenzene	330 - 350	5	21,500	No
Hexachlorobutadiene	330 - 350	5	256,000	No
Hexachlorocyclopentadiene	330 - 350	5	4.38E+06	No
Hexachloroethane	330 - 350	5	1.28E+06	No
Indeno(1,2,3-cd)pyrene	330 - 350	5	43,600	No
Isophorone	330 - 350	5	3.63E+07	No
Methylene Chloride	5 - 5	4	3.13E+06	No
Naphthalene	330 - 350	5	1.61E+07	No
Nitrobenzene	330 - 350	5	497,000	No
N-Nitroso-di-n-propylamine	330 - 350	5	4,930	No
N-nitrosodiphenylamine	330 - 350	5	7.04E+06	No
Pentachlorophenol	1,600 - 1,800	5	203,000	No
Phenanthrene	330 - 350	5	N/A	UT

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Table A1.2
Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil/Subsurface Sediment[a]

Analyte	Range of Reported Results	Total Number of Results	PRG	Maximum Reported Result > PRG?
Phenol	330 - 350	5	2.76E+08	No
Pyrene	330 - 350	5	2.55E+07	No
Styrene	5 - 5	4	1.59E+08	No
Tetrachloroethene	5 - 5	4	77,100	No
trans-1,3-Dichloropropene	5 - 5	4	223,000	No
Trichloroethene	5 - 5	4	20,400	No
Vinyl acetate	10 - 11	4	3.04E+07	No
Vinyl Chloride	10 - 11	4	24,900	No
Xylene	5 - 5	4	1.22E+07	No

[a] No sediment data greater than 0.5 ft deep are available for the WAEU. The data summary in this table consists of subsurface soil data only.
N/A = Not Available or Not Applicable.
UT = Uncertain Toxicity.
[a] No analytes detected in less than 5 percent of samples.

Table A1.3
Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Surface Soil[a]

Analyte	Range of Reported Detection Limits	Total Number of Results	Lowest ESL	Maximum Reported Result > ESL?
Inorganics (mg/kg)				
Cadmium	0.069 - 0.35	10	0.705	No
Selenium	**0.85 - 1.1**	**10**	**0.421**	**Yes**
Tin	0.89 - 2.2	10	2.90	No
Uranium	1.5 - 1.7	10	5.00	No

Bold = Maximum reported result is greater than the minimum ESL.

[a] No analytes detected in less than 5 percent of samples.

Table A1.4
Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil[a]

Analyte	Range of Reported Results	Total Number of Results	Prairie Dog NOAEL ESL	Maximum Reported Result > ESL?
Inorganics (mg/kg)				
Antimony	2.5 - 11.8	7	18.7	No
Cadmium	0.58 - 1	7	198	No
Cyanide	2.5 - 2.7	5	2,200	No
Molybdenum	1.1 - 4.1	7	27.1	No
Silver	0.39 - 0.95	7	N/A	UT
Thallium	0.2 - 0.24	7	204	No
Organics (ug/kg)				
1,1,1-Trichloroethane	5 - 5	4	4.85E+07	No
1,1,2,2-Tetrachloroethane	5 - 5	4	4.70E+06	No
1,1,2-Trichloroethane	5 - 5	4	N/A	UT
1,1-Dichloroethane	5 - 5	4	215,000	No
1,1-Dichloroethene	5 - 5	4	1.28E+06	No
1,2,4-Trichlorobenzene	330 - 350	5	94,500	No
1,2-Dichlorobenzene	330 - 350	5	N/A	UT
1,2-Dichloroethane	5 - 5	4	2.00E+06	No
1,2-Dichloroethene	5 - 5	4	1.87E+06	No
1,2-Dichloropropane	5 - 5	4	3.92E+06	No
1,3-Dichlorobenzene	330 - 350	5	N/A	UT
1,4-Dichlorobenzene	330 - 350	5	5.93E+06	No
2,4,5-Trichlorophenol	1,600 - 1,800	5	N/A	UT
2,4,6-Trichlorophenol	330 - 350	5	17,300	No
2,4-Dichlorophenol	330 - 350	5	249,000	No
2,4-Dimethylphenol	330 - 350	5	N/A	UT
2,4-Dinitrophenol	1,600 - 1,800	5	4.90E+06	No
2,4-Dinitrotoluene	330 - 350	5	24,700	No
2,6-Dinitrotoluene	330 - 350	5	477,000	No
2-Butanone	10 - 11	4	4.94E+07	No
2-Chloronaphthalene	330 - 350	5	N/A	UT
2-Chlorophenol	330 - 350	5	21,600	No
2-Methylnaphthalene	330 - 350	5	319,000	No
2-Methylphenol	330 - 350	5	9.26E+06	No
2-Nitroaniline	1,600 - 1,800	5	418,000	No
2-Nitrophenol	330 - 350	5	N/A	UT
3,3'-Dichlorobenzidine	660 - 710	5	N/A	UT
3-Nitroaniline	1,600 - 1,800	5	N/A	UT
4,6-Dinitro-2-methylphenol	1,600 - 1,800	5	44,300	No
4-Bromophenyl-phenylether	330 - 350	5	N/A	UT
4-Chloro-3-methylphenol	330 - 350	5	N/A	UT
4-Chloroaniline	330 - 350	5	48,900	No
4-Chlorophenyl-phenyl ether	330 - 350	5	N/A	UT
4-Methylphenol	330 - 350	5	N/A	UT
4-Nitroaniline	1,600 - 1,800	5	2.62E+06	No
4-Nitrophenol	1,600 - 1,800	5	1.02E+06	No
Acenaphthene	330 - 350	5	N/A	UT
Acenaphthylene	330 - 350	5	N/A	UT

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Table A1.4
Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil[a]

Analyte	Range of Reported Results	Total Number of Results	Prairie Dog NOAEL ESL	Maximum Reported Result > ESL?
Anthracene	330 - 350	5	N/A	UT
Benzene	5 - 5	4	1.10E+06	No
Benzo(a)anthracene	330 - 350	5	N/A	UT
Benzo(a)pyrene	330 - 350	5	503,000	No
Benzo(b)fluoranthene	330 - 350	5	N/A	UT
Benzo(g,h,i)perylene	330 - 350	5	N/A	UT
Benzo(k)fluoranthene	330 - 350	5	N/A	UT
Benzoic Acid	1,600 - 1,800	5	N/A	UT
Benzyl Alcohol	330 - 350	5	253,000	No
bis(2-Chloroethoxy) methane	330 - 350	5	N/A	UT
bis(2-Chloroethyl) ether	330 - 350	5	N/A	UT
bis(2-Chloroisopropyl) ether	330 - 350	5	N/A	UT
Bromodichloromethane	5 - 5	4	381,000	No
Bromoform	5 - 5	4	199,000	No
Bromomethane	10 - 11	4	N/A	UT
Butylbenzylphthalate	330 - 350	5	3.37E+06	No
Carbon Disulfide	5 - 5	4	411,000	No
Carbon Tetrachloride	5 - 5	4	736,000	No
Chlorobenzene	5 - 5	4	414,000	No
Chloroethane	10 - 11	4	N/A	UT
Chloroform	5 - 5	4	560,000	No
Chloromethane	10 - 11	4	N/A	UT
Chrysene	330 - 350	5	N/A	UT
cis-1,3-Dichloropropene	5 - 5	4	222,000	No
Dibenz(a,h)anthracene	330 - 350	5	N/A	UT
Dibenzofuran	330 - 350	5	2.44E+06	No
Dibromochloromethane	5 - 5	4	389,000	No
Dimethylphthalate	330 - 350	5	1.35E+07	No
Di-n-octylphthalate	330 - 350	5	2.58E+08	No
Ethylbenzene	5 - 5	4	N/A	UT
Fluorene	330 - 350	5	N/A	UT
Hexachlorobenzene	330 - 350	5	190,000	No
Hexachlorobutadiene	330 - 350	5	151,000	No
Hexachlorocyclopentadiene	330 - 350	5	800,000	No
Hexachloroethane	330 - 350	5	45,700	No
Indeno(1,2,3-cd)pyrene	330 - 350	5	N/A	UT
Isophorone	330 - 350	5	N/A	UT
Methylene Chloride	5 - 5	4	210,000	No
Naphthalene	330 - 350	5	1.60E+07	No
Nitrobenzene	330 - 350	5	N/A	UT
N-Nitroso-di-n-propylamine	330 - 350	5	N/A	UT
N-nitrosodiphenylamine	330 - 350	5	2.15E+06	No
Pentachlorophenol	1,600 - 1,800	5	18,400	No
Phenanthrene	330 - 350	5	N/A	UT
Phenol	330 - 350	5	1.49E+06	No
Pyrene	330 - 350	5	N/A	UT

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Table A1.4

Evaluation of Maximum Detection Limits for Nondetected Analytes and Analytes with a Detection Frequency Less than 5 Percent in Subsurface Soil[a]

Analyte	Range of Reported Results	Total Number of Results	Prairie Dog NOAEL ESL	Maximum Reported Result > ESL?
Styrene	5 - 5	4	1.53E+06	No
Tetrachloroethene	5 - 5	4	72,500	No
trans-1,3-Dichloropropene	5 - 5	4	222,000	No
Trichloroethene	5 - 5	4	32,400	No
Vinyl acetate	10 - 11	4	731,000	No
Vinyl Chloride	10 - 11	4	6,490	No
Xylene	5 - 5	4	112,000	No

NA = Not Available or Not Applicable.

UT = Uncertain Toxicity.

[a] No analytes detected in less than 5 percent of samples.

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COMPREHENSIVE RISK ASSESSMENT

WEST AREA EXPOSURE UNIT

VOLUME 3: ATTACHMENT 2

Data Quality Assessment

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ACRONYMS AND ABBREVIATIONS

AA	atomic absorption
AI	adequate intake
ASD	Analytical Services Division
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
CRDL	contract required detection limit
DER	duplicate error ratio
DQA	Data Quality Assessment
DQO	data quality objective
DRC	data review checklist
EDD	electronic data deliverable
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
EU	Exposure Unit
IAG	Interagency Agreement
ICP	inductively couple plasma
IDL	instrument detection limit
LCS	laboratory control sample
MDA	minimum detectable activity
MDL	method detection limit
MS	matrix spike
MSA	method of standard additions
MSD	matrix spike duplicate

NIST	National Institute of Standards Technology
PARCC	precision, accuracy, representativeness, completeness, and comparability
PPT	pipette
PCB	polychlorinated biphenyl
QC	quality control
RDL	required detection limit
RFEDS	Rocky Flats Environmental Data System
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
RL	reporting limit
RPD	relative percent difference
SDP	standard data package
SOW	Statement of Work
SVOC	semi-volatile organic compound
SWD	Soil Water Database
TCLP	Toxicity Characteristic Leaching Procedure
TIC	tentatively identified compound
V&V	verification and validation
VOC	volatile organic compound
WAEU	West Area Exposure Unit

EXECUTIVE SUMMARY

This document provides an assessment of the quality of the data used in the West Area Exposure Unit (EU) (WAEU) Comprehensive Risk Assessment (CRA). This Data Quality Assessment (DQA) focuses on all elements of quality control (QC) including both laboratory and sample-specific QC data.

Depending on the matrix and analyte group, anywhere from 57 to 100 percent of the WAEU data have been verified and/or validated by a validator from the Analytical Services Division (ASD) at the Rocky Flats Environmental Technology Site (RFETS) (or from an outside subcontractor) using verification and validation (V&V) guidelines for each analytical method developed for RFETS. V&V data are identified in the RFETS Soil Water Database (SWD) by a data qualifier flag and reason code(s) that provide an explanation for the qualifier flag. All rejected data have been removed from the data set used in the CRA because the validator has determined the data are unusable. The remaining V&V data have associated qualifier flags indicating that the data are valid, estimated, or undetected, and are used in the CRA. Of the WAEU V&V data, approximately 15 percent was qualified as estimated and/or undetected. Less than 2 percent of the data reported as detected by the laboratory were qualified as undetected due to blank contamination. Data qualified as estimated or undetected are a result of various minor laboratory noncompliance issues that are insufficient to render the data unusable. A review of the WAEU V&V data indicates that the data meet the data quality objectives (DQOs) outlined in the Final CRA Work Plan and Methodology (K-H 2004) (hereafter referred to as the CRA Methodology) and, therefore, are adequate for use in the CRA. All non-V&V data was used as provided by the laboratory. A review of the most common observations found in the V&V data determined that a minimal amount, less than 1 percent, of the non-V&V data may have been qualified if a review had been performed. Based on this DQA, data for the WAEU are of sufficient quality for use in the CRA.

1.0 INTRODUCTION

The West Area Exposure Unit (EU) (WAEU) Comprehensive Risk Assessment (CRA) for the Rocky Flats Environmental Technology Site (RFETS) has been prepared in accordance with the CRA Methodology. The CRA Methodology was developed jointly with the regulatory agencies using the consultative process, and was approved by the agencies on September 28, 2004. Consistent with the CRA Methodology, data quality was assessed using a standard precision, accuracy, representativeness, completeness, and comparability (PARCC) parameter analysis (EPA 2002). Both laboratory and field quality control (QC) were evaluated for the WAEU data set.

Although many of the elements of QC that are reviewed in this document affect more than one PARCC parameter, their major impact on data quality is described below:

- Precision, as a measure of agreement among replicate measurements, is determined quantitatively based on the results of replicate laboratory measurements. Precision of the laboratory data was verified through review of:
  - Relative percent differences (RPDs) for laboratory control samples (LCSs) and LCS duplicates compared to the acceptable ranges (analytical precision);
  - RPDs (nonradionuclides) and duplicate error ratios (DERs) (radionuclides) for field sample and field duplicates compared to the acceptable ranges[1] (field precision);
  - RPDs for matrix spike (MS) and matrix spike duplicates (MSDs) compared to acceptable control ranges (matrix precision); and
  - RPDs for primary- and second-column analyses (analytical precision).
- Accuracy, as a measure of the distortion of a measurement process that causes error in measuring the true value, is determined quantitatively based on the analysis of samples with a known concentration. Accuracy of the laboratory data was verified through review of:
  - LCS data, calibration verification data, internal standard data, and instrument tune parameters (laboratory accuracy); and
  - Surrogate recoveries, MSs, and sample preparation (sample-specific accuracy).
- Representativeness of the data was verified through review of:

[1] The CRA Methodology states that the overall precision of the data is considered adequate if the RPD between the target and duplicate, at concentrations five times the reporting limit (RL), is less than 35 percent for solids and 20 percent for liquids. The precision adequacy requirement for radiological contaminants is a DER less than 1.96.

- Laboratory blank data;
- Sample preservation/storage;
- Adherence to sample holding times;
- Documentation issues;
- Contract noncompliance issues; and
- Laboratory activities affecting ability to properly identify compounds.

- Completeness is a data adequacy criterion and is addressed in Appendix A, Volume 2 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation (RI)/Corrective Measures Study (CMS)-Feasibility Study (FS) Report (hereafter referred to as the RI/FS Report). It refers to the spatial and temporal distribution of the data, and their adequacy for estimating exposure point concentrations (EPCs) for the CRA.

- Comparability of the data was verified through evaluation of:
  - Analytical procedures, and whether they were standard U.S. Environmental Protection Agency (EPA)- and RFETS-approved procedures;
  - Instrument types and maintenance, sample preparation techniques, and standard units for reporting; and
  - MS and surrogate samples, ensuring accuracy within acceptable ranges.

2.0 ANALYTICAL DATA

Approximately 12,000 specific analytical records exist in the WAEU CRA data set, some 88 percent of which (10,722 records) have undergone verification and validation (V&V). The fraction of the data that was verified and/or validated is shown in Table A2.1 by analyte group and matrix. These data were reviewed by validators and their observations and comments are captured in the Soil Water Database (SWD). All of the data that have been flagged due to verification and validation (V&V) findings (except "R"-flagged data) and data that have no flags as a result of V&V are used in the WAEU CRA. The small amount of data that has not undergone V&V is used as provided by the laboratories. The most common errors found during V&V such as transcription errors, calculation errors, and excluded records that were later added by the validator were reviewed to determine the possible effect on non-V&V data. It was determined that less than 1 percent of the entire WAEU data set is at risk for such unacknowledged and, therefore, uncorrected errors.

Data V&V involves an in-depth review of the data packages from the laboratory to assess compliance with contract requirements. In general, data validation includes all of the

activities of verification, as well as additional QC checks and review of some raw laboratory instrument data and calculations. After V&V, a data qualifier flag and/or reason code(s) are assigned to the data record (Tables A2.2 and A2.3). The reason codes provide an explanation for the qualifier flag, thereby making it possible to determine which of the PARCC parameters is affected by the observation (Table A2.4). Qualifier flags are discussed in this Data Quality Assessment (DQA) as those V&V flags that note issues in the data. V&V flags "V," "V1," and "1" represent data that were reviewed by validators, but no issues were observed. Eighty-two percent of the V&V data fall into this category. Additional qualifier flags such as "A," "E," and "Z" were also applied. These validation qualifiers are notations that do not indicate estimation or a change in the status of detection. The data are valid and useable as reported by the laboratory. Three percent of the V&V data are represented by these additional qualifier flags. The specific definitions of these additional V&V flags are presented in Table A2.2. Data with noted issues are presented in Table A2.5 and discussed in detail in Section 3.0.

V&V qualifier flags are not specifically addressed in this data assessment, but rather the reason codes associated with the qualifier flags for each analytical record are summarized and evaluated. This approach was chosen because the validator's specific observations (reason codes), and not the qualifier flags, provide the best descriptors of the data quality.

V&V data records contain a field with V&V reason codes (5, 18/52, 200, 99/101/701, and so forth), or the field is null. These reason codes represent observations related to assessment of precision, accuracy, and representativeness. For example, the reason code 110 definition (see Table A2.3) is "LCS recovery criteria were not met," which is an observation related to data accuracy.

Multiple reason codes were routinely applied to a specific sample method/matrix/analyte combination. Therefore, it was necessary to parse out the individual codes to create a table that included a unique record identifier and the associated parsed data V&V reason code (5, 18, 52, 200, 99, 101, 701, and so forth). With this information and the data V&V reason code definitions, the data validator's observations related to this data set can be re-created for each analytical record.

To summarize the reason codes in a logical manner for presentation, it was first necessary to group the reason codes that have slightly different definitions but convey the same meaning. A standardized definition was then applied to the individual reason codes within the group. The grouped reason codes were also assigned a QC category (for example, blanks, calibration, and holding time), and the affected PARCC parameter (Table A2.4). The reason codes were then summarized for each medium and analyte group within each QC category, applying the standardized definition to the summarized codes. The summary is presented in Table A2.5.

Rejected data (data qualifier flag "R"), consisting of less than 5 percent of all V&V data, have been removed from the data used in the WAEU CRA because the validator has determined the data to be unusable. The fraction of the data that was rejected during validation and/or verification is shown in Table A2.6 by analyte group and matrix.

Finally, evaluating the RPD (DER for radionuclides) between a target sample and the associated field duplicate is not a QC parameter performed during V&V, but is still an important analysis when determining data precision. Because this analysis was not performed during V&V, the target sample/field duplicate RPD and DER calculations were performed separately and are presented in Table A2.7 as the number of exceedances per analyte group/matrix combination. Only those analyte group/matrix combinations having records that met the criteria for calculating an RPD or DER are presented. RPDs and DERs for target sample/field duplicate analyte pairs where one or both of the results are less than five times the RL are not calculated as outlined in the CRA Methodology.

3.0 FINDINGS

V&V observations affecting the CRA data set are summarized by analyte group/matrix/QC category/V&V observation in Table A2.5. The detected and nondetected results are summarized separately to give the reader a better idea of the impact on data usability. Only those issues observed in notable percentages (generally greater than 5 percent) of the data are discussed below in further detail. RPDs (DERs for radionuclides) presented in Table A2.7 are only discussed below when RPD (DER for radionuclides) exceedances of control criteria are greater than 10 percent for any given analyte group/matrix combination. Instances of elevated rates (greater than 10 percent) of rejected data are also discussed below.

3.1 Herbicides – Soil

Surrogate and other issues resulted in data V&V qualifications related to this analyte group/matrix combination. While the percentage of all qualifications is high, it is important to note that all data were qualified as usable.

3.2 Metals – Soil

Blank, calibration, documentation, LCS, matrix, sensitivity, and other observations resulted in data V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified due to low LCS and predigestion MS recoveries, and expired instrument detection limit (IDL) studies. While the importance of these three QC parameters should not be overlooked, it is also important to note that the data were qualified as usable, although estimated. Finally, although almost 17 percent of the target sample/field duplicate analyte pairs exceeded RPD control criteria, it was determined that the effect on data precision is minimal. All exceedances occurred in the same target sample/field duplicate pair, and although RPD exceedances noted in one sample may indicate matrix interference, the overall precision of the data is not impacted.

3.3 Metals – Water

Blank, calculation error, calibration, documentation, holding time, instrument setup, LCS, matrix, sample preparation, sensitivity, and other observations resulted in V&V qualifications associated with this analyte group/matrix combination. The percentage of all observations is low and within method expectations.

3.4 Polychlorinated Biphenyls (PCBs) – Soil

Documentation issues resulted in data V&V observations related to this analyte group/matrix combination. While the percentage of noted transcription errors is high, the quality of the data is not affected. All transcription errors have previously been evaluated and corrected.

3.5 Polychlorinated Biphenyls – Water

Documentation and surrogate issues resulted in data V&V observations related to this analyte group/matrix combination. The percentage of all observations is high, but it is important to note that those records qualified for surrogate observations were also qualified as usable. Transcription errors have no effect on data quality as all issues have previously been evaluated and corrected.

3.6 Pesticides – Soil

Surrogate and other observations resulted in data V&V qualifications related to this analyte group/matrix combination. The percentage of all observations is low and within method expectations.

3.7 Pesticides – Water

Documentation and surrogate issues resulted in data V&V observations related to this analyte group/matrix combination. The percentage of all observations is high, but it is important to note that those records qualified for surrogate observations were also qualified as usable. Transcription errors have no effect on data quality as all issues have previously been evaluated and corrected.

3.8 Radionuclides – Soil

Blank, calibration, documentation, LCS, matrix, sample preparation, sensitivity, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with few exceptions. Insufficient documentation indicates that a complete V&V evaluation may not have been performed, but it is important to note that the data were qualified as usable, although estimated. Transcription errors and validator-calculated minimum detectable activities (MDAs) have no effect on data quality as all issues have previously been evaluated and corrected.

While the importance of blank and other QC analyses should not be overlooked, it is important to note that these records were also qualified as usable, although estimated. Most of those records qualified as directing the data user to the hard copy validation report for further explanation of the observation were also qualified as estimated. The CRA is performed with this uncertainty in mind, and no further effort was made to identify the issues. Finally, although greater than 30 percent of the V&V data for this analyte group/matrix combination was rejected, 99 percent of all associated data underwent V&V. This leaves a fraction of a percent of the data related to this analyte group/matrix combination that may have been rejected if a review had been performed.

3.9 Radionuclides – Water

Blank, calibration, documentation, holding time, instrument setup, LCS, matrix, sensitivity, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with few exceptions. Insufficient documentation indicates that a complete V&V evaluation may not have been performed, but it is important to note that the data were qualified as usable, although estimated. Transcription errors and validator-calculated MDAs have no effect on data quality as all issues have previously been evaluated and corrected. While the importance of blank analyses and continuing calibration verifications should not be overlooked, it is important to note that these records were also qualified as usable, although estimated. Most of those records qualified as directing the data user to the hard copy validation report for further explanation of the observation were also qualified as estimated. The CRA is performed with this uncertainty in mind, and no further effort was made to identify the issues. Finally, although 18 percent of the V&V data for this analyte group/matrix combination were rejected, 82 percent of all associated data underwent V&V. This leaves only approximately 3 percent of the data for this analyte group/matrix combination that may have been rejected if a review had been performed.

3.10 Semi-Volatile Organic Compounds (SVOCs) – Soil

Calibration, internal standard, surrogate, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified due to low surrogate recoveries, or because the results were not validated due to reanalysis. Although the importance of these observations should not be overlooked, it is important to note that the data were qualified as usable.

3.11 Semi-Volatile Organic Compounds – Water

Blank, calibration, documentation, holding time, internal standard, LCS, and other issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified because the internal standards did not meet control criteria. While the importance of internal standard analyses should not be overlooked, it is also important to note that the data were qualified as usable, although estimated.

3.12 Volatile Organic Compounds (VOCs) – Soil

Blank, calibration, internal standard, surrogate, and other issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of all observations is low and within method expectations.

3.13 Volatile Organic Compounds – Water

Blank, calibration, confirmation, documentation, holding time, internal standard, LCS, and surrogate issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of all observations is low and within method expectations.

3.14 Wet Chemistry Parameters – Soil

Holding time, matrix, and other issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of many observations is high, but it is important to note that this analyte group contains numerous general chemistry parameters having little or no impact on site characterization.

3.15 Wet Chemistry Parameters – Water

Blank, calibration, documentation, holding time, matrix, sample preparation, and other issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of all observations is low and within method expectations.

4.0 CONCLUSIONS

The quality of the laboratory results were evaluated for compliance with the CRA Methodology data quality objectives (DQOs) through an overall review of PARCC parameters.

Of the data used in the WAEU CRA, approximately 88 percent underwent the V&V process. Of that 88 percent, 82 percent was qualified as having no QC issues, and approximately 15 percent was qualified as estimated or undetected (Table A2.8). The remaining 3 percent of the V&V data are made up of records qualified with additional flags indicating acceptable data such as "A," "E," or "P." Two percent of the data reported as detected by the laboratory were flagged as undetected by the validators due to blank contamination (Table A2.9). Data qualified as estimated or undetected indicate some issues with PARCC parameters, but not to a degree sufficient to mark the data unusable. Approximately 5 percent of the entire data set was rejected during the V&V process (Table A2.6).

Although many of the elements of QC that are reviewed in this document affect more than one PARCC parameter, the general discussion below summarizes the data quality per the validation reason codes affecting each specific PARCC parameter. Several V&V

reason codes have no real impact on data quality because they represent issues that were noted but corrected, or represent observations related to missing documentation that was not required for data assessment. Approximately 11 percent of the WAEU V&V data were flagged with these "Other" V&V observations.

- Precision, as a measure of agreement among replicate measurements, is determined quantitatively based on the results of replicate laboratory measurements.

  Of the V&V data, approximately 2 percent was noted for observations related to precision. Of that 2 percent, 98 percent was qualified for issues related to sample matrices and 2 percent was qualified for issues related to result confirmation. No LCS, instrument setup, or sensitivity issues related to precision were noted.

  RPDs and DERs for target sample/field duplicate pairs were found to be acceptable for all analyte group/matrix combinations. Overall, the method precision was found to be generally acceptable.

- Accuracy is a measure of the distortion of a measurement process that causes error in the true value.

  Of the V&V data, 32 percent was noted for accuracy-related observations. Of that 32 percent, 69 percent was noted for laboratory practice-related observations, while sample-specific accuracy observations make up the other 31 percent. Although the percentage of data with noted accuracy issues is slightly elevated, it is important to note that most of the data flagged with these accuracy-related observations are also flagged as estimated, and the CRA is performed with this uncertainty in mind.

  Accuracy was generally acceptable with infrequent performance outside QC limits.

- Representativeness of the data was verified.

  Of the V&V data, approximately 37 percent was noted for observations related to representativeness. Of that 37 percent, 85 percent was qualified for blank observations, 8 percent for failure to observe allowed holding times, and 4 percent for documentation issues. Instrument setup, LCS, matrix, sample preparation, sensitivity, and other observations make up the other 3 percent of the data qualified for observations related to sample representativeness.

  Reportable levels of target analytes were not routinely detected in the laboratory blanks greater than the laboratory RLs except for relatively isolated incidences. Samples were generally stored and preserved properly. Overall, these elements of QC exceedances are indicative of normal laboratory operations and have little impact the sample data as reported.

  Sample data are representative of the site conditions at the time of sample collection.

- Comparability of the data was reviewed and no systematic errors were noted.
  - The use of standard EPA- and RFETS-approved analytical procedures;
  - Instrument types and maintenance, sample preparation techniques, and standard units for reporting; and
  - Evaluation of MS and surrogate samples, ensuring accuracy within acceptable ranges.

  Examination of these parameters did not show any systematic issues with comparability.

- Completeness, as defined in the CRA Methodology, is addressed in Appendix A, Volume 2 of the RI/FS Report.

  Another indication of completeness that is sometimes used is a measure of the number of valid measurements obtained in relation to the total number of measurements planned.

  Because only 5 percent of the overall data were rejected, the use of non-V&V data for the WAEU CRA does not contribute to any completeness issues.

This review concludes that the PARCC of the data are generally acceptable and the CRA objectives have been met.

5.0 REFERENCES

K-H, 2004. Final Comprehensive Risk Assessment Work Plan and Methodology, Environmental Restoration, Rocky Flats Environmental Technology Site, Golden, Colorado. September.

EPA, 2002. Guidance for Quality Assurance Project Plans. EPA QA/G-5, EPA/240/R-02/009. Office of Environmental Information, Washington, D.C. December.

TABLES

Table A2.1
CRA Data V&V Summary

Analyte Group	Matrix	Total No. of V&V Records	Total No. of CRA Records	Percent V&V (%)
Herbicide	SOIL	8	14	57.14
Herbicide	WATER	6	9	66.67
Metal	SOIL	777	777	100.00
Metal	WATER	3,916	4,323	90.59
PCB	SOIL	56	70	80.00
PCB	WATER	42	56	75.00
Pesticide	SOIL	169	215	78.60
Pesticide	WATER	127	172	73.84
Radionuclide	SOIL	161	163	98.77
Radionuclide	WATER	597	726	82.23
SVOC	SOIL	545	875	62.29
SVOC	WATER	413	589	70.12
VOC	SOIL	494	518	95.37
VOC	WATER	2,855	3,004	95.04
Wet Chemistry	SOIL	31	32	96.88
Wet Chemistry	WATER	525	579	90.67
	Total	**10,722**	**12,122**	**88.45%**

Table A2.2
V&V Qualifier Flag Definitions

Validation Qualifier Code	Description
1	QC data from a data package – Verification
A	Data acceptable with qualifications
B	Compound was found in BLK and sample
C	Calibration
E	Associated value exceeds calibration range; dilute and reanalyze
J	Estimated quantity – Validation
J1	Estimated quantity – Verification
JB	Organic method blank contamination – Validation
JB1	Organic method blank contamination – Verification
N	Historical – Validators asked not to validate this
NJ	Associated value is presumptively estimated
NJ1	Value presumptively estimated – Verification
P	Systematic error
R	Data unusable – Validation
R1	Data unusable – Verification
S	Matrix spike
U	Analyzed, not detected at/above method detection limit
U1	Analyzed, not detect at/above method detection limit – Verification
UJ	Associated value is considered estimated at an elevated detection
UJ1	Estimated at elevated level – Verification
V	No problems with the data – Validation
V1	No problems with the data – Verification
Y	Analytical results in validation process
Z	Validation was not requested or could not be performed

Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
***	Unknown code from RFEDS
1	Holding times were exceeded
2	Holding times were grossly exceeded
3	Initial calibration correlation coefficient <0.995
4	Calibration verification criteria were not met
5	CRDL check sample recovery criteria were not met
6	Incorrect calibration of instrument
7	Analyte values > IDL were found in the blanks
8	Negative bias was indicated in the blanks
9	Interference indicated in the ICP interference check sample
10	Laboratory control sample recovery criteria were not met
11	Duplicate sample precision criteria were not met
12	Predigestion matrix spike criteria were not met (+/- 25 percent)
13	Predigestion matrix spike criteria were not met (<30 percent)
14	Post-digestion matrix spike recovery criteria were not met
15	MSA was required but not performed
16	MSA calibration correlation coefficient <0.995
17	Serial dilution criteria not met
18	Documentation was not provided
19	Calibration verification criteria not met
20	AA duplicate injection precision criteria were not met
21	Reagent blanks exceeded MDA
22	Tracer contamination
23	Improper aliquot size
24	Sample aliquot not taken quantitatively
25	Primary standard had exceeded expiration date
26	No raw data submitted by the laboratory
27	Recovery criteria were not met
28	Duplicate analysis was not performed
29	Verification criteria were not met
30	Replicate precision criteria were not met
31	Replicate analysis was not performed
32	Laboratory control samples >+/- 3 sigma
33	Laboratory control samples >+/- 2 sigma and <+/- 3 sigma
35	Transformed spectral index external ST criteria were not met
36	MDA exceeded the RDL
37	Sample exceeded efficiency curve weight limit
38	Excessive solids on planchet
39	Tune criteria not met
40	Organics initial calibration criteria were not met
41	Organics continuing calibration criteria were not met
42	Surrogates were outside criteria
43	Internal standards outside criteria
44	No mass spectra were provided
45	Results were not confirmed
47	Percent breakdown exceeded 20 percent
48	Linear range of instrument was exceeded
49	Method blank contamination

Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
51	Nonverifiable laboratory results and/or unsubmitted data
52	Transcription error
53	Calculation error
54	Incorrect reported activity or MDA
55	Result exceeds linear range; serial dilution value reported
56	IDL changed due to significant figure discrepancy
57	Percent solids < 30 percent
58	Percent solids < 10 percent
59	Blank activity exceeded RDL
60	Blank recovery criteria were not met
61	Replicate recovery criteria were not met
62	LCS relative percent error criteria not met
63	LCS expected value not submitted/verifiable
64	Nontraceable/noncertified standard was used
67	Sample results not submitted/verifiable
68	Frequency of quality control samples not met
69	Samples not distilled
70	Resolution criteria not met
71	Unit conversion of results
72	Calibration counting statistics not met
73	Daily instrument performance assessment not performed
74	LCS data not submitted
75	Blank data not submitted
76	Instrument gain and/or efficiency not submitted
77	Detector efficiency criteria not met
78	MDAs were calculated by reviewer
79	Result obtained through dilution
80	Spurious counts of unknown origin
81	Repeat count outside of 3 sigma counting error
82	Sample results were not corrected for decay
83	Sample results were not included on Data Summary Table
84	Key fields wrong
85	Record added by QLI
86	Results considered qualitative not quantitative
87	Laboratory did no analysis for this record
88	Blank corrected results
89	Sample analysis was not requested
90	Sample result was not validated due to reanalysis
91	Unit conversion; QC sample activity/uncertainty/MDA
99	See hard copy for further explanation
101	Holding times were exceeded (attributed to laboratory problem)
102	Holding times were grossly exceeded (attribute to laboratory problem)
103	Calibration correlation coefficient does not meet requirement
104	Calibration verification recovery criteria were not met
105	Low-level check sample recovery criteria were not met
106	Calibration did not contain minimum number of standards
107	Analyte detected but < RDL in calibration blank verification
109	Interference indicated in the ICP interference check sample

Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
110	Laboratory control sample recovery criteria were not met
111	Laboratory duplicate sample precision criteria were not met
112	Predigestion matrix spike criteria were not met (+/- 25 percent)
113	Predigestion matrix spike recovery is <30 percent
114	Post-digestion matrix spike criteria were not met
115	MSA was required but not performed
116	MSA calibration correlation coefficient <0.995
117	Serial dilution percent D criteria not met
123	Improper aliquot size
128	Laboratory duplicate was not analyzed
129	Verification criteria for frequency or sequence were not met
130	Replicate precision criteria were not met
131	Confirmation percent difference criteria not met
132	Laboratory control samples >+/- 3 sigma
136	MDA exceeded the RDL
139	Tune criteria not met
140	Requirements for independent calibration verification were not met
141	Continuing calibration verification criteria were not met
142	Surrogates were outside criteria
143	Internal standards outside criteria
145	Results were not confirmed
147	Percent breakdown exceeded 20 percent
148	Linear range of measurement system was exceeded
149	Method, preparation, or reagent blank contamination > RDL
150	Unknown carrier volume
152	Reported data do not agree with raw data
153	Calculation error
155	Original result exceeds linear range; serial dilution value reported
159	Magnitude of calibration verification blank result exceeded the RDL
164	Standard traceability or certification requirements not met
166	Carrier aliquot nonverifiable
168	QC sample frequency does not meet requirements
170	Resolution criteria not met
172	Calibration counting statistics not met
174	LCS data not submitted
175	Blank data not submitted
177	Detector efficiency criteria not met
188	Blank corrected results
199	See hard copy for further explanation
201	Preservation requirements not met by the laboratory
205	Unobtainable omissions or errors on SDP (required for databases)
206	Analyses were not requested according to the SOW
207	Sample pretreatment or sample preparation method is incorrect
211	Poor cleanup recovery
212	Instrument detection limit was not provided
213	Instrument detection limit is > the associated RDL
214	IDL is older than 3 months from date of analysis
215	Blank results were not reported to the IDL/MDL

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Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
216	Post-digestion spike recoveries outside of 85-115 percent criteria
217	Post-digestion spike recoveries were < 10 percent
218	Sample COC was not verifiable (attributed to laboratory)
219	Standards have expired or are not valid
220	TCLP sample percent solids < 0.5 percent
222	TCLP particle size was not performed
224	Incomplete TCLP extraction data
225	Insufficient TCLP extraction time
226	TIC misidentification
227	No documentation regarding deviations from methods or SOW
228	Calibration recoveries affecting data quality have not been met
229	Element not analyzed in ICP interference check sample
230	QC sample/analyte (e.g., spike, duplicate, LCS) not analyzed
231	MS/MSD criteria not met
232	Control limits not assigned correctly
233	Sample matrix QC does not represent samples analyzed
234	QC sample does not meet method requirement
235	Duplicate sample control limits do not pass
236	LCS control limits do not pass
237	Preparation blank control limits do not pass
238	Blank correction was not performed
239	Winsorized mean plus standard deviation of the same not calculated or calculated wrong
240	Sample preparations for soil/sludge/sediment were not homog/aliq properly
241	No micro PPT or electroplating data available
242	Tracer requirements were not met
243	Standard values were not calculated correctly (LCS, tracer, standards)
244	Standard or tracer is not NIST traceable
245	Energy calibration criteria not met
246	Background calibration criteria were not met
247	Sample or control analysis not chemically separated from each other
248	Single combined TCLP result was not repeated for sample with both mis+nonm
249	Result qualified due to blank contamination
250	Incorrect analysis sequence
251	Misidentified target compounds
252	Result is suspect DU
701	Holding times were exceeded (not attributed to laboratory)
702	Holding times were grossly exceeded (not attributed to laboratory)
703	Samples were not preserved properly in the field (not attributed to laboratory)
801	Missing deliverables (required for data assessment)
802	Missing deliverables (not required for data assessment)
803	Omissions or errors on SDP deliverables (required for data assessment)
804	Omissions or errors on SDP deliverables (not required for data assessment
805	Information missing from case narrative
806	Site samples not used for sample matrix QC
807	Original documentation not provided
808	Incorrect or incomplete DRC
809	Non-site samples reported with site samples
810	EDD does not match hard copy; EDD may be resubmitted

Table A2.4

Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
188, 88	Blank corrected results	Blanks	Representativeness
238	Blank correction was not performed	Blanks	Representativeness
175, 75	Blank data not submitted	Blanks	Representativeness
60	Blank recovery criteria were not met	Blanks	Representativeness
215	Blank results were not reported to the IDL/MDL	Blanks	Representativeness
107, 159	Calibration verification blank contamination	Blanks	Representativeness
149, 21, 237, 249, 49, 59, 7	Method, preparation, or reagent blank contamination	Blanks	Representativeness
8	Negative bias indicated in the blanks	Blanks	Representativeness
153, 53	Calculation error	Calculation Errors	Other
232	Control limits not assigned correctly	Calculation Errors	Other
246	Background calibration criteria were not met	Calibration	Accuracy
103, 3	Calibration correlation coefficient did not meet requirements	Calibration	Accuracy
172, 72	Calibration counting statistics did not meet criteria	Calibration	Accuracy
106	Calibration did not contain minimum number of standards	Calibration	Accuracy
228	Calibration requirements affecting data quality have not been met	Calibration	Accuracy
104, 141, 19, 29, 4, 40, 41	Continuing calibration verification criteria were not met	Calibration	Accuracy
245	Energy calibration criteria not met	Calibration	Accuracy
6	Incorrect calibration of instrument	Calibration	Accuracy
148, 48	Result exceeded linear range of measurement system	Calibration	Accuracy
155, 55	Original result exceeded linear range, serial dilution value reported	Calibration	Accuracy
140	Requirements for independent calibration verification were not met	Calibration	Accuracy
129	Frequency or sequencing verification criteria not met	Calibration	Accuracy
131	Confirmation percent difference criteria not met	Confirmation	Precision
145, 45	Results were not confirmed	Confirmation	Precision
18	Sufficient documentation not provided by the laboratory	Documentation issues	Representativeness
705	Electronic qualifiers were applied from validation report by hand	Documentation issues	Other
805	Information missing from case narrative	Documentation issues	Other
84	Key data field incorrect	Documentation issues	Other
802	Missing deliverables (not required for validation)	Documentation issues	Other
801	Missing deliverables (required for validation)	Documentation issues	Representativeness
227	No documentation regarding deviations from methods or SOW	Documentation issues	Other
44	No mass spectra were provided	Documentation issues	Representativeness
241	No micro pipette or electroplating data available	Documentation issues	Other
26	No raw data submitted by the laboratory	Documentation issues	Representativeness
804	Omissions or errors in SDP (not required for validation)	Documentation issues	Other
803	Omissions or errors in SDP (required for validation)	Documentation issues	Representativeness
807	Original documentation not provided	Documentation issues	Other

Table A2.4

Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
85	Record added by the validator	Documentation issues	Other
152	Reported data do not agree with raw data	Documentation issues	Other
89	Sample analysis was not requested	Documentation issues	Other
218	Sample COC was not verifiable (attributed to laboratory)	Documentation issues	Representativeness
704	Sample COC was not verifiable (not attributed to laboratory)	Documentation issues	Representativeness
83	Sample results were not included on Data Summary Table	Documentation issues	Other
52	Transcription error	Documentation issues	Other
205	Unobtainable omissions or errors on SDP (required for data assessment)	Documentation issues	Representativeness
1, 101, 701	Holding times were exceeded	Holding times	Representativeness
2, 102, 702	Holding times were grossly exceeded	Holding times	Representativeness
251	Misidentified target compounds	Identification errors	Representativeness
70	Resolution criteria not met	Identification errors	Representativeness
226	TIC misidentification	Identification errors	Representativeness
143, 43	Internal standards did not meet criteria	Internal standards	Accuracy
5	CRDL check sample recovery criteria were not met	LCS	Accuracy
33	LCS > ± 2 sigma and < ± 3 sigma	LCS	Accuracy
10, 110, 236	LCS recovery criteria were not met	LCS	Accuracy
132, 32	Laboratory control samples > ± 3 sigma	LCS	Accuracy
174, 74	LCS data not submitted	LCS	Representativeness
63	Expected LCS value not submitted/verifiable	LCS	Representativeness
62	LCS relative percent error criteria not met	LCS	Accuracy
105	Low-level check sample recovery criteria were not met	LCS	Accuracy
230	QC sample/analyte (e.g., spike, duplicate, LCS) not analyzed	LCS	Representativeness
28	Duplicate analysis was not performed	Matrices	Precision
11, 235	Duplicate sample precision criteria were not met	Matrices	Precision
111	LCS/LCSD precision criteria were not met	Matrices	Precision
128	Laboratory duplicate was not analyzed	Matrices	Precision
231	MS/MSD criteria not met	Matrices	Precision
116, 16	MSA calibration correlation coefficient <0.995	Matrices	Accuracy
115, 15	MSA was required but not performed	Matrices	Representativeness
58	Sample contained < 10 percent solid material	Matrices	Representativeness
57	Sample contained < 30 percent solid material	Matrices	Representativeness
217	Post-digestion spike recoveries were < 10%	Matrices	Accuracy
14, 114, 216	Post-digestion matrix spike criteria were not met	Matrices	Accuracy
113, 13	Predigestion matrix spike recovery is <30%	Matrices	Accuracy
112, 12	Predigestion matrix spike recovery criteria were not met	Matrices	Accuracy
27	Recovery criteria were not met	Matrices	Accuracy
31	Replicate analysis was not performed	Matrices	Precision
130, 30	Replicate precision criteria were not met	Matrices	Precision
61	Replicate recovery criteria were not met	Matrices	Accuracy
233	Sample matrix QC does not represent samples analyzed	Matrices	Representativeness
117, 17	Serial dilution criteria not met	Matrices	Accuracy

Table A2.4

Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameters
806	Site samples not used for sample matrix QC	Matrices	Representativeness
810	EDD does not match hard copy; EDD may be resubmitted	Other	Other
214	IDL is older than 3 months from date of analysis	Other	Accuracy
250	Incorrect analysis sequence	Other	Representativeness
808	Incorrect or incomplete DRC	Other	Representativeness
212	Instrument detection limit was not provided	Other	Other
87	Laboratory did no analysis for this record	Other	Other
809	Nonsite samples reported with Site samples	Other	Other
64	Nontraceable/noncertified standard was used	Other	Accuracy
51	Nonverifiable laboratory results and/or unsubmitted data	Other	Representativeness
211	Poor cleanup recovery	Other	Accuracy
25	Primary standard had exceeded expiration date	Other	Accuracy
234	QC sample does not meet method requirement	Other	Representativeness
168, 68	QC sample frequency does not meet requirements	Other	Representativeness
252	Result is suspect due to dilution	Other	Other
79	Result obtained through dilution	Other	Other
37	Sample exceeded efficiency curve weight limit	Other	Accuracy
247	Sample or control analyses not chemically separated from each other	Other	Representativeness
90	Sample result was not validated due to re-analysis	Other	Other
67	Sample results not submitted/verifiable	Other	Representativeness
199, 99	See hard copy for further explanation	Other	Other
248	Single combined TCLP results was not reported for sample with both mis+nonm	Other	Accuracy
80	Spurious counts of unknown origin	Other	Representativeness
244	Standard or tracer is not NIST traceable	Other	Accuracy
164	Standard traceability or certification requirements not met	Other	Accuracy
219	Standards have expired or are not valid	Other	Accuracy
243	Standard values were not calculated correctly (LCS, tracer, standards)	Other	Other
22	Tracer contamination	Other	Accuracy
242	Tracer requirements were not met	Other	Accuracy
71	Unit conversion of results	Other	Other
239	Winsorized mean+standard deviation of the same not calculated or calculated wrong	Other	Other
38	Excessive solids on planchet	Sample preparation	Accuracy
123, 23	Improper aliquot size	Sample preparation	Accuracy
224	Incomplete TCLP extraction data	Sample preparation	Representativeness
225	Insufficient TCLP extraction time	Sample preparation	Representativeness
201	Preservation requirements not met by the laboratory	Sample preparation	Representativeness
24	Sample aliquot not taken quantitatively	Sample preparation	Accuracy
240	Sample preparation for soil/sludge/ sediment were not homog/aliq properly	Sample preparation	Representativeness
207	Sample pretreatment or preparation method is incorrect	Sample preparation	Representativeness
69	Samples not distilled	Sample preparation	Representativeness
703	Samples were not preserved properly in the field	Sample preparation	Representativeness

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Table A2.4
Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
222	TCLP particle size was not performed	Sample preparation	Representativeness
220	TCLP sample percent solids < 0.5 percent	Sample preparation	Representativeness
56	IDL changed due to significant figure discrepancy	Sensitivity	Representativeness
54	Incorrect reported activity or MDA	Sensitivity	Other
213	Instrument detection limit > the associated RDL	Sensitivity	Representativeness
136, 36	MDA exceeded the RDL	Sensitivity	Representativeness
78	MDA was calculated by reviewer	Sensitivity	Other
81	Repeat count outside of 3 sigma counting error	Sensitivity	Precision
86	Results considered qualitative not quantitative	Sensitivity	Accuracy
82	Sample results were not corrected for decay	Sensitivity	Other
91	Unit conversion, QC sample activity uncertainty/MDA	Sensitivity	Representativeness
142, 42	Surrogates were outside criteria	Surrogate	Accuracy
20	AA duplicate injection precision criteria were not met	Instrument Set-up	Precision
73	Daily instrument performance assessment not performed	Instrument Set-up	Accuracy
177, 77	Detector efficiency criteria not met	Instrument Set-up	Accuracy
229	Element not analyzed in ICP interference check sample	Instrument Set-up	Representativeness
76	Instrument gain and/or efficiency not submitted	Instrument Set-up	Representativeness
109, 9	Interference indicated in the ICP interference check sample	Instrument Set-up	Accuracy
147, 47	Percent breakdown exceeded 20 percent	Instrument Set-up	Representativeness
170	Resolution criteria not met	Instrument Set-up	Representativeness
35	Transformed spectral index external site criteria were not met	Instrument Set-up	Representativeness
139, 39	Tune criteria not met	Instrument Set-up	Accuracy
206	Analysis was not requested according to SOW	Unknown	Other
166	Carrier aliquot nonverifiable	Unknown	Representativeness
150	Unknown carrier volume	Unknown	Representativeness

Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Herbicide	SOIL	Other	Sample results were not validated due to re-analysis	No	5	8	62.50
Herbicide	SOIL	Surrogates	Surrogate recovery criteria were not met	No	1	8	12.50
Metal	SOIL	Blanks	Calibration verification blank contamination	No	26	777	3.35
Metal	SOIL	Blanks	Calibration verification blank contamination	Yes	5	777	0.64
Metal	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	19	777	2.45
Metal	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	4	777	0.51
Metal	SOIL	Blanks	Negative bias indicated in the blanks	No	7	777	0.90
Metal	SOIL	Blanks	Negative bias indicated in the blanks	Yes	9	777	1.16
Metal	SOIL	Calibration	Calibration correlation coefficient did not meet requirements	Yes	3	777	0.39
Metal	SOIL	Documentation Issues	Transcription error	Yes	3	777	0.39
Metal	SOIL	LCS	CRDL check sample recovery criteria were not met	No	3	777	0.39
Metal	SOIL	LCS	CRDL check sample recovery criteria were not met	Yes	4	777	0.51
Metal	SOIL	LCS	LCS recovery criteria were not met	No	32	777	4.12
Metal	SOIL	LCS	LCS recovery criteria were not met	Yes	67	777	8.62
Metal	SOIL	LCS	Low level check sample recovery criteria were not met	No	11	777	1.42
Metal	SOIL	LCS	Low level check sample recovery criteria were not met	Yes	21	777	2.70
Metal	SOIL	Matrices	Duplicate sample precision criteria were not met	No	4	777	0.51
Metal	SOIL	Matrices	Duplicate sample precision criteria were not met	Yes	11	777	1.42
Metal	SOIL	Matrices	Post-digestion MS did not meet control criteria	No	2	777	0.26
Metal	SOIL	Matrices	Post-digestion MS did not meet control criteria	Yes	2	777	0.26
Metal	SOIL	Matrices	Predigestion MS recovery criteria were not met	No	21	777	2.70
Metal	SOIL	Matrices	Predigestion MS recovery criteria were not met	Yes	43	777	5.53
Metal	SOIL	Matrices	Serial dilution criteria were not met	Yes	20	777	2.57
Metal	SOIL	Other	IDL is older than 3 months from date of analysis	No	80	777	10.30
Metal	SOIL	Other	IDL is older than 3 months from date of analysis	Yes	220	777	28.31
Metal	SOIL	Other	See hard copy for further explanation	No	5	777	0.64
Metal	SOIL	Other	See hard copy for further explanation	Yes	20	777	2.57
Metal	SOIL	Sensitivity	IDL changed due to a significant figure discrepancy	No	1	777	0.13
Metal	WATER	Blanks	Calibration verification blank contamination	No	66	3,916	1.69
Metal	WATER	Blanks	Calibration verification blank contamination	Yes	7	3,916	0.18
Metal	WATER	Blanks	Method, preparation, or reagent blank contamination	No	236	3,916	6.03
Metal	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	78	3,916	1.99
Metal	WATER	Blanks	Negative bias indicated in the blanks	No	45	3,916	1.15
Metal	WATER	Blanks	Negative bias indicated in the blanks	Yes	23	3,916	0.59
Metal	WATER	Calculation Errors	Control limits not assigned correctly	Yes	1	3,916	0.03
Metal	WATER	Calibration	Calibration correlation coefficient did not meet requirements	No	16	3,916	0.41
Metal	WATER	Calibration	Calibration correlation coefficient did not meet requirements	Yes	8	3,916	0.20
Metal	WATER	Calibration	Frequency or sequencing verification criteria not met	No	1	3,916	0.03
Metal	WATER	Calibration	Frequency or sequencing verification criteria not met	Yes	6	3,916	0.15
Metal	WATER	Documentation Issues	Key data fields incorrect	No	4	3,916	0.10
Metal	WATER	Documentation Issues	Key data fields incorrect	Yes	18	3,916	0.46
Metal	WATER	Documentation Issues	Missing deliverables (not required for validation)	No	18	3,916	0.46
Metal	WATER	Documentation Issues	Missing deliverables (not required for validation)	Yes	12	3,916	0.31
Metal	WATER	Documentation Issues	Missing deliverables (required for validation)	No	23	3,916	0.59
Metal	WATER	Documentation Issues	Missing deliverables (required for validation)	Yes	32	3,916	0.82
Metal	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	46	3,916	1.17
Metal	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	122	3,916	3.12
Metal	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	No	1	3,916	0.03
Metal	WATER	Documentation Issues	Transcription error	No	44	3,916	1.12
Metal	WATER	Documentation Issues	Transcription error	Yes	34	3,916	0.87
Metal	WATER	Holding Times	Holding times were exceeded	No	3	3,916	0.08
Metal	WATER	Holding Times	Holding times were grossly exceeded	Yes	1	3,916	0.03

Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Metal	WATER	Instrument Set-up	Interference was indicated in the interference check sample	No	2	3,916	0.05
Metal	WATER	Instrument Set-up	Interference was indicated in the interference check sample	Yes	3	3,916	0.08
Metal	WATER	LCS	CRDL check sample recovery criteria were not met	No	29	3,916	0.74
Metal	WATER	LCS	CRDL check sample recovery criteria were not met	Yes	27	3,916	0.69
Metal	WATER	LCS	LCS recovery criteria were not met	No	26	3,916	0.66
Metal	WATER	LCS	LCS recovery criteria were not met	Yes	62	3,916	1.58
Metal	WATER	LCS	Low level check sample recovery criteria were not met	No	14	3,916	0.36
Metal	WATER	LCS	Low level check sample recovery criteria were not met	Yes	9	3,916	0.23
Metal	WATER	Matrices	Duplicate sample precision criteria were not met	No	7	3,916	0.18
Metal	WATER	Matrices	Duplicate sample precision criteria were not met	Yes	18	3,916	0.46
Metal	WATER	Matrices	LCS/LCSD precision criteria were not met	No	2	3,916	0.05
Metal	WATER	Matrices	LCS/LCSD precision criteria were not met	Yes	12	3,916	0.31
Metal	WATER	Matrices	MSA calibration correlation coefficient < 0.995	No	1	3,916	0.03
Metal	WATER	Matrices	MSA was required, but not performed	Yes	1	3,916	0.03
Metal	WATER	Matrices	Post-digestion MS did not meet control criteria	No	29	3,916	0.74
Metal	WATER	Matrices	Post-digestion MS did not meet control criteria	Yes	6	3,916	0.15
Metal	WATER	Matrices	Predigestion MS recovery criteria were not met	No	42	3,916	1.07
Metal	WATER	Matrices	Predigestion MS recovery criteria were not met	Yes	64	3,916	1.63
Metal	WATER	Matrices	Serial dilution criteria were not met	No	3	3,916	0.08
Metal	WATER	Matrices	Serial dilution criteria were not met	Yes	61	3,916	1.56
Metal	WATER	Other	IDL is older than 3 months from date of analysis	No	12	3,916	0.31
Metal	WATER	Other	IDL is older than 3 months from date of analysis	Yes	19	3,916	0.49
Metal	WATER	Sample Preparation	Samples were not properly preserved in the field	No	13	3,916	0.33
Metal	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	41	3,916	1.05
Metal	WATER	Sensitivity	IDL changed due to a significant figure discrepancy	No	4	3,916	0.10
PCB	SOIL	Documentation Issues	Transcription error	No	7	56	12.50
PCB	WATER	Documentation Issues	Transcription error	No	7	42	16.67
PCB	WATER	Surrogates	Surrogate recovery criteria were not met	No	7	42	16.67
Pesticide	SOIL	Other	Sample results were not validated due to re-analysis	No	5	169	2.96
Pesticide	SOIL	Surrogates	Surrogate recovery criteria were not met	No	1	169	0.59
Pesticide	WATER	Documentation Issues	Transcription error	No	11	127	8.66
Pesticide	WATER	Surrogates	Surrogate recovery criteria were not met	No	21	127	16.54
Radionuclide	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	1	161	0.62
Radionuclide	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	12	161	7.45
Radionuclide	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	3	161	1.86
Radionuclide	SOIL	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	20	161	12.42
Radionuclide	SOIL	Documentation Issues	Transcription error	No	2	161	1.24
Radionuclide	SOIL	Documentation Issues	Transcription error	Yes	20	161	12.42
Radionuclide	SOIL	LCS	LCS recovery > +/- 3 sigma	Yes	8	161	4.97
Radionuclide	SOIL	LCS	LCS recovery criteria were not met	No	1	161	0.62
Radionuclide	SOIL	LCS	LCS relative percent error criteria not met	Yes	6	161	3.73
Radionuclide	SOIL	Matrices	Recovery criteria were not met	Yes	4	161	2.48
Radionuclide	SOIL	Matrices	Replicate analysis was not performed	No	1	161	0.62
Radionuclide	SOIL	Matrices	Replicate precision criteria were not met	No	1	161	0.62
Radionuclide	SOIL	Matrices	Replicate precision criteria were not met	Yes	7	161	4.35
Radionuclide	SOIL	Other	Lab results not verified due to unsubmitted data	Yes	2	161	1.24
Radionuclide	SOIL	Other	QC sample does not meet method requirements	No	15	161	9.32
Radionuclide	SOIL	Other	QC sample does not meet method requirements	Yes	10	161	6.21
Radionuclide	SOIL	Other	Sample exceeded efficiency curve weight limit	Yes	3	161	1.86
Radionuclide	SOIL	Other	See hard copy for further explanation	Yes	14	161	8.70
Radionuclide	SOIL	Sample Preparation	Improper aliquot size	Yes	1	161	0.62
Radionuclide	SOIL	Sensitivity	MDA exceeded the RDL	Yes	5	161	3.11
Radionuclide	SOIL	Sensitivity	MDA was calculated by reviewer	Yes	43	161	26.71
Radionuclide	SOIL	Sensitivity	Results considered qualitative not quantitative	Yes	2	161	1.24
Radionuclide	WATER	Blanks	Blank recovery criteria were not met	Yes	3	597	0.50

Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Radionuclide	WATER	Blanks	Method, preparation, or reagent blank contamination	No	11	597	1.84
Radionuclide	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	38	597	6.37
Radionuclide	WATER	Calibration	Calibration counting statistics did not meet criteria	No	4	597	0.67
Radionuclide	WATER	Calibration	Continuing calibration verification criteria were not met	No	14	597	2.35
Radionuclide	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	95	597	15.91
Radionuclide	WATER	Documentation Issues	Sufficient documentation not provided by the laboratory	No	6	597	1.01
Radionuclide	WATER	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	71	597	11.89
Radionuclide	WATER	Documentation Issues	Transcription error	No	55	597	9.21
Radionuclide	WATER	Documentation Issues	Transcription error	Yes	34	597	5.70
Radionuclide	WATER	Holding Times	Holding times were exceeded	No	4	597	0.67
Radionuclide	WATER	Holding Times	Holding times were exceeded	Yes	3	597	0.50
Radionuclide	WATER	Holding Times	Holding times were grossly exceeded	No	1	597	0.17
Radionuclide	WATER	Holding Times	Holding times were grossly exceeded	Yes	1	597	0.17
Radionuclide	WATER	Instrument Set-up	Resolution criteria were not met	Yes	4	597	0.67
Radionuclide	WATER	LCS	Expected LCS value not submitted/verifiable	No	1	597	0.17
Radionuclide	WATER	LCS	Expected LCS value not submitted/verifiable	Yes	6	597	1.01
Radionuclide	WATER	LCS	LCS recovery > +/- 3 sigma	No	16	597	2.68
Radionuclide	WATER	LCS	LCS recovery > +/- 3 sigma	Yes	19	597	3.18
Radionuclide	WATER	LCS	LCS recovery criteria were not met	No	2	597	0.34
Radionuclide	WATER	LCS	LCS recovery criteria were not met	Yes	10	597	1.68
Radionuclide	WATER	LCS	LCS relative percent error criteria not met	No	3	597	0.50
Radionuclide	WATER	LCS	LCS relative percent error criteria not met	Yes	28	597	4.69
Radionuclide	WATER	Matrices	Recovery criteria were not met	No	1	597	0.17
Radionuclide	WATER	Matrices	Recovery criteria were not met	Yes	5	597	0.84
adionuclide	WATER	Matrices	Replicate analysis was not performed	No	4	597	0.67
Radionuclide	WATER	Matrices	Replicate analysis was not performed	Yes	9	597	1.51
Radionuclide	WATER	Matrices	Replicate precision criteria were not met	No	7	597	1.17
Radionuclide	WATER	Matrices	Replicate precision criteria were not met	Yes	27	597	4.52
Radionuclide	WATER	Matrices	Replicate recovery criteria were not met	No	2	597	0.34
Radionuclide	WATER	Matrices	Replicate recovery criteria were not met	Yes	4	597	0.67
Radionuclide	WATER	Other	Lab results not verified due to unsubmitted data	Yes	1	597	0.17
Radionuclide	WATER	Other	See hard copy for further explanation	No	3	597	0.50
Radionuclide	WATER	Other	See hard copy for further explanation	Yes	36	597	6.03
Radionuclide	WATER	Sensitivity	Incorrect reported activity or MDA	Yes	1	597	0.17
Radionuclide	WATER	Sensitivity	MDA exceeded the RDL	No	1	597	0.17
Radionuclide	WATER	Sensitivity	MDA exceeded the RDL	Yes	15	597	2.51
Radionuclide	WATER	Sensitivity	MDA was calculated by reviewer	Yes	185	597	30.99
SVOC	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	1	545	0.18
SVOC	SOIL	Internal Standards	Internal standards did not meet criteria	No	7	545	1.28
SVOC	SOIL	Other	Sample results were not validated due to re-analysis	No	261	545	47.89
SVOC	SOIL	Other	Sample results were not validated due to re-analysis	Yes	10	545	1.83
SVOC	SOIL	Surrogates	Surrogate recovery criteria were not met	No	56	545	10.28
SVOC	SOIL	Surrogates	Surrogate recovery criteria were not met	Yes	1	545	0.18
SVOC	WATER	Blanks	Method, preparation, or reagent blank contamination	No	2	413	0.48
SVOC	WATER	Calibration	Continuing calibration verification criteria were not met	No	4	413	0.97
SVOC	WATER	Documentation Issues	Transcription error	No	2	413	0.48
SVOC	WATER	Documentation Issues	Transcription error	Yes	3	413	0.73
SVOC	WATER	Holding Times	Holding times were exceeded	No	3	413	0.73
SVOC	WATER	Internal Standards	Internal standards did not meet criteria	No	23	413	5.57
SVOC	WATER	LCS	LCS recovery criteria were not met	No	1	413	0.24
SVOC	WATER	Other	Sample results were not validated due to re-analysis	No	2	413	0.48
SVOC	WATER	Other	Sample results were not validated due to re-analysis	Yes	3	413	0.73
VOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	10	494	2.02
VOC	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	2	494	0.40
VOC	SOIL	Internal Standards	Internal standards did not meet criteria	No	9	494	1.82
OC	SOIL	Other	Sample results were not validated due to re-analysis	No	20	494	4.05

Table A2.5
Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
VOC	SOIL	Surrogates	Surrogate recovery criteria were not met	No	4	494	0.81
VOC	WATER	Blanks	Method, preparation, or reagent blank contamination	No	20	2,855	0.70
VOC	WATER	Calibration	Continuing calibration verification criteria were not met	No	4	2,855	0.14
VOC	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	1	2,855	0.04
VOC	WATER	Confirmation	Results were not confirmed	No	2	2,855	0.07
VOC	WATER	Documentation Issues	Record added by the validator	No	33	2,855	1.16
VOC	WATER	Holding Times	Holding times were exceeded	No	55	2,855	1.93
VOC	WATER	Internal Standards	Internal standards did not meet criteria	No	34	2,855	1.19
VOC	WATER	LCS	LCS recovery criteria were not met	No	20	2,855	0.70
VOC	WATER	LCS	LCS recovery criteria were not met	Yes	1	2,855	0.04
VOC	WATER	Surrogates	Surrogate recovery criteria were not met	No	100	2,855	3.50
VOC	WATER	Surrogates	Surrogate recovery criteria were not met	Yes	1	2,855	0.04
Wet Chem	SOIL	Holding Times	Holding times were exceeded	Yes	5	31	16.13
Wet Chem	SOIL	Holding Times	Holding times were grossly exceeded	No	2	31	6.45
Wet Chem	SOIL	Matrices	Predigestion MS recovery criteria were not met	No	1	31	3.23
Wet Chem	SOIL	Matrices	Predigestion MS recovery was < 30 percent	Yes	10	31	32.26
Wet Chem	SOIL	Other	IDL is older than 3 months from date of analysis	Yes	10	31	32.26
Wet Chem	WATER	Blanks	Calibration verification blank contamination	No	1	525	0.19
Wet Chem	WATER	Blanks	Method, preparation, or reagent blank contamination	No	5	525	0.95
Wet Chem	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	1	525	0.19
Wet Chem	WATER	Blanks	Negative bias indicated in the blanks	No	2	525	0.38
Wet Chem	WATER	Blanks	Negative bias indicated in the blanks	Yes	2	525	0.38
Wet Chem	WATER	Calibration	Calibration correlation coefficient did not meet requirements	Yes	3	525	0.57
Wet Chem	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	3	525	0.57
Wet Chem	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	12	525	2.29
Wet Chem	WATER	Documentation Issues	Transcription error	No	11	525	2.10
Wet Chem	WATER	Documentation Issues	Transcription error	Yes	14	525	2.67
Wet Chem	WATER	Holding Times	Holding times were exceeded	No	5	525	0.95
Wet Chem	WATER	Holding Times	Holding times were exceeded	Yes	8	525	1.52
Wet Chem	WATER	Holding Times	Holding times were grossly exceeded	No	8	525	1.52
Wet Chem	WATER	Holding Times	Holding times were grossly exceeded	Yes	3	525	0.57
Wet Chem	WATER	Matrices	Duplicate sample precision criteria were not met	Yes	1	525	0.19
Wet Chem	WATER	Matrices	Predigestion MS recovery criteria were not met	Yes	14	525	2.67
Wet Chem	WATER	Other	Lab results not verified due to unsubmitted data	No	1	525	0.19
Wet Chem	WATER	Other	Lab results not verified due to unsubmitted data	Yes	4	525	0.76
Wet Chem	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	3	525	0.57

Table A2.6
Summary of Data Rejected During V&V

Analyte Group	Matrix	Total No. of Rejected Records	Total No. of Records	Percent Rejected (%)
Herbicide	SOIL	1	21	4.76
Herbicide	WATER	0	7	0.00
Metal	SOIL	14	1,454	0.96
Metal	WATER	101	5,662	1.78
PCB	SOIL	0	98	0.00
PCB	WATER	0	49	0.00
Pesticide	SOIL	1	301	0.33
Pesticide	WATER	0	148	0.00
Radionuclide	SOIL	155	481	32.22
Radionuclide	WATER	205	1,158	17.70
SVOC	SOIL	11	1,239	0.89
SVOC	WATER	2	493	0.41
VOC	SOIL	32	832	3.85
VOC	WATER	296	4,421	6.70
Wet Chemistry	SOIL	0	41	0.00
Wet Chemistry	WATER	13	782	1.66
	Total	**831**	**17,187**	**4.84%**

Table A2.7
Summary of RPDs/DERs of Field Duplicate Analyte Pairs

Analyte Group	Matrix	No. of Duplicates Failing RPD/DER Criteria	Total No. of Duplicate Pairs	Percent Failure (%)	Field Duplicate Frequency (%)
Metal	SOIL	5	30	16.67	3.86
Metal	WATER	5	331	1.51	7.66
Radionuclide	WATER	0	32	0.00	4.41
Wet Chemistry	SOIL	0	1	0.00	3.13
Wet Chemistry	WATER	0	41	0.00	7.08

Table A2.8
Summary of Data Estimated or Undetected Due to V&V Determinations

Analyte Group	Matrix	No. of CRA Data Records Qualified	Total No. of V&V CRA Records	Detect?	Percent Qualified (%)
Herbicide	SOIL	1	8	No	12.50
Metal	SOIL	114	777	No	14.67
Metal	SOIL	179	777	Yes	23.04
Metal	WATER	485	3,916	No	12.39
Metal	WATER	351	3,916	Yes	8.96
PCB	WATER	7	42	No	16.67
Pesticide	SOIL	1	169	No	0.59
Pesticide	WATER	21	127	No	16.54
Radionuclide	SOIL	1	161	Yes	0.62
Radionuclide	WATER	4	597	No	0.67
Radionuclide	WATER	12	597	Yes	2.01
SVOC	SOIL	63	545	No	11.56
SVOC	WATER	27	413	No	6.54
VOC	SOIL	23	494	No	4.66
VOC	WATER	219	2,855	No	7.67
VOC	WATER	3	2,855	Yes	0.11
Wet Chemistry	SOIL	3	31	No	9.68
Wet Chemistry	SOIL	15	31	Yes	48.39
Wet Chemistry	WATER	21	525	No	4.00
Wet Chemistry	WATER	38	525	Yes	7.24
	Total	**1,588**	**10,722**		**14.81%**

Table A2.9
Summary of Data Qualified as Undetected Due to Blank Contamination

Analyte Group	Matrix	No. of CRA Records Qualified as Undetected	Total No. of CRA Records with Detected Results[a]	Percent Qualified as Undetected
Metal	SOIL	14	555	2.52
Metal	WATER	38	1,930	1.97
Wet Chemistry	WATER	1	374	0.27
	Total	**53**	**2,859**	**1.85%**

[a] As determined by the laboratory prior to V&V.

COMPREHENSIVE RISK ASSESSMENT

WEST AREA EXPOSURE UNIT

VOLUME 3: ATTACHMENT 3

Statistical Analyses and Professional Judgment

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qv

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ACRONYMS AND ABBREVIATIONS

AI	adequate intake
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
ECOI	ecological contaminant of interest
EcoSSL	Ecological Soil Screening Level
ECOPC	ecological contaminant of potential concern
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	Ecological Risk Assessment
ESL	ecological screening level
EU	Exposure Unit
HHRA	Human Health Risk Assessment
IDEU	Inter-Drainage Exposure Unit
MDC	maximum detected concentration
mg/kg	milligrams per kilogram
NCP	National Contingency Plan
NOAEL	no observed adverse effect level
PCOC	potential contaminant of concern
PMJM	Preble's meadow jumping mouse
PRG	preliminary remediation goal
RCEU	Rock Creek Drainage Exposure Unit
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study

tESL	threshold ESL
UCL	upper confidence limit
UTL	upper tolerance limit
WAEU	West Area Exposure Unit
WRW	wildlife refuge worker

1.0 INTRODUCTION

This attachment presents the results for the statistical analyses and professional judgment evaluation used to select human health contaminants of concern (COCs) as part of the Human Health Risk Assessment (HHRA) and ecological contaminants of potential concern (ECOPCs) as part of the Ecological Risk Assessment (ERA) for the West Area Exposure Unit (EU) (WAEU) at the Rocky Flats Environmental Technology Site (RFETS). The methods used to perform the statistical analysis and the professional judgment evaluation that follow the Final Comprehensive Risk Assessment (CRA) Work Plan and Methodology (DOE 2005) and are described in Sections 2.2.5 (HHRA) and 2.3.4 (ERA) of Appendix A, Volume 2 of the RCRA Facility Investigation (RFI)-Remedial Investigation (RI)/Corrective Measures Study (CMS)-Feasibility Study (FS) Report (hereafter referred to as the RI/FS Report).

2.0 RESULTS OF STATISTICAL COMPARISONS TO BACKGROUND FOR THE WEST AREA EXPOSURE UNIT

The results of the statistical background comparisons for inorganic and radionuclide potential contaminants of concern (PCOCs) and ecological contaminants of interest (ECOIs) in surface soil/surface sediment, subsurface soil/subsurface sediment, surface soil, and subsurface soil samples collected from the WAEU are presented in this section. Box plots are provided for analytes that were carried forward into the statistical comparison step and are presented in Figures A3.2.1 to A3.2.11.[1] The box plots display several reference points: 1) the line inside the box is the median; 2) the lower edge of the box is the 25th percentile; 3) the upper edge of the box is the 75th percentile; 4) the upper lines (called whiskers) are drawn to the greatest value that is less than or equal to 1.5 times the inter-quartile range (the inter-quartile range is between the 75th and 25th percentiles); 5) the lower whiskers are drawn to the lowest value that is greater than or equal to 1.5 times the inter-quartile range; and 6) solid circles are data points greater or less than the whiskers.

PCOCs with concentrations in the WAEU that are statistically greater than background (or if background comparisons were not performed) are carried through to the professional judgment evaluation step of the COC selection process. ECOIs (for non-Preble's meadow jumping mouse [PMJM] receptors) with concentrations in the WAEU that are statistically greater than background (or if background comparisons are not performed) are carried through to the upper-bound exposure point concentration (EPC)-

[1] Statistical background comparisons are not performed for analytes if: 1) the background concentrations are nondetections; 2) background data are unavailable; 3) the analyte has low detection frequency in the WAEU or background data set (less than 20 percent); or 4) the analyte is an organic compound. Box plots are not provided for these analytes. However, these analytes are carried forward into the professional judgment evaluation.

to-threshold ecological screening level (ESL) comparison step of the ECOPC selection process. ECOIs with surface soil concentrations in PMJM habitat that are statistically greater than background (or if background comparisons were not performed) are carried through to the professional judgment evaluation step of the ECOPC selection process.

PCOCs and ECOIs with concentrations that are not statistically greater than background are not identified as COCs/ECOPCs and are not evaluated further.

2.1 Surface Soil/Surface Sediment Data Used in the HHRA

For the WAEU surface soil/surface sediment data set, the maximum detected concentration (MDC) for manganese exceeded the wildlife refuge worker (WRW) preliminary remediation goals (PRGs), but the upper confidence limit (UCL) on the mean concentration for the site data set for manganese does not exceed the PRG. Consequently, manganese is not evaluated further.

The MDCs and UCLs for arsenic, cesium-134, cesium-137, and radium-228 exceed the PRGs for the WAEU data set. However, it is important to note that the PRG exceedances observed for cesium-134, cesium-137, and radium-228 were from samples that are part of the background data set; therefore, these three analytes were not carried forward through the formal statistical analysis. Consequently, of these four analytes, only arsenic was carried forward into the statistical background comparison step. The results of the statistical comparison of the WAEU surface soil/surface sediment data to background data for arsenic are presented in Table A3.2.1, while the summary statistics for background and WAEU surface soil/surface sediment data are shown in Table A3.2.2.

The results of the statistical comparisons of the WAEU surface soil/surface sediment data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Arsenic

Background Comparison Not Performed[1]

- Cesium-134
- Cesiuim-137
- Radium-228

2.2 Subsurface Soil/Subsurface Sediment Data Used in the HHRA

No analytes exceeded the applicable PRG for the combined WAEU subsurface soil and subsurface sediment data set.

2.3 Surface Soil Data Used in the ERA (Non-PMJM Receptors)

For the WAEU surface soil data set, the MDCs for aluminum, arsenic, boron, chromium, copper, lead, lithium, mercury, nickel, thallium, vanadium, and zinc exceeded a non-PMJM ESL and, consequently, these analytes were carried forward into the statistical background comparison step. The results of the statistical comparison of the WAEU surface soil data to background data are presented in Table A3.2.3 and the summary statistics for background and WAEU surface soil data are shown in Table A3.2.4.

The results of the statistical comparisons of the WAEU surface soil to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Aluminum
- Arsenic
- Chromium
- Lithium

Not Statistically Greater than Background at the 0.1 Significance Level

- Copper
- Lead
- Mercury
- Nickel
- Vanadium
- Zinc

Background Comparison not Performed[1]

- Boron
- Thallium

2.4 Surface Soil Data used in the ERA (PMJM Receptors)

No PMJM receptors were evaluated in the WAEU data set because the limited habitat within the WAEU boundary is assessed with the more extensive PMJM habitat that occurs in the Rock Creek Drainage EU (RCEU) and the Inter-Drainage EU (IDEU). See Appendix A, Volumes 4 (RCEU) and 5 (IDEU) of the RI/FS Report for additional information. The HHRA and ERA methods and selection of receptors are described in detail in Appendix A, Volume 2, Section 2.0 of the RI/FS Report.

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2.5 Subsurface Soil Data used in the ERA

No analytes exceeded the applicable ESL for the subsurface soil data set at the WAEU.

3.0 UPPER-BOUND EXPOSURE POINT CONCENTRATION COMPARISON TO LIMITING ECOLOGICAL SCREENING LEVELS

ECOIs in surface soil and subsurface soil with concentrations that are statistically greater than background (or if background comparisons were not performed) are evaluated further by comparing the EPC concentrations to the threshold ESLs (tESLs). The upper-bound EPCs are the 95 percent UCL of the 90th percentile [upper tolerance limit (UTL)] for small home-range receptors, the UCL for large home-range receptors, or the MDC in the event that the UCL or UTL is greater than the MDC.

3.1 ECOIs in Surface Soil (Non-PMJM)

All six ECOIs (aluminum, arsenic, boron, chromium, lithium, and thallium) whose concentrations were considered to be statistically greater than background were also found to have upper-bound EPCs greater than the tESLs. These six ECOIs are evaluated in the professional judgment evaluation screening step (Section 4.0).

3.2 ECOIs in Subsurface Soil

No ECOIs were found to be statistically greater than background and above an ESL in accordance with the ECOPC selection process. Therefore, the upper-bound EPC comparison to tESLs was not performed.

4.0 PROFESSIONAL JUDGMENT

This section describes the professional judgment applied in the COC and ECOPC selection processes for the HHRA and ERA, respectively, for the WAEU. Based on the weight of evidence evaluated in the professional judgment step, PCOCs and ECOIs are either included for further evaluation as COCs/ECOPCs in the risk characterization step, or excluded from further evaluation.

The professional judgment evaluation takes into account the following lines of evidence: process knowledge, spatial trends, pattern recognition[2], comparison to RFETS

[2] The pattern recognition evaluation includes the use of probability plots. If two or more distinct populations are evident in the probability plot, this suggests that one or more local releases may have occurred. Conversely, if only one distinct low-concentration population is defined, likely representing a background population, a local release may or may not have occurred. Similar to all statistical methods, the probability plot has limitations in cases where there is inadequate sampling and the magnitude of the release is relatively small. Thus, absence of two clear populations in the probability plots is consistent with, but not definitive proof of, the hypothesis that no releases have occurred. However, if a release has occurred within the sampled area and has been included in the samples, then the elemental concentrations associated with that release are either within the background concentration range or the entire sampled population represents a release, a highly unlikely probability.

background and other background data sets[3], and risk potential to human health receptors or plants and wildlife. For PCOCs or ECOIs where the process knowledge and/or spatial trends indicate that the presence of the analyte in the EU may be related to site activities, the professional judgment discussion includes only two of the lines of evidence listed above, and it is concluded that these analytes are COCs/ECOPCs and are carried forward into risk characterization. For the other PCOCs and ECOIs that are evaluated in the professional judgment step, each of the lines of evidence listed above are included in the discussion.

Details of the process knowledge and spatial trend evaluations for metals are provided in Appendix A, Volume 2, Attachment 8 of the RI/FS Report. The conclusions for these evaluations for the WAEU are noted in this attachment.

The following PCOCs/ECOIs are evaluated further in the professional judgment step for WAEU:

- Surface soil/surface sediment (HHRA)
  - Arsenic
- Surface soil for non-PMJM receptors (ERA)
  - Aluminum
  - Arsenic
  - Boron
  - Chromium
  - Lithium
  - Thallium

The following sections provide the professional judgment evaluations, by analyte and then by medium, for the PCOCs/ECOIs listed above.

4.1 Aluminum

Aluminum has an EPC in surface soil (for non-PMJM receptors) greater than the tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if aluminum should be retained for risk characterization are summarized below.

[3] The regional background data set for Colorado and the bordering states was extracted from data for the western United States (Shacklette and Boerngen 1984) and is composed of data from Colorado as well as Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming. Although the background data set for Colorado and bordering states is not specific to Colorado's Front Range, it is useful for the professional judgment evaluation in the absence of a robust data set for the Front Range. Colorado's Front Range has highly variable terrain that changes elevation over short distances. Consequently, numerous soil types and geologic materials are present at RFETS, and the data set for Colorado and bordering states may be more representative of these variable soil types.

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4.1.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential to have been released into the RFETS soil because of the aluminum metal inventory and presence of aluminum in waste generated during former operations. However, the localized documented source areas are remote from WAEU.

4.1.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that aluminum concentrations in WAEU surface soil reflect variations in naturally occurring aluminum.

4.1.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log transformed data set for aluminum (Figure A3.4.1) suggests a single background population, which is indicative of background conditions. However, 10 sampling locations represent a limited data set for conclusive definition of the full range of a background population.

4.1.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Within the WAEU, eight of the 10 surface soil samples have concentrations within the background range. There are two surface soil samples with aluminum concentrations of 18,000 milligrams per kilogram (mg/kg). Aluminum concentrations collected in the 10 surface soil samples at the WAEU range from 8,200 to 18,000 mg/kg, with a mean concentration of 13,520 mg/kg and a standard deviation of 3,168 mg/kg. Background aluminum concentrations range from 4,050 to 17,100 mg/kg, with a mean concentration of 10,203 mg/kg and a standard deviation of 3,256 mg/kg (Table A3.2.4). The ranges of the WAEU and background data sets significantly overlap, with the means and standard deviations being extremely close for the two data sets. The two locations whose concentrations of 18,000 mg/kg exceed the background MDC are only slightly above the maximum background concentration of 17,100 mg/kg. Because these two points are extremely close to background concentrations and do not show a concentration gradient, they are considered to be indicative of background concentrations.

Although the site-specific background MDC is exceeded, aluminum concentrations at the WAEU are well within the range of reported literature values. Aluminum concentrations reported in surface soil samples at the WAEU are well within the range for aluminum in soils of Colorado and the bordering states (5,000 to 100,000 mg/kg, with mean concentration of 50,800 mg/kg and a standard deviation of 23,500 mg/kg) (Table A3.4.1).

4.1.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The MDC for aluminum in the WAEU (18,000 mg/kg) exceeds the no observed adverse effect level (NOAEL) ESL for only one receptor group, terrestrial plants (50 mg/kg). However, U.S. Environmental Protection Agency (EPA) Ecological Soil Screening Level (EcoSSL) guidance (EPA 2003) for aluminum recommends that aluminum not be considered an ECOPC for soils at sites where the soil pH exceeds 5.5 due to its limited bioavailability in non-acidic soils. The average pH value for RFETS surface soils is 8.2. Aluminum concentrations in the WAEU show a distribution similar to sitewide background concentrations and there are no historical records of a source area in the WAEU. Therefore, it is unlikely that the aluminum concentrations in surface soil within the WAEU could represent potential risk concerns for wildlife populations.

4.1.6 Conclusion

Review of process knowledge indicates that aluminum may be a present in RFETS soils as a result of historical site-related activities; however, the weight of evidence presented above shows that aluminum concentrations in WAEU surface soil (non-PMJM receptors) have a spatial distribution and a single data population indicative of naturally occurring aluminum, are well within regional background levels, and are unlikely to result in risk concerns for wildlife populations. Aluminum is not considered an ECOPC in surface soil for the WAEU and, therefore, is not further evaluated quantitatively.

4.2 Arsenic

Arsenic has concentrations statistically greater than background in surface soil/surface sediment and, therefore, was carried forward to the professional judgment step. In addition, arsenic had an EPC in surface soil (for non-PMJM receptors) greater than the tESL. The lines of evidence used to determine whether arsenic should be retained for risk characterization are summarized below.

4.2.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates arsenic is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.2.2 Evaluation of Spatial Trends

Surface Soil/ Surface Sediment

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that arsenic concentrations in WAEU surface soil/surface sediment reflect variations in naturally occurring arsenic.

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Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that arsenic concentrations in WAEU surface soil reflect variations in naturally occurring arsenic.

4.2.3 Pattern Recognition

Surface Soil/Surface Sediment and Surface Soil (Non-PMJM)

The probability plot for the natural log transformed data set for arsenic (Figure A3.4.2) suggests a single population which is indicative of background conditions. However, 10 sampling locations represent a limited data set for a conclusive definition of the full range of a background population. Although the highest concentration of arsenic (22 mg/kg in sample 04F0707-002) does not fit the distribution of the other data, this single data point does not provide sufficient evidence of a second population.

4.2.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil/Surface Sediment and Surface Soil (Non-PMJM)

Arsenic was detected in each of the 10 surface soil/surface sediment samples, excluding the 10 surface sediment samples assigned to background, collected in the WAEU. These 10 samples also correspond to the 10 surface soil (non-PMJM) samples in the WAEU. Arsenic concentrations in these samples range from 3.60 to 22.0 mg/kg, with a mean concentration of 8.48 mg/kg and a standard deviation of 5.07 mg/kg. Arsenic concentrations in the background data set range from 0.270 to 9.6 mg/kg, with a mean concentration of 3.42 mg/kg and a standard deviation of 2.55 mg/kg (Table A3.2.2).

Arsenic concentrations reported in surface soil samples at the WAEU are well within the range for arsenic in soils of Colorado and the bordering states (1.22 to 97 mg/kg, with a mean concentration of 6.9 mg/kg and a standard deviation of 7.64 mg/kg) (Table A3.4.1).

4.2.5 Risk Potential for HHRA

Surface Soil/Surface Sediment

The arsenic MDC for surface soil/surface sediment is 9.40 mg/kg and the UCL is 5.98 mg/kg. Although the UCL of 5.98 mg/kg is slightly more than three times greater than the PRG (2.41 mg/kg), the surface soil/surface sediment concentrations for arsenic within the WAEU are within naturally occurring concentrations in soils in Colorado and bordering states. The PRG is based on an excess carcinogenic risk of 1E-06; therefore, the risk to human health, approximately 2E-06, is well within the National Contingency Plan (NCP) risk range of 1E-06 to 1E-04. Risks estimated for arsenic background surface soil/surface sediment concentrations (2E-06) are similar. Furthermore, because arsenic concentrations in the WAEU appear to represent naturally occurring arsenic, this risk is unassociated with arsenic releases from RFETS.

4.2.6 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL, 22 mg/kg, exceeds ESLs for the herbivorous deer mouse (2.57 mg/kg), the prairie dog (9.35 mg/kg), terrestrial plants (10 mg/kg), mule deer (13 mg/kg), and herbivorous mourning dove (20 mg/kg). The ESLs for the herbivorous deer mouse and prairie dog are both below background concentrations, with the deer mouse ESL less than the average background concentration. These are screening level values for assessing risks to the deer mouse and prairie dog receptor populations. The MDC is also located within an active gravel mining operation that does not represent an attractive area of habitat for the terrestrial receptors discussed above. Therefore, it is highly unlikely that one slightly elevated arsenic detection which exceeds several ESLs within an area of active mining has the potential to cause risk to populations of terrestrial receptors in the WAEU.

4.2.7 Conclusion

The weight of evidence presented above shows that arsenic concentrations in WAEU surface soil/surface sediment and surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; have a spatial distribution and a single data population indicative of naturally occurring arsenic; are well within regional background levels; result in estimated risks to WRW that would be similar to background risks (2E-06); and are unlikely to result in risk concerns for wildlife populations. Arsenic is not considered a COC in surface soil/surface sediment and is not considered an ECOPC in surface soil for the WAEU. Therefore, arsenic is not further evaluated quantitatively.

4.3 Boron

Boron has an EPC in surface soil (for non-PMJM receptors) greater than the tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if boron should be retained for risk characterization are summarized below.

4.3.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates boron is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.3.2 Evaluation of Spatial Trends

Surface Soil (Non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that boron concentrations in WAEU surface soil reflect variations in naturally occurring boron.

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4.3.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log transformed data set for boron (Figure A3.4.4) suggests a single background population indicative of background conditions. However, 10 sampling locations represent a limited data set for a conclusive definition of the full range of a background population.

4.3.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

RFETS background data were not collected for boron. However, the reported range for boron in surface soil within Colorado and the bordering states is 20 to 150 mg/kg, with a mean concentration of 27.9 mg/kg and a standard deviation of 19.7 mg/kg (Table A3.4.1). Boron concentrations reported in surface soil samples at the WAEU ranged from 2.80 to 7.10 mg/kg, with a mean concentration of 5.11 mg/kg and a standard deviation of 1.20 mg/kg (Table A3.2.4). The range of boron concentrations in surface soil at the WAEU are well within the range for boron in soils of Colorado and the bordering states.

4.3.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The MDC and UTL for boron in the WAEU (10.4 mg/kg and 7.93 mg/kg, respectively) exceed the NOAEL ESL for only one receptor group, terrestrial plants (0.5 mg/kg). All other NOAEL ESLs were greater than the MDC and ranged from 30 to 6,070 mg/kg. Site-specific background data for boron were not available, but the MDC did not exceed the low end (20 mg/kg) of the background range presented in Shacklette and Boerngen (1984). This indicates the terrestrial plant NOAEL ESL (0.5 mg/kg) is well below expected background concentrations, and MDCs above the NOAEL ESL are not likely to be indicative of site-related risk to the terrestrial plant community in the WAEU. Kabata-Pendias and Pendias (1992) indicate soil with boron concentrations equal to 0.3 mg/kg is critically deficient in boron, and effects on plant reproduction would be expected. Additionally, the summary of boron toxicity in Efroymson et al. (1997) notes that the source of the 0.5-mg/kg NOAEL ESL indicates boron was toxic when added at 0.5 mg/kg to soil, but gives no indication of the boron concentration in the baseline soil before the addition. The confidence placed by Efroymson et al. (1997) was low. Because no NOAEL ESLs other than the terrestrial plant NOAEL ESL are exceeded by the MDC, boron is highly unlikely to present a risk to terrestrial receptor populations in the WAEU.

4.3.6 Conclusion

The weight of evidence presented above shows that boron concentrations in WAEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; have a spatial distribution and single data

population indicative of naturally occurring boron; are well within regional background levels; and are unlikely to result in risk concerns for wildlife populations. Boron is not considered an ECOPC in surface soil for the WAEU and, therefore, is not further evaluated quantitatively.

4.4 Chromium

Chromium has concentrations statistically greater than background in surface soil/surface sediment and, therefore, was carried forward to the professional judgment step. In addition, chromium had an upper-bound EPC in surface soil (for non-PMJM receptors) greater than the tESL. The lines of evidence used to determine if chromium should be retained for risk characterization are summarized below.

4.4.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates the potential for chromium to be a ECOPC in the SWEU is low due to a moderate inventory, and limited identification as a constituent in wastes generated at RFETS and localized documented historical source areas remote from WAEU.

4.4.2 Evaluation of Spatial Trends

Surface Soil (non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that chromium concentrations in WAEU surface soil reflect variation in naturally occurring chromium.

4.4.3 Pattern Recognition

Surface Soil (non-PMJM)

The probability plot for the natural log transformed data set for chromium (Figure A3.4.5) suggests a single background population indicative of background conditions. However, 10 sampling locations represent a limited data set for a conclusive definition of the full range of a background population.

4.4.4 Comparison to RFETS Background and Other Background Data Sets

Chromium was detected in each of the 10 surface soil samples collected in the WAEU. Chromium concentrations at the WAEU range from 8.10 to 17 mg/kg, with a mean concentration of 13.3 mg/kg and a standard deviation of 2.65 mg/kg. Background chromium concentrations range from 5.50 to 16.9 mg/kg, with a mean concentration of 11.2 mg/kg and a standard deviation of 2.78 mg/kg (Table A3.2.4). The reported range for chromium in surface soils of Colorado and the bordering states is 3 to 500 mg/kg, with an arithmetic mean of 48.2 mg/kg (Table A3.4.1). Chromium concentrations reported in surface soil samples at the WAEU are well within this range.

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4.4.5 Risk Potential for Plants and Wildlife

The UTL for chromium (19.5 mg/kg) exceeds NOAEL ESLs for the terrestrial invertebrate (0.4 mg/kg), terrestrial plant (1.0 mg/kg), insectivorous mourning dove (1.34 mg/kg), American kestrel (14.2 mg/kg), and insectivore deer mouse (15.9 mg/kg) receptors, but the MDC is equal to the maximum detected background concentration (16.9 mg/kg) and less than the EPA EcoSSLs for birds (26 mg/kg) and mammals (34 mg/kg), which is based on chromium III. An EPA EcoSSL for chromium VI is not available for birds and is 81 mg/kg for mammals (EPA 2005). The chromium ESLs are based on toxicity of hexavalent chromium, which is likely to represent only a small fraction of the total chromium detected in soils. The mammalian ESLs for trivalent chromium are considerably greater than the hexavalent chromium ESLs. This indicates that the ESL based on hexavalent chromium may be overly conservative for use in assessing risk to plants and wildlife.

A chromium source was not identified in the WAEU, indicating that chromium concentrations are due to local variations. It is unlikely that chromium poses a risk potential to non-PMJM receptors in the WAEU.

4.4.6 Conclusion

Based on process knowledge, chromium may be present in RFETS soil as a result of historical site-related activities. However, the weight of evidence presented above shows that chromium concentrations in WAEU surface soil (non-PMJM receptors) appear to suggest a single data population indicative of naturally occurring chromium; are well within regional background levels; and are unlikely to result in risk concerns for wildlife populations. Chromium is not considered an ECOPC in surface soil for the WAEU and, therefore, is not further evaluated quantitatively.

4.5 Lithium

Lithium had an upper-bound EPC in surface soil (for non-PMJM receptors) greater than the tESL so was carried forward to the professional judgment step. The lines of evidence used to determine if lithium should be retained as an ECOPC are summarized below.

4.5.1 Summary of Process Knowledge

Based on process knowledge as detailed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the potential for lithium to be an ECOPC in the WAEU is low due to localized documented historical source areas remote from the WAEU. Based on process knowledge, lithium is unlikely to be a site-related contaminant.

4.5.2 Evaluation of Spatial Trends

Surface Soil (non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that lithium concentrations in WAEU surface soil reflect variations in naturally occurring lithium.

4.5.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log-transformed data set for lithium (Figure A3.4.6) suggests a single background population indicative of background conditions. However, 10 sampling locations represent a limited data set for a conclusive definition of the full range of a background population.

4.5.4 Comparison to RFETS Background and Other Background Data Sets

Lithium was detected in 100 percent of the 10 surface soil samples collected at the WAEU in a range from 5.70 to 12.00 mg/kg, with a mean concentration of 9.28 and a standard deviation of 1.74 mg/kg. Background concentrations of lithium range from 4.8 to 11.6 mg/kg, with a mean of 7.66 mg/kg and a standard deviation of 1.89 mg/kg (Table A3.2.4).

The reported range for lithium in surface soils within Colorado and the bordering states is 5 to 130 mg/kg, with an arithmetic mean of 25.3 mg/kg and a standard deviation of 14.4 mg/kg (Table A3.4.1). Lithium concentrations reported in surface soil samples at the WAEU are well within this range.

4.5.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The lithium MDC (12.0 mg/kg) exceeds the NOAEL ESL for only one receptor, terrestrial plants (2.0 mg/kg), which is lower than the minimum detection of lithium in background surface soil (4.80 mg/kg). None of the NOAEL ESLs for mammalian receptors are exceeded by the MDC. NOAEL ESLs were not available for avian receptors due to lack of toxicity information. The authors of the document from which the lithium NOAEL ESL was selected (Efroymson et al. 1997) placed a low confidence rating on the value. Other studies reported in Efroymson et al. (1997) cited no observed adverse effects at 25 mg/kg, which is greater than the MDC. Lithium concentrations in WAEU surface soil have the same range as the background concentrations and are most likely due to local variations in natural sources and are below available ESLs for vertebrate receptors. The ESL for terrestrial plants is lower than all detected background concentrations. Because risks to ecological receptors are not expected at background concentrations, the terrestrial plant ESL may be overly conservative.

4.5.6 Conclusion

Process knowledge indicates lithium may be present in RFETS soil as a result of historical site-related activities. However, the weight of evidence presented above shows that lithium concentrations in WAEU surface soil (non-PMJM receptors) have a spatial distribution and single data population indicative of naturally occurring lithium; are well within regional background levels; and are unlikely to result in risk concerns for wildlife populations. Lithium is not considered an ECOPC in surface soil for the WAEU and, therefore, is not further evaluated quantitatively.

4.6 Thallium

Thallium has an EPC in surface soil (for non-PMJM receptors) greater than the tESL and, therefore, was carried forward to the professional judgment step. The lines of evidence used to determine if thallium should be retained for risk characterization are summarized below.

4.6.1 Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates thallium is unlikely to be present in RFETS soil as a result of historical site-related activities.

4.6.2 Evaluation of Spatial Trends

Surface Soil (non-PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that thallium concentrations in WAEU surface soil reflect variations in naturally occurring thallium.

4.6.3 Pattern Recognition

Surface Soil (Non-PMJM)

Thallium was detected in only one of the 10 samples (at sample location 040732-001) collected within WAEU, this at a concentration of 1.30 mg/kg. All other nine locations were nondetects. Because there was only one detected concentration within the WAEU, it was not possible to use a probability plot to evaluate a background concentration range.

4.6.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Thallium was detected in only 10 percent (one) of the 10 surface soil samples collected at the WAEU. The thallium concentration of this single detected sample was 1.30 mg/kg, with a mean concentration for the data set of 0.571 and a standard deviation of 0.256 mg/kg. Site-specific background data for thallium were all nondetect and, therefore, a

statistical background comparison could not be made. The reported range for thallium in surface soil of Colorado and bordering states is 2.45 to 20.79 mg/kg (Table A3.4.1). The thallium concentration reported in a single surface soil sample at the WAEU (1.30 mg/kg) is below reported regional ranges.

4.6.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The single detected sample within the WAEU, which is evaluated as the MDC and UTL for thallium in the WAEU (1.30 mg/kg), exceeds the NOAEL ESL for only one receptor group, terrestrial plants (1.0 mg/kg). All other NOAEL ESLs were greater than the MDC and ranged from 7.24 to 1,038.96 mg/kg. Site-specific background data for thallium were not available, but the MDC did not exceed the low end (2.4 mg/kg) of the background range for Colorado and bordering states (Table A3.4.1). This indicates the terrestrial plant NOAEL ESL (1.0 mg/kg) is well below expected background concentrations, and the MDC of 1.30 mg/kg is just above the conservative NOAEL ESL, and is not likely to be indicative of site-related risk to the terrestrial plant community in the WAEU. Because no NOAEL ESLs other than the terrestrial plant NOAEL ESL are exceeded by the MDC, thallium is highly unlikely to present a risk to terrestrial receptor populations in the WAEU.

4.6.6 Conclusion

Although no site-specific background data are available, the weight of evidence presented above shows that thallium concentrations in WAEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; have a spatial distribution indicative of naturally occurring thallium; are well within regional background levels; and are unlikely to result in risk concerns for wildlife populations. Only the lowest ESL for thallium (1.0 mg/kg) was exceeded by the MDC of 1.30 mg/kg. Thallium is not considered an ECOPC in surface soil for the WAEU and, therefore, is not further evaluated quantitatively.

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TABLES

Table A3.2.1
Statistical Distribution and Comparison to Background for WAEU Surface Soil/Surface Sediment

		Statistical Distribution Testing Results								
		Background Dataset			WAEU Dataset (excluding background samples)			Background Comparison Test Results		
Analyte	Units	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Arsenic	**mg/kg**	**73**	**GAMMA**	**91.8**	**10**	**GAMMA**	**100.00**	**WRS**	**7.07E-05**	**Yes**

WRS = Wilcoxon Rank Sum

Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table A3.2.2
Summary Statistics for WAEU Surface Soil/Surface Sediment[a]

		Background					WAEU (excluding background samples)				
Analyte	Units	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Arsenic	mg/kg	73	0.270	9.60	3.42	2.55	10	3.60	22.0	8.48	5.07

[a] Statistics are computed using one-half of the reported values for nondetects.

Table A3.2.3
Statistical Distribution and Comparison to Background for WAEU Surface Soil

		Statistical Distribution Testing Results								
		Background Data Set			WAEU Data Set (excluding background samples)			Background Comparison Test Results		
Analyte	Units	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Aluminum	mg/kg	20	NORMAL	100.0	10	NORMAL	100.00	t-Test_N	0.006	Yes
Arsenic	mg/kg	20	NORMAL	100.0	10	GAMMA	100.00	WRS	0.067	Yes
Boron	mg/kg	N/A	N/A	N/A	10	NORMAL	100.00	N/A	N/A	N/A
Chromium	mg/kg	20	NORMAL	100.0	10	NORMAL	100.00	t-Test_N	0.030	Yes
Copper	mg/kg	20	NONPARAMETRIC	100.0	10	NORMAL	100.00	WRS	0.999	No
Lead	mg/kg	20	NORMAL	100.0	10	NORMAL	100.00	t-Test_N	0.764	No
Lithium	mg/kg	20	NORMAL	100.0	10	NORMAL	100.00	t-Test_N	0.016	Yes
Mercury	mg/kg	20	NONPARAMETRIC	40.0	10	NORMAL	100.00	WRS	1.000	No
Nickel	mg/kg	20	NORMAL	100.0	10	NORMAL	100.00	t-Test_N	0.812	No
Thallium	mg/kg	14	NORMAL	0.0	10	NONPARAMETRIC	10.00	N/A	N/A	N/A
Vanadium	mg/kg	20	NORMAL	100.0	10	NORMAL	100.00	t-Test_N	0.461	No
Zinc	mg/kg	20	NORMAL	100.0	10	NORMAL	100.00	t-Test_N	0.997	No

WRS = Wilcoxon Rank Sum
t-Test_N = Student's t-test using normal data
N/A = Not applicable. Background comparison was not performed because background data were not available or detection frequency of an analyte in EU or background data set is less than 20 percent.
Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table A3.2.4

Summary Statistics for Background and WAEU Surface Soil[a]

		Background					WAEU (excluding background samples)				
Analyte	Units	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Aluminum	mg/kg	20	4,050	17,100	10,203	3,256	10	8,200	18,000	13,520	3,168
Arsenic	mg/kg	20	2.30	9.60	6.09	2.00	10	3.60	22.0	8.48	5.07
Boron	mg/kg	N/A	N/A	N/A	N/A	N/A	10	2.80	7.10	5.11	1.20
Chromium	mg/kg	20	5.50	16.9	11.2	2.78	10	8.10	17.0	13.3	2.65
Copper	mg/kg	20	5.20	16.0	13.0	2.58	10	5.20	13.0	9.77	2.20
Lead	mg/kg	20	8.60	53.3	33.5	10.5	10	9.90	48.0	30.5	11.3
Lithium	mg/kg	20	4.80	11.6	7.66	1.89	10	5.70	12.0	9.28	1.74
Manganese	mg/kg	20	129	357	237	63.9	10	150	320	260	55.8
Mercury	mg/kg	20	0.090	0.120	0.072	0.031	10	0.020	0.030	0.025	0.003
Nickel	mg/kg	20	3.80	14.0	9.60	2.59	10	4.90	11.0	8.79	1.62
Thallium	mg/kg	14	N/A	N/A	0.414	0.015	10	1.30	1.30	0.571	0.256
Vanadium	mg/kg	20	10.8	45.8	27.7	7.68	10	19.0	34.0	28.0	5.06
Zinc	mg/kg	20	21.1	75.9	49.8	12.2	10	21.0	50.0	37.0	9.01

[a] Statistics are computed using one-half of the reported values for nondetects.

N/A = Not applicable.

Table A3.4.1

Summary of Element Concentrations in Colorado and Bordering States Surface Soil[a]

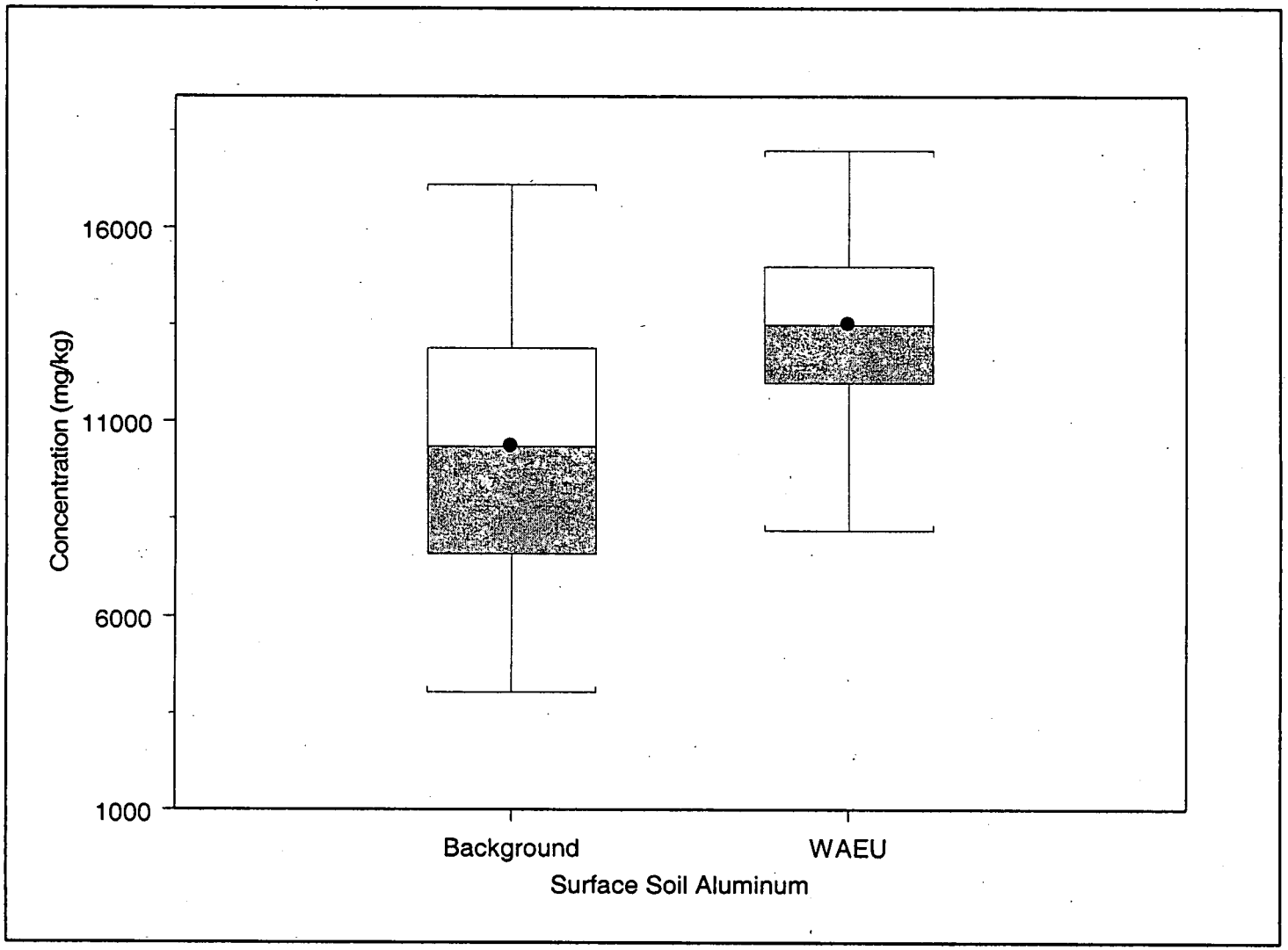
Analyte	Total Number of Results	Detection Frequency (%)	Range of Detected Values (mg/kg)	Average (mg/kg)[b]	Standard Deviation (mg/kg)[b]
Aluminum	303	100%	5,000 - 100,000	50,800	23,500
Antimony	84	15%	1.038 - 2.531	0.647	0.378
Arsenic	307	99%	1.224 - 97	6.9	7.64
Barium	342	100%	100 - 3,000	642	330
Beryllium	342	36%	1 - 7	0.991	0.876
Boron	342	67%	20 - 150	27.9	19.7
Bromine	85	51%	0.5038 - 3.522	0.681	0.599
Calcium	342	100%	0.055 - 32	3.09	4.13
Carbon	85	100%	0.3 - 10	2.18	1.92
Cerium	291	16%	150 - 300	90	38.4
Chromium	342	100%	3 - 500	48.2	41
Cobalt	342	89%	3 - 30	8.09	5.03
Copper	342	100%	2 - 200	23.1	17.7
Fluorine	264	97%	10 - 1,900	394	261
Gallium	340	99%	5 - 50	18.3	8.9
Germanium	85	100%	0.5777 - 2.146	1.18	0.316
Iodine	85	79%	0.516 - 3.487	1.07	0.708
Iron	342	100%	3,000 - 100,000	21,100	13,500
Lanthanum	341	66%	30 - 200	39.8	28.8
Lead	342	93%	10 - 700	24.8	41.5
Lithium	307	100%	5 - 130	25.3	14.4
Magnesium	341	100%	300 - 50,000	8,630	6,400
Manganese	342	100%	70 - 2,000	414	272
Mercury	309	99%	0.01 - 4.6	0.0768	0.276
Molybdenum	340	4%	3 - 7	1.59	0.522
Neodymium	256	23%	70 - 300	47.1	31.7
Nickel	342	96%	5 - 700	18.8	39.8
Niobium	335	63%	10 - 100	11.4	8.68
Phosphorus	249	100%	40 - 4,497	399	397
Potassium	341	100%	1,900 - 63,000	18,900	6,980
Rubidium	85	100%	35 - 140	75.8	25
Scandium	342	85%	5 - 30	8.64	4.69
Selenium	309	81%	0.1023 - 4.3183	0.349	0.415
Silicon	85	100%	149,340 - 413,260	302,000	61,500
Sodium	335	100%	500 - 70,000	10,400	6,260
Strontium	342	100%	10 - 2,000	243	212
Sulfur	85	16%	816 - 47,760	1,250	5,300
Thallium	76	100%	2.45 - 20.79	9.71	3.54
Tin	85	96%	0.117 - 5.001	1.15	0.772
Titanium	342	100%	500 - 7,000	2,290	1,350
Uranium	85	100%	1.11 - 5.98	2.87	0.883
Vanadium	342	100%	7 - 300	73	41.7
Ytterbium	330	99%	1 - 20	3.33	2.06
Yttrium	342	98%	10 - 150	26.9	18.1
Zinc	330	100%	10 - 2,080	72.4	159
Zirconium	342	100%	30 - 1,500	220	157

[a] Based on data from Shacklette and Boerngen 1984 for the states of Colorado, Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming.

[b] One-half the detection limit used as proxy value for nondetects in computation of the mean and standard deviation.

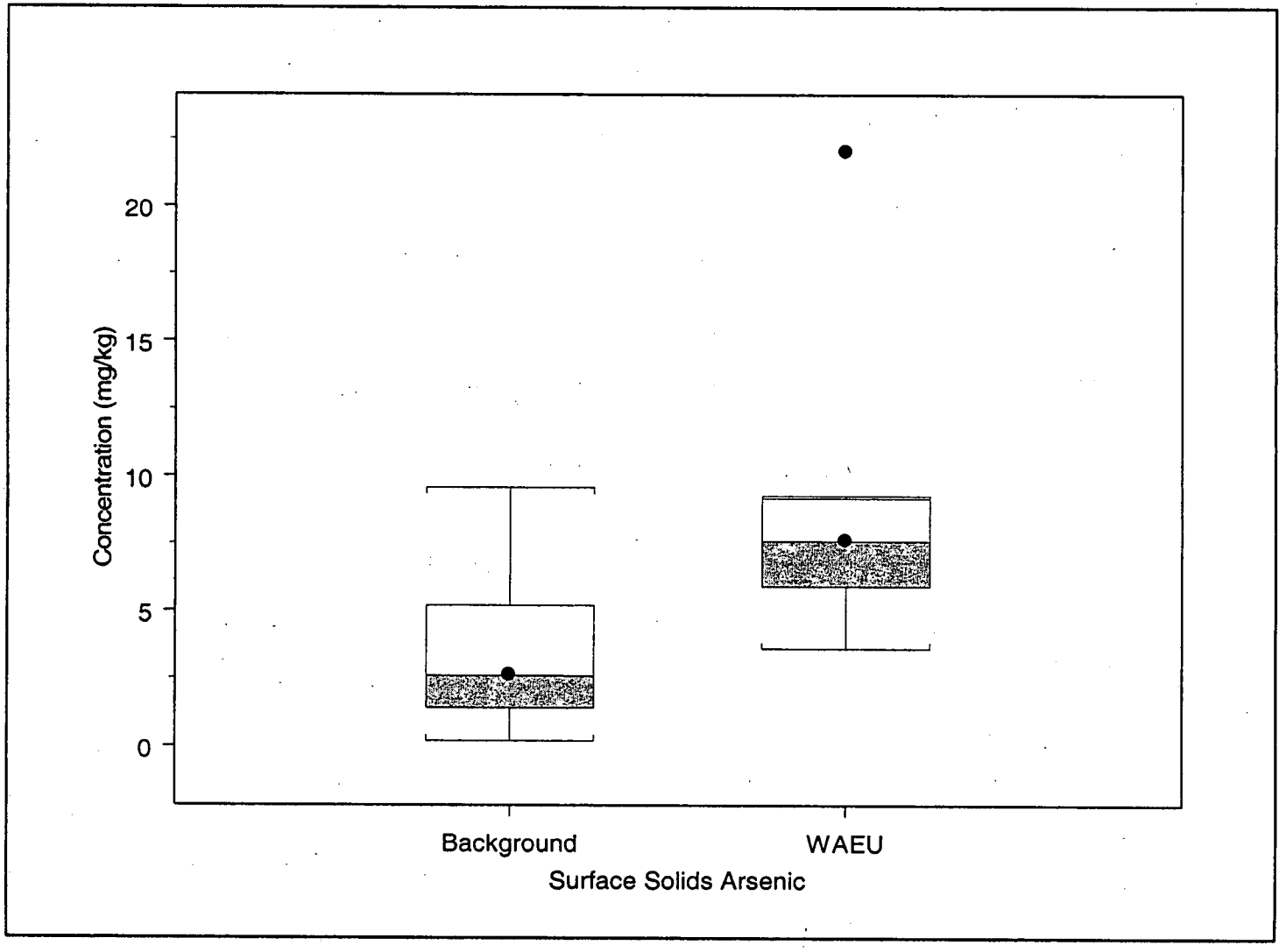
FIGURES

Figure A3.2.1
WAEU Surface Soil Box Plot for Aluminum



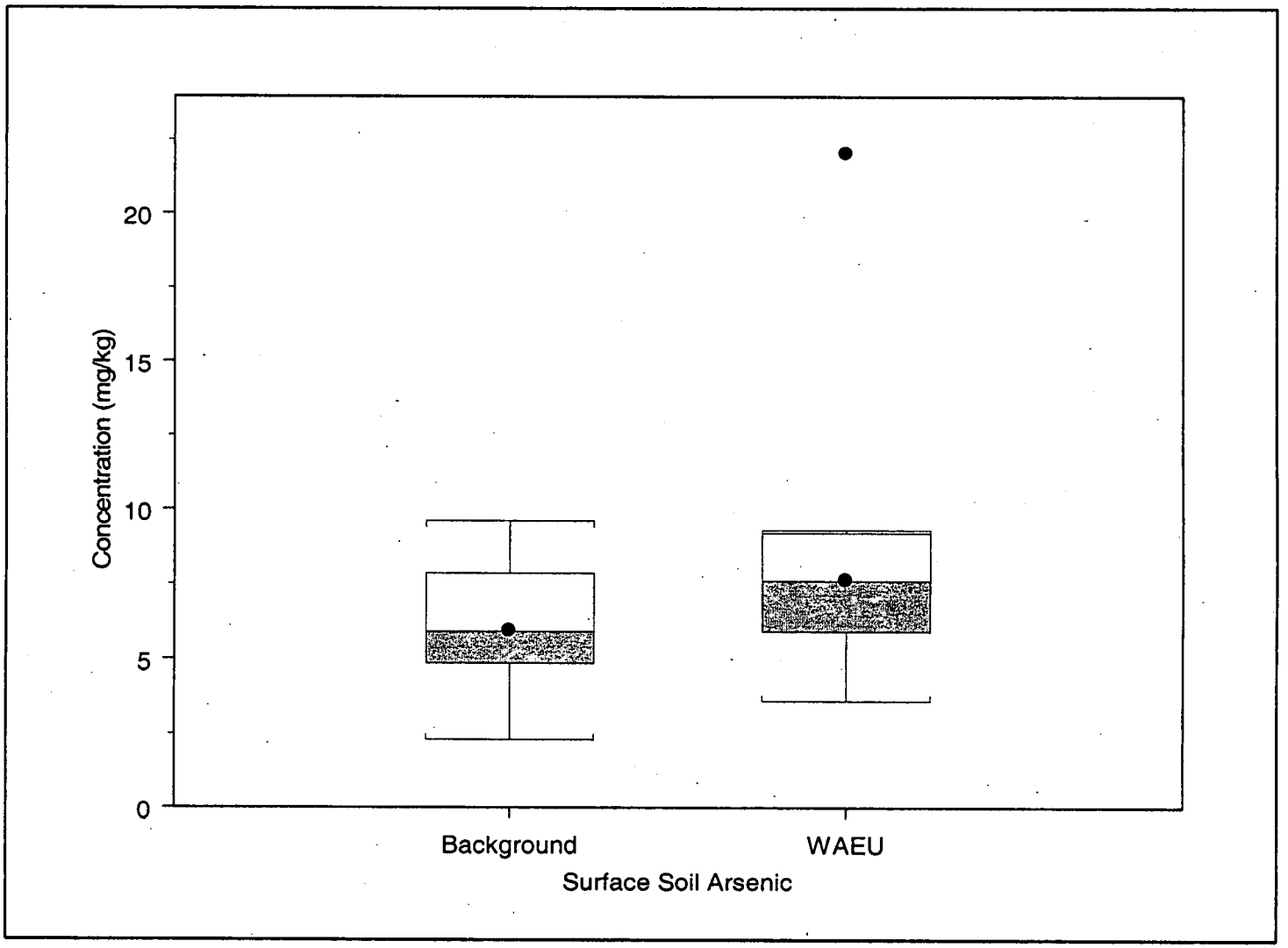
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.2
WAEU Surface Soil/Surface Sediment Box Plot for Arsenic



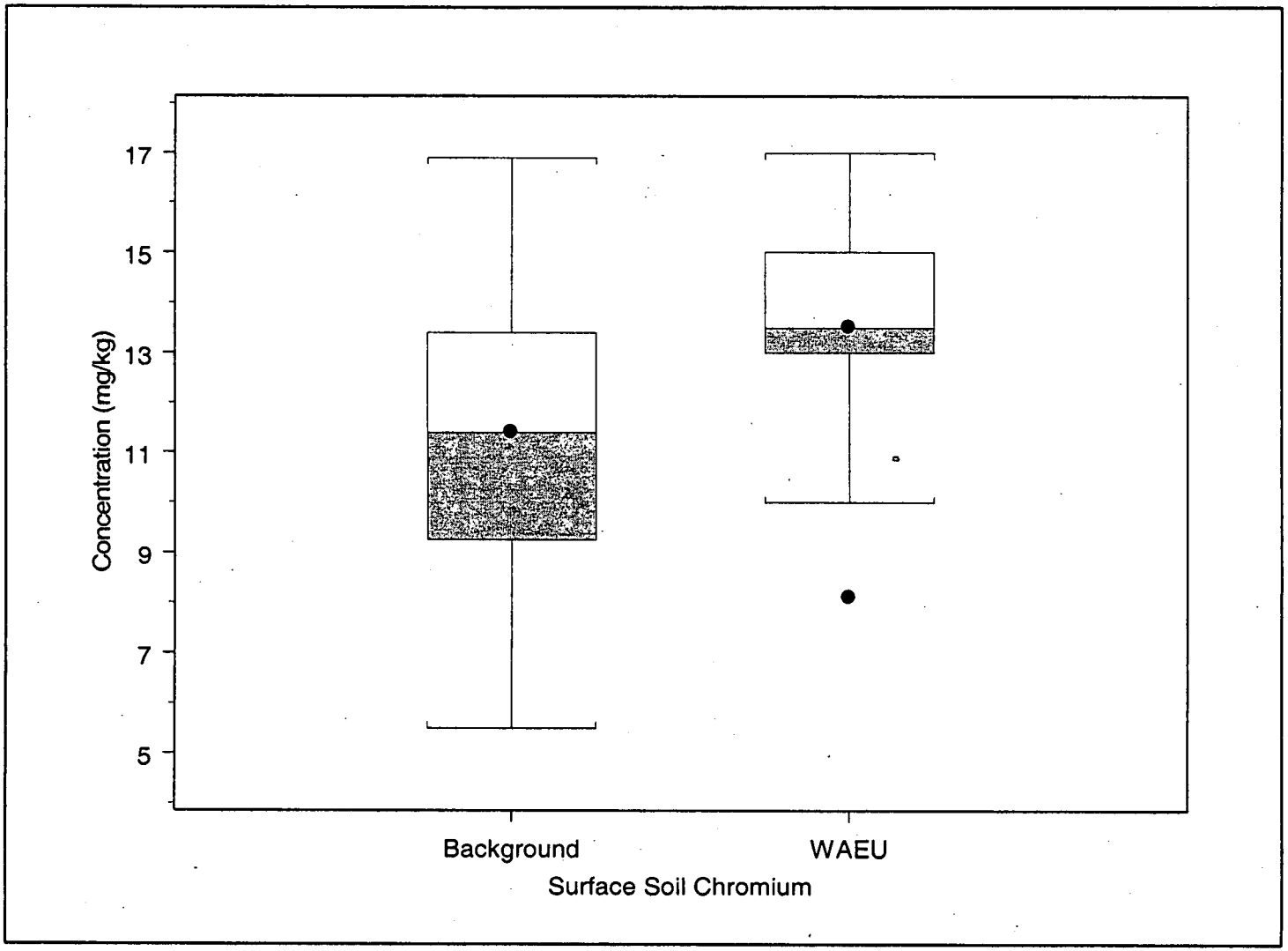
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.3
WAEU Surface Soil Box Plot for Arsenic



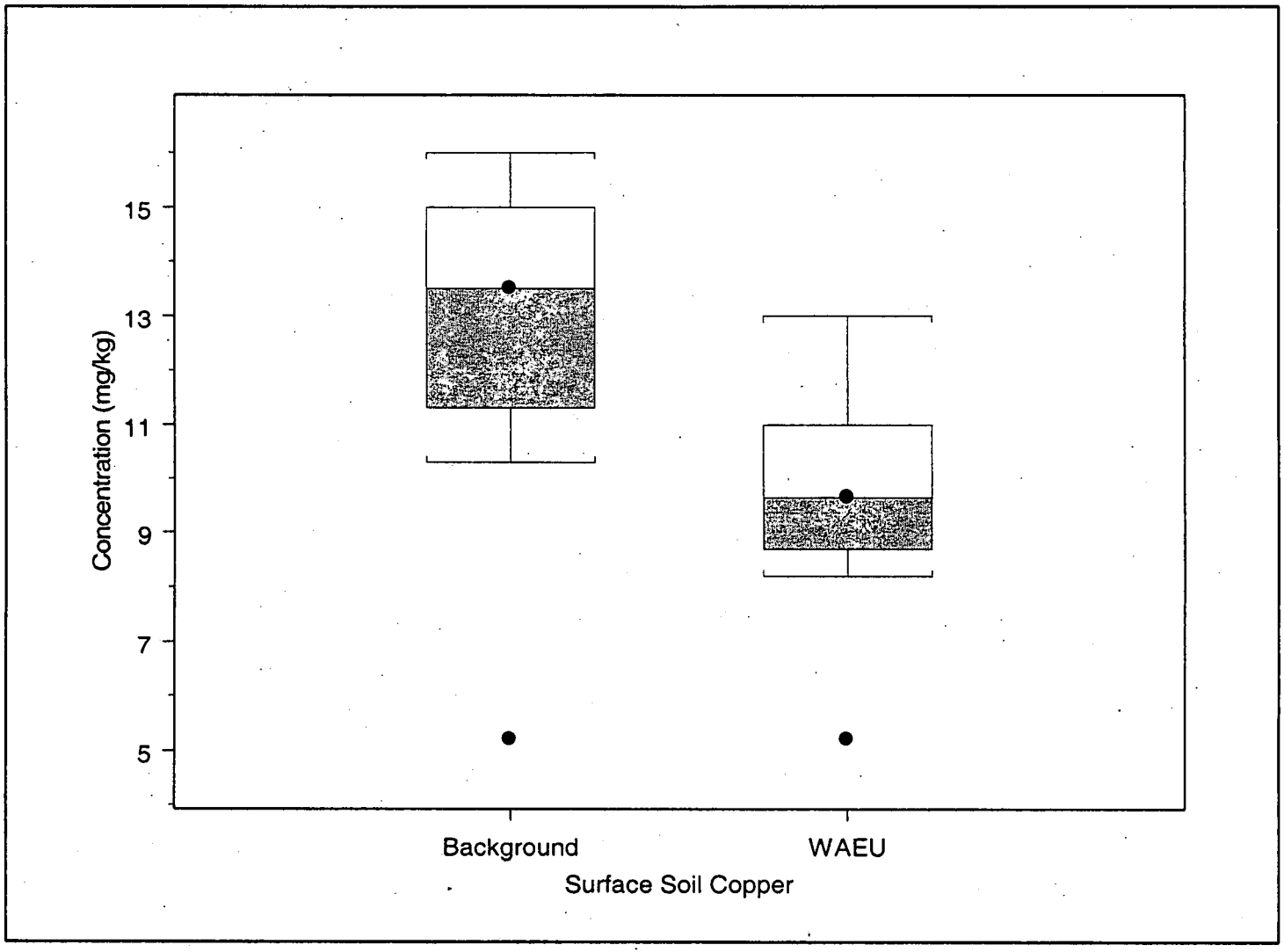
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.4
WAEU Surface Soil Box Plot for Chromium



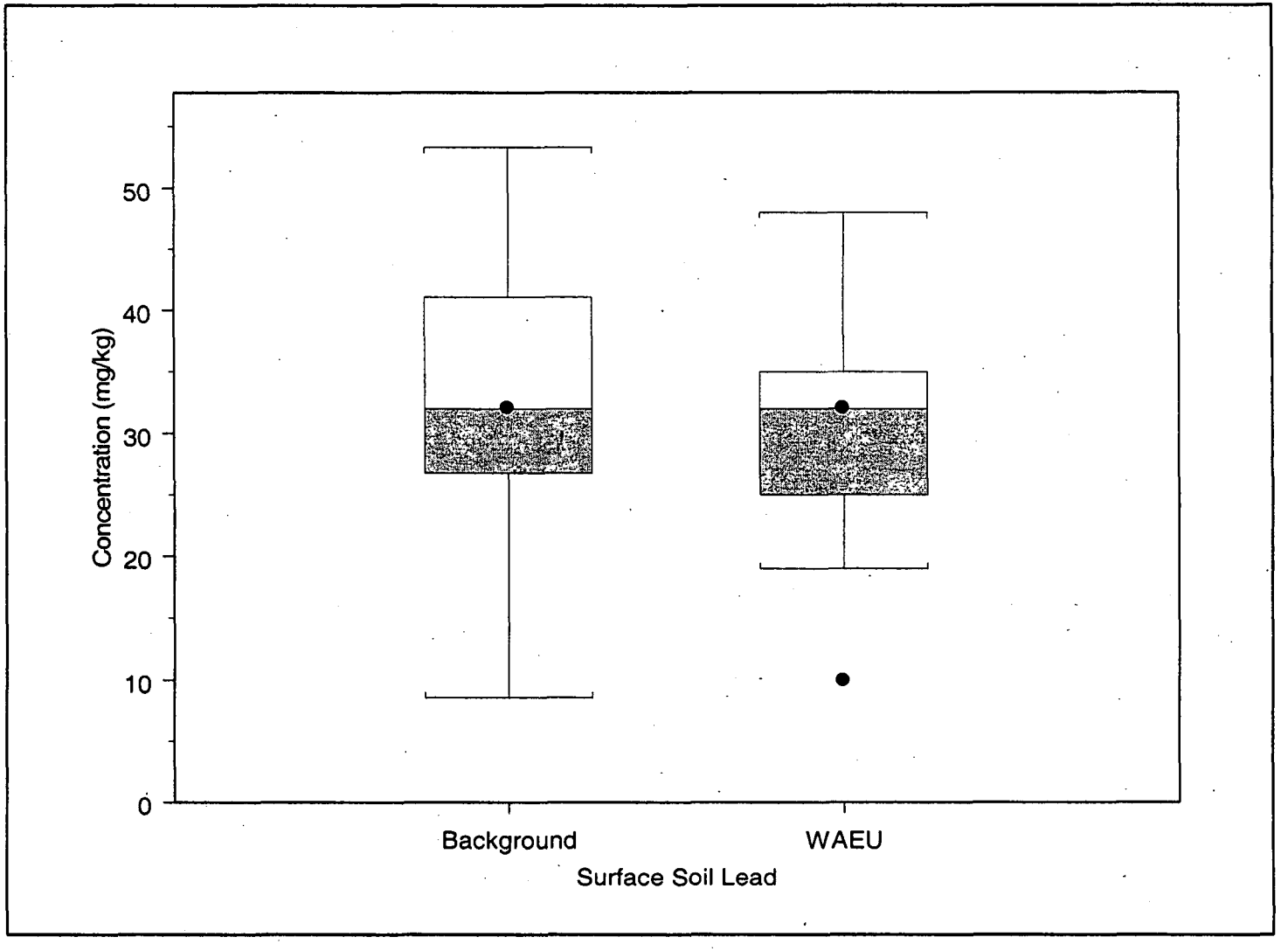
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.5
WAEU Surface Soil Box Plot for Copper



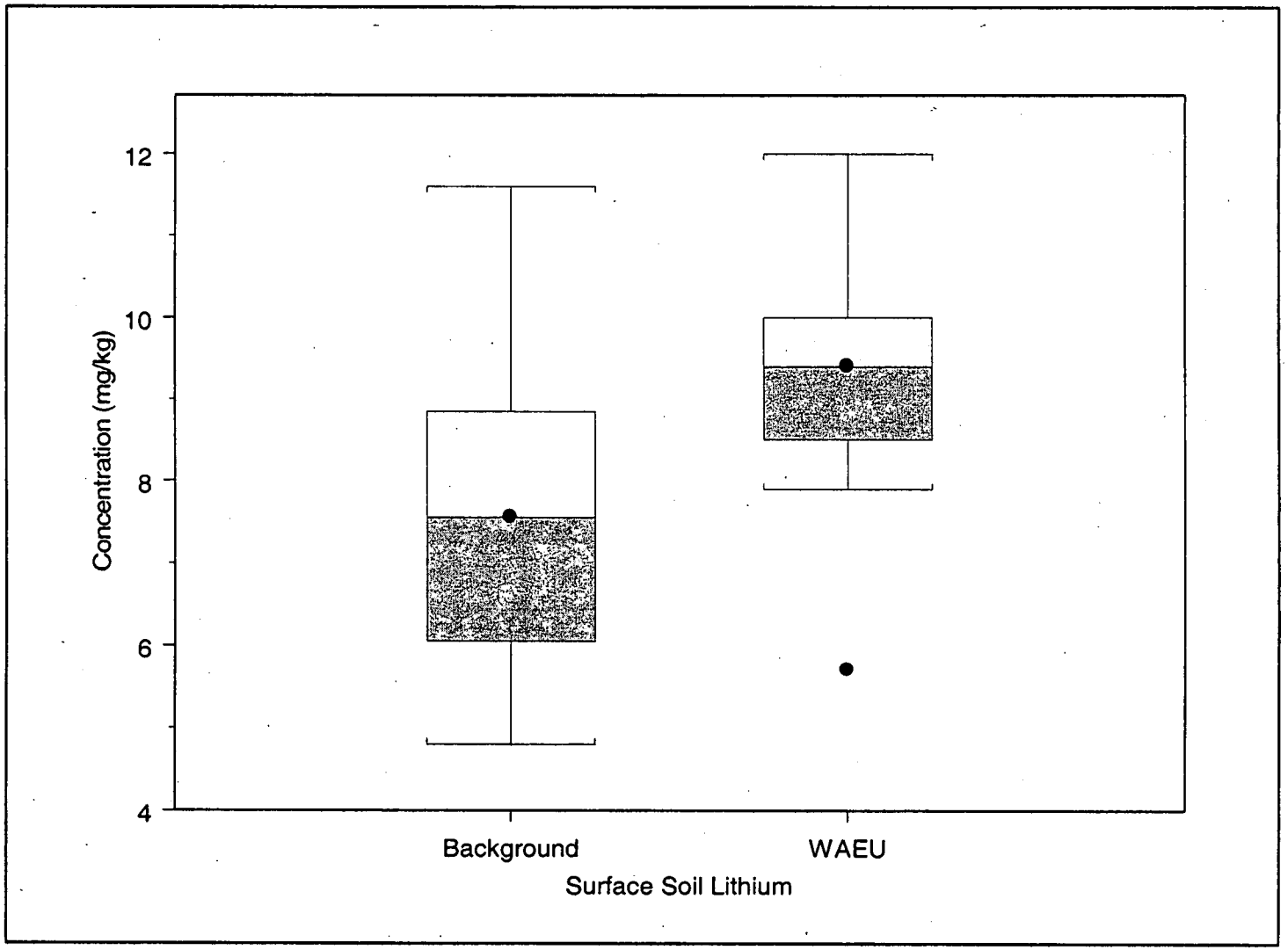
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.6
WAEU Surface Soil Box Plot for Lead



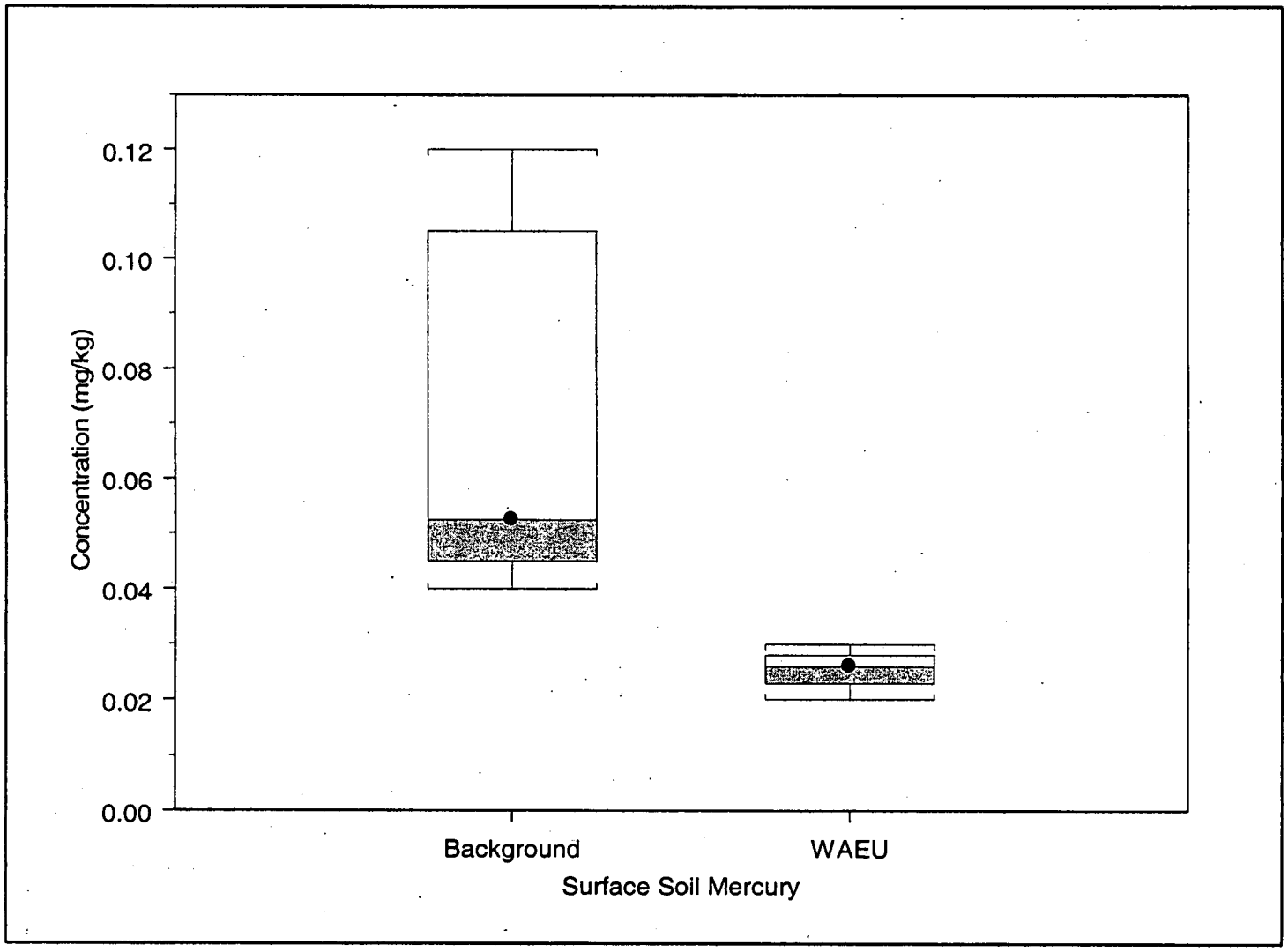
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.7
WAEU Surface Soil Box Plot for Lithium



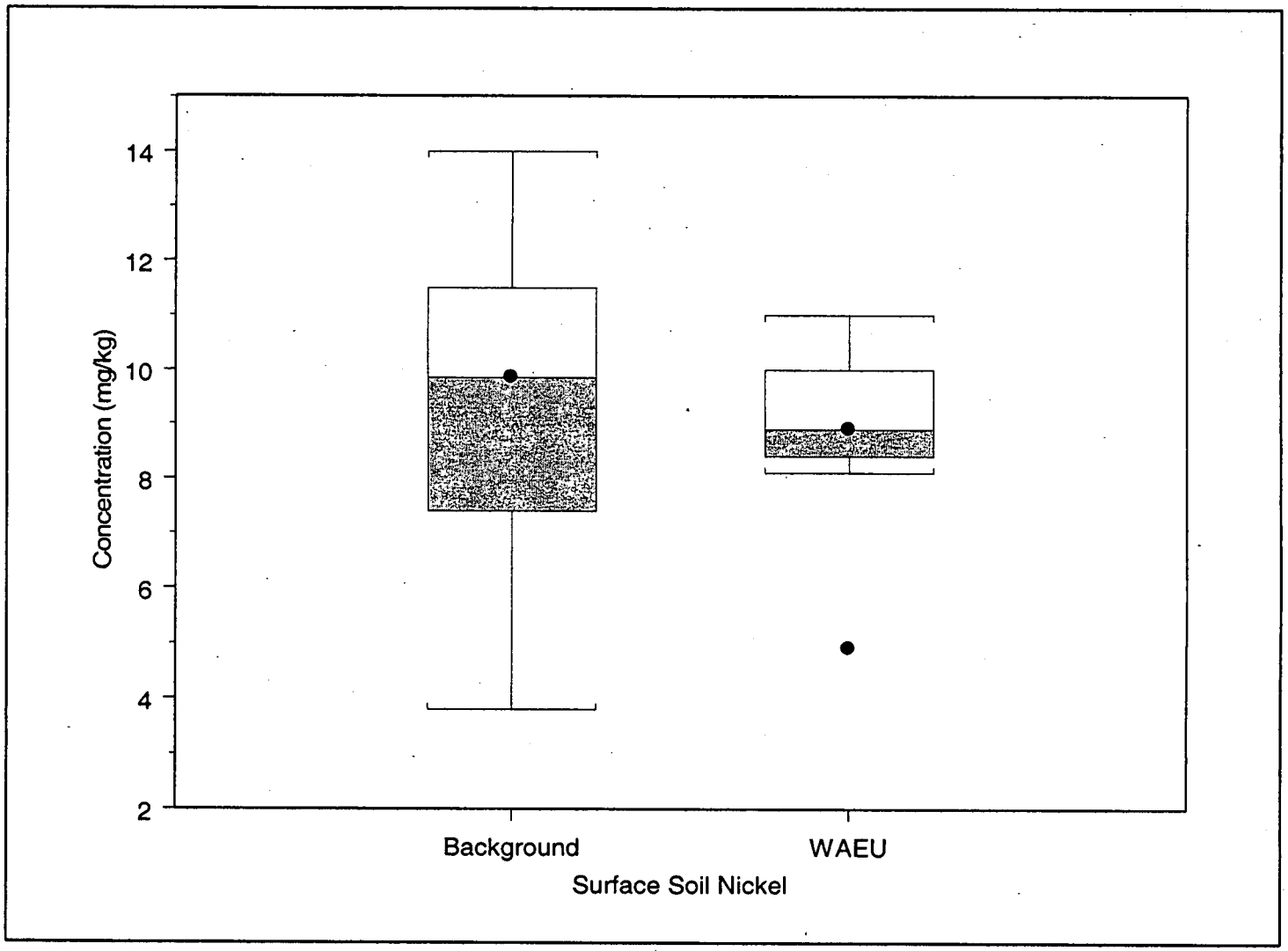
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.8
WAEU Surface Soil Box Plot for Mercury



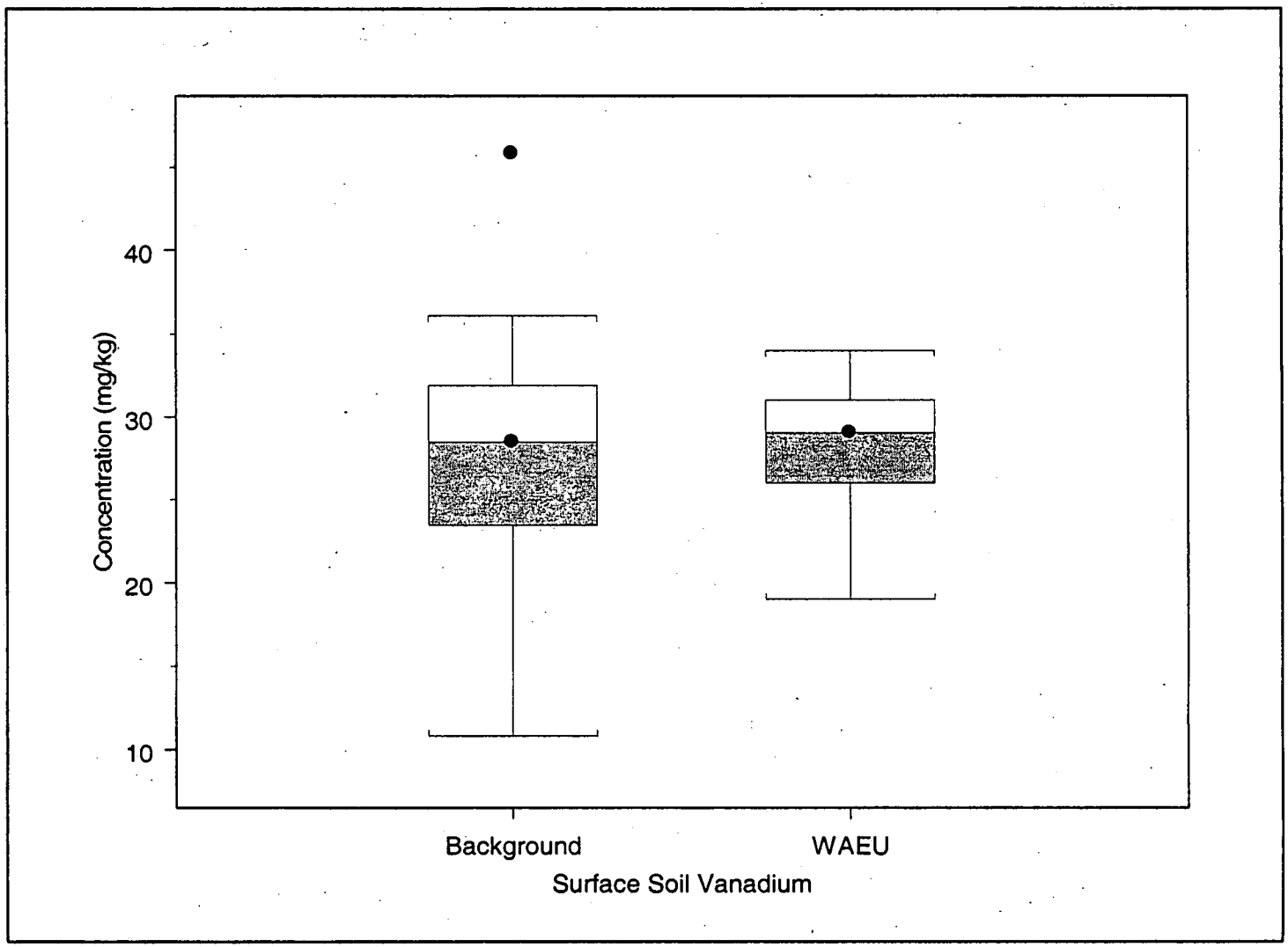
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.9
WAEU Surface Soil Box Plot for Nickel



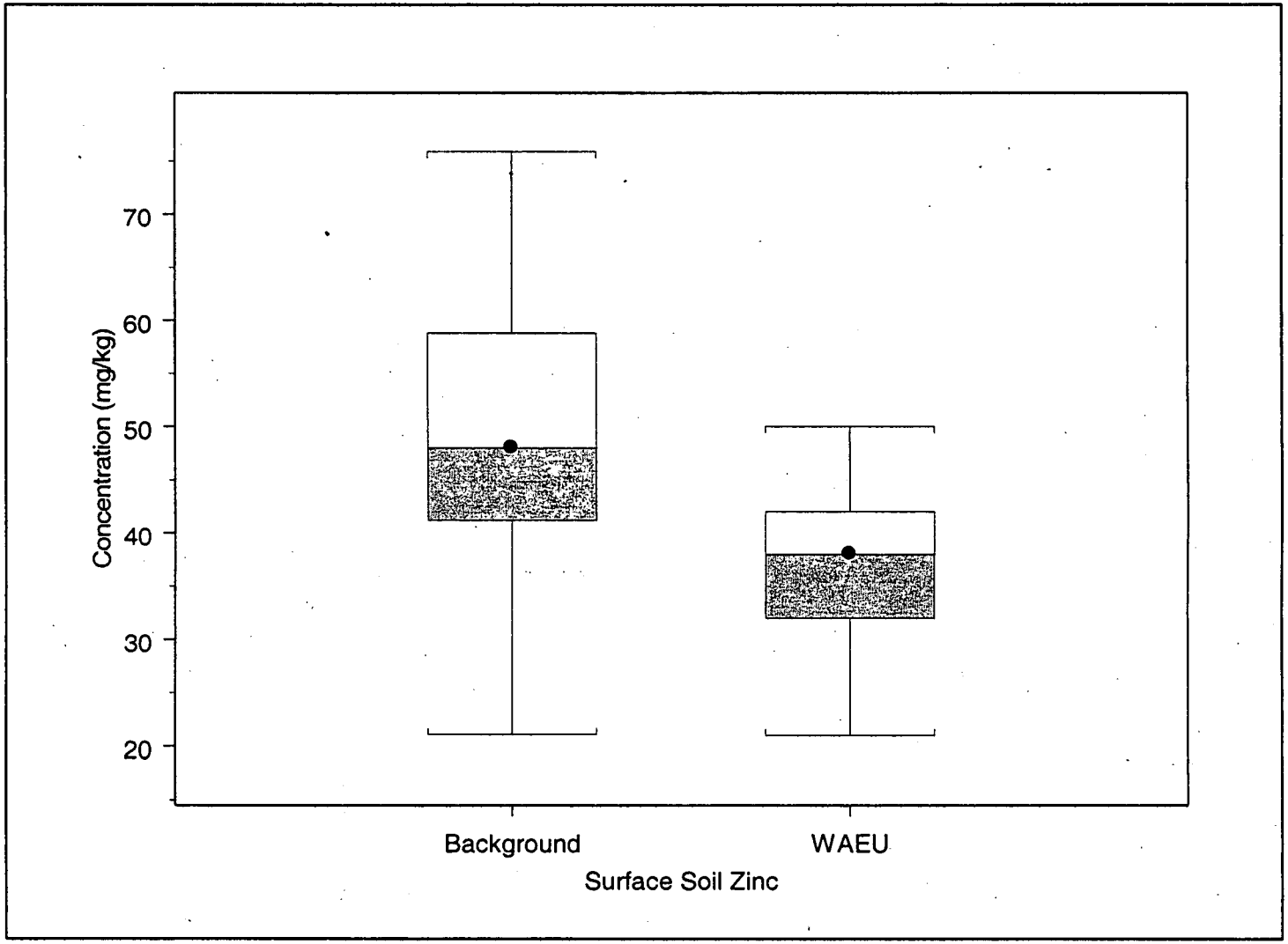
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.10
WAEU Surface Soil Box Plot for Vanadium



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.11
WAEU Surface Soil Box Plot for Zinc



Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

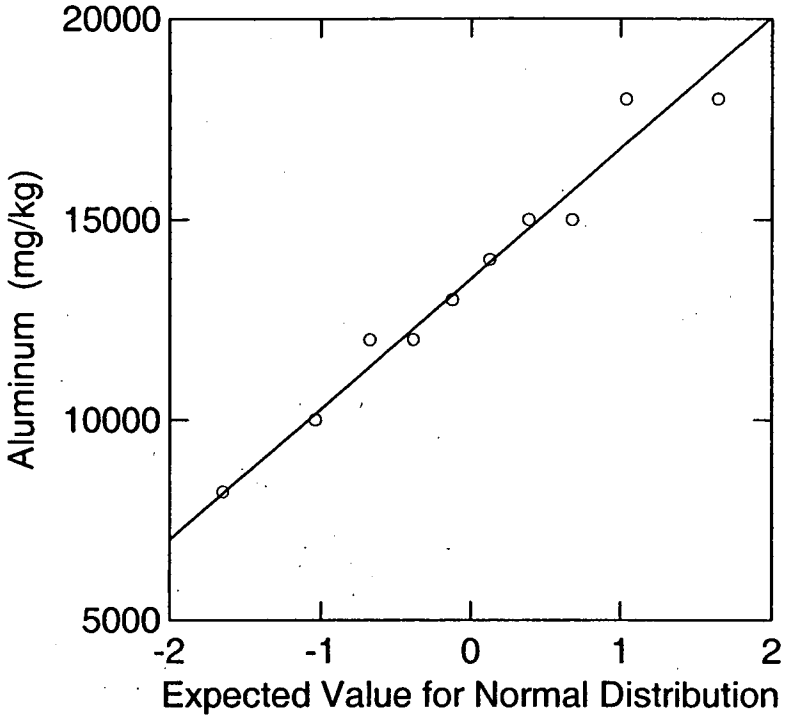


Figure A3.4.1. Probability Plot for Aluminum Concentrations (Natural Logarithm) in WAEU Surface Soil

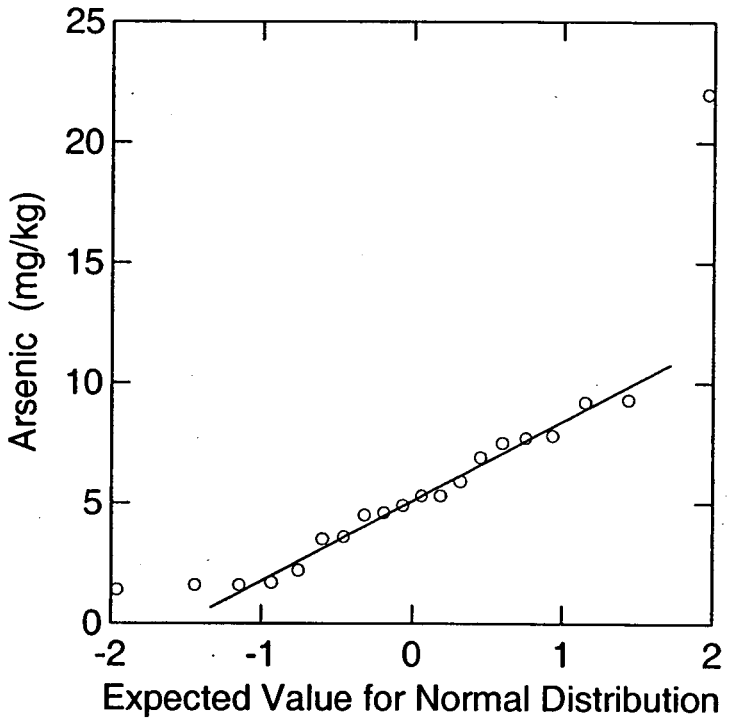


Figure A3.4.2. **Probability Plot for Arsenic Concentrations (Natural Logarithm) in WAEU Surface Soil/Surface Sediment**

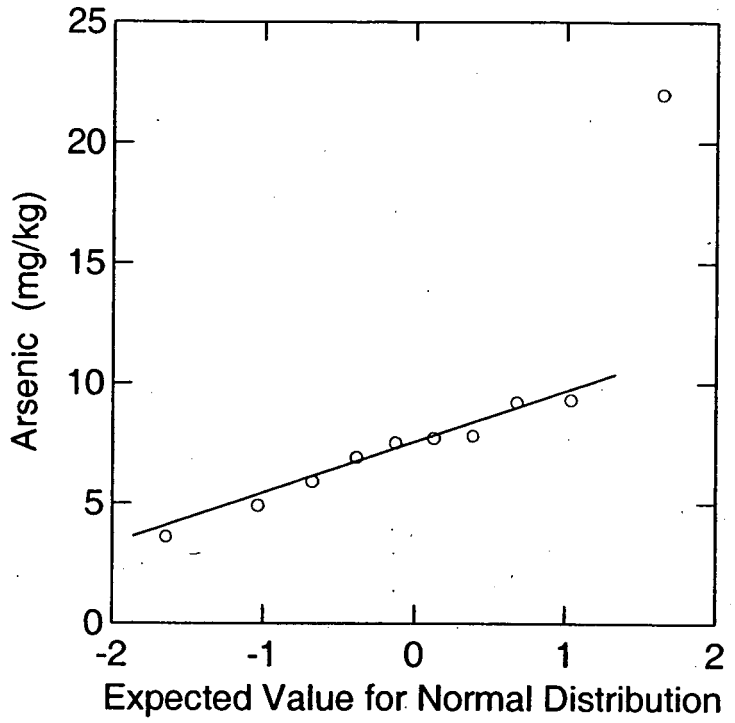


Figure A3.4.3. **Probability Plot for Arsenic Concentrations (Natural Logarithm) in WAEU Surface Soil**

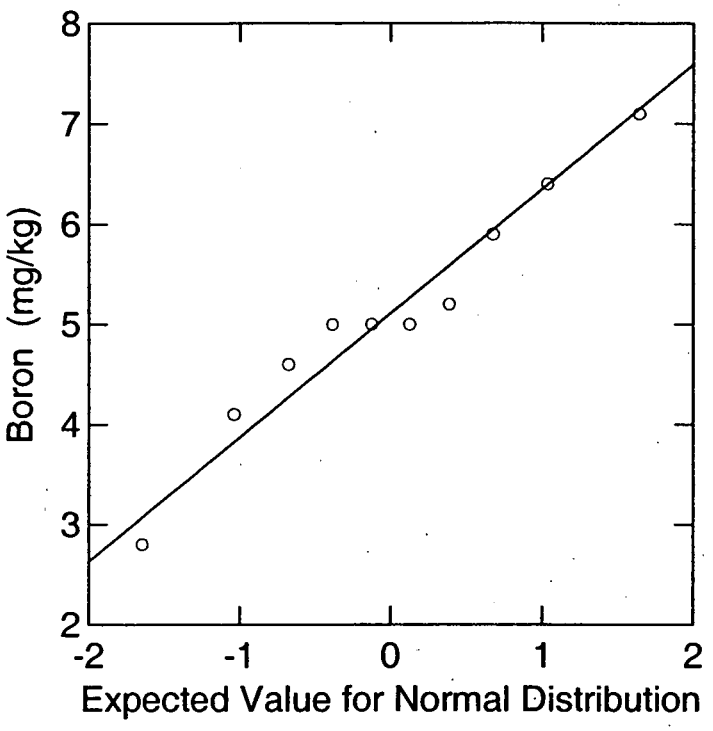


Figure A3.4.4. Probability Plot for Boron Concentrations (Natural Logarithm) in WAEU Surface Soil

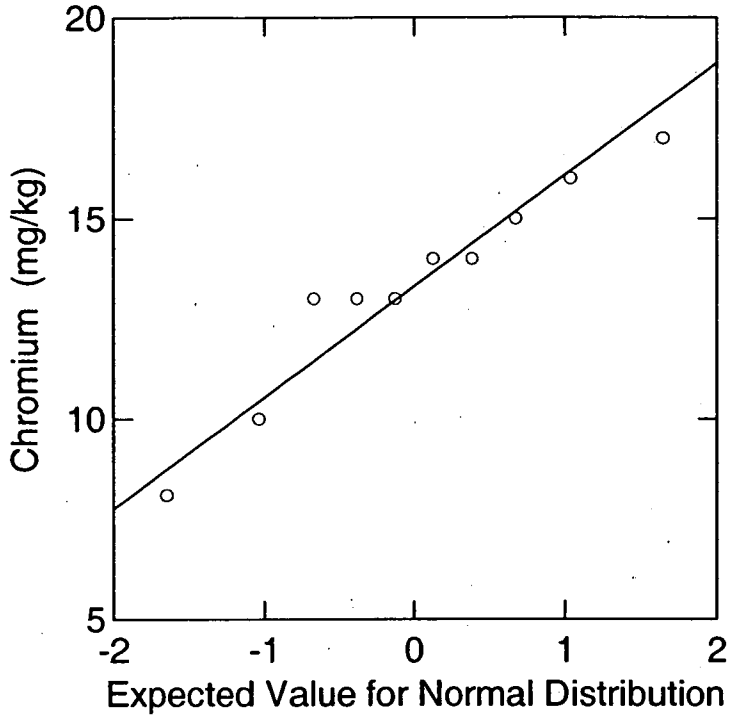


Figure A3.4.5. Probability Plot for Chromium Concentrations (Natural Logarithm) in WAEU Surface Soil

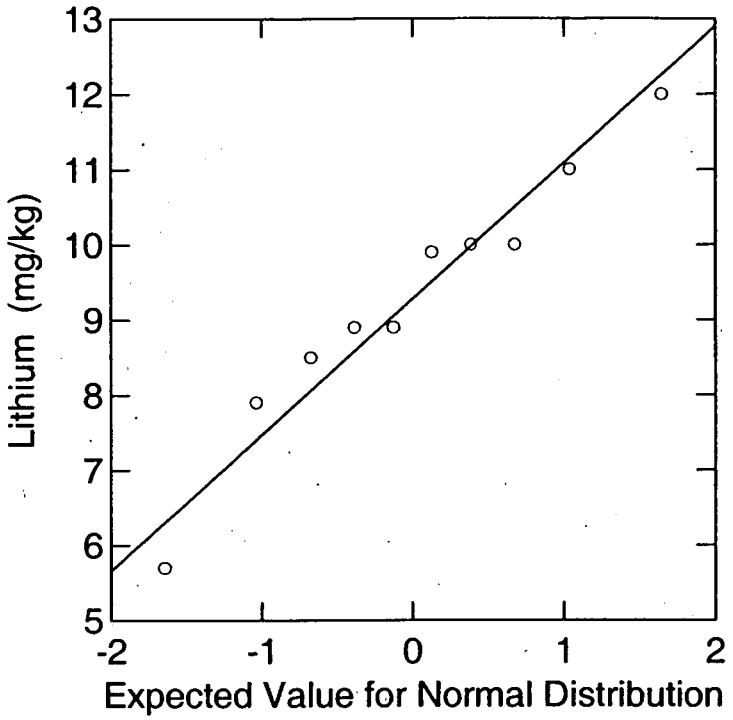


Figure A3.4.6. Probability Plot for Lithium Concentrations (Natural Logarithm) in WAEU Surface Soil

COMPREHENSIVE RISK ASSESSMENT

SOUTHWEST BUFFER ZONE AREA EXPOSURE UNIT

VOLUME 12: ATTACHMENT 4

CRA Analytical Data Set CD