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

Volume 12 of 15
Risk Assessment for the Southwest Buffer Zone Area Exposure Unit

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ACRONYMS AND ABBREVIATIONS

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
CDPHE	Colorado Department of Public Health and Environment
CMS	Corrective Measures Study
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
IHSS	Individual Hazardous Substance Site
kg	kilogram
LOAEL	lowest observed adverse effect level
LOEC	lowest effects concentration
MDC	maximum detected concentration
mg	milligram
mg/day	milligram per day
mg/kg	milligram per kilogram
mg/l	milligram per liter
mL	milliliter
msl	mean sea level
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
PCB	polychlorinated biphenyl
pCi	picocurie
pCi/g	picocuries per gram
pCi/L	picocuries per liter
PCOC	potential contaminant of concern
PMJM	Preble's meadow jumping mouse
PRG	preliminary remediation goal

QAPjP	Quality Assurance Project Plan
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
RFI	RCRA Facility Investigation
RI/FS	Remedial Investigation/Feasibility Study
SAP	Sampling and Analysis Plan
SCM	Site Conceptual Model
SEEU	Southeast Buffer Zone Area Exposure Unit
SWEU	Southwest Buffer Zone Area Exposure Unit
tESL	threshold ESL
TRV	toxicity reference value
UBC	Under Building Contamination
UCL	upper confidence limit
UL	upper limit (daily intake)
UT	uncertain toxicity
UTL	upper tolerance limit
UWOEU	Upper Woman Drainage Exposure Unit
VOC	volatile organic compound
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 476-acre Southwest Buffer Zone Area Exposure Unit (EU) (SWEU) at the Rocky Flats Environmental Technology Site (RFETS). The purpose of this report is to assess 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 SWEU 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 SWEU. 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 the ERA, no ECOPCs in surface soil were identified for non-Preble's jumping mouse (PMJM) or PMJM receptors and no ECOPCs in subsurface soil were identified for burrowing receptors. The ECOPC identification process constitutes a screening level risk assessment. Because this process did not identify any ECOPCs in the SWEU, risks to ecological receptors from site-related contaminants are likely to be negligible in this EU.

1.0 SOUTHWEST BUFFER ZONE 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 Southwest Buffer Zone Area Exposure Unit (EU) (SWEU) at the 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, including the Preble's meadow jumping mouse (PMJM), a federally listed threatened species present at the RFETS.

1.1 Southwest Buffer Zone Area Exposure Unit Description

This section provides a brief description of the SWEU, 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 1992) 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 1991) and the 1996 Rocky Flats Cleanup Agreement (RFCA 1996), 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 SWEU is located within the Buffer Zone (BZ) OU, south of the Industrial Area (IA) that was used for RFETS operations (Figure 1.1). A small portion of the PAC Roadway Spraying (PAC 000-501) is the only IHSS within the SWEU (Table 1.1 and Figure 1.2) and was one of 79 IHSSs/PACs proposed for No Further Action (NFA) by the NFA Working Group in 1991. The NFA was approved in 2002 (EPA et al. 2002) and is documented in the 2002 HRR Update (DOE 2002).

1.1.1 Exposure Unit Characteristics and Location

The 476-acre SWEU is located in the southwestern portion of RFETS (Figure 1.1) and contains several distinguishing features:

- The SWEU is located within the BZ OU and is outside areas that were used historically for operation of the RFETS;
- Sources of contamination are limited within the SWEU boundaries. The EU contains only one PAC, Roadway Spraying (PAC 000-501), which is upwind[1] and is hydraulically isolated relative to the major contaminant release locations in the IA and elsewhere at RFETS; and
- Most of the surface water flow in the SWEU is through Smart Ditch, an irrigation ditch that receives no runoff from the IA.

The SWEU is bounded by the Upper Woman Drainage EU (UWOEU) to the north and the Southeast Buffer Zone Area EU (SEEU) to the east (Figure 1.1). Land west of the SWEU, outside of the RFETS property boundary, is owned by the State of Colorado and includes Rocky Flats Lake. Land south of the SWEU (outside the RFETS boundary) is privately owned and used for horse operations, small hay fields, and cattle grazing.

1.1.2 Topography and Surface Water Hydrology

The SWEU is within the southwestern most portion of the Woman Creek drainage basin at RFETS. The western half of the SWEU is characterized by a broad, gentle, easterly-sloping plain, while the eastern half is characterized by incised drainages (Figure 1.2). Several ephemeral streams (draws) are present in these drainages, but most of the flow through the EU is conveyed by Smart Ditch (Figure 1.2), which is privately owned and operated. Smart Ditch and the draws in the SWEU receive no runoff from the former IA.

[1] Winds, though variable, are predominately from the northwest quadrant. Therefore, the SWEU is in a predominantly upwind direction.

Elevations range from 5,850 feet mean sea level (msl) at the southeastern corner of the SWEU to 6,130 feet msl at the southwestern corner of the SWEU.

Smart Ditch fills two ponds (D-1 and D-2) in the SEEU that are used for irrigation. Water from Rocky Flats Lake, located off-site west of the SWEU, flows through Smart Ditch for approximately 2.5 miles before reaching a splitter box in the SEEU that diverts water to the southeast away from the main channel of Woman Creek (Figure 1.1). Overland runoff is also intercepted and conveyed by Smart Ditch, and high flows can exceed the diversion capacity of the splitter box and flow into Woman Creek.

There are no prominent surface disturbance features in the SWEU (Figure 1.3).

1.1.3 Flora and Fauna

A vegetation map for the SWEU is shown on Figure 1.4. Vegetation in the SWEU is predominantly grassland, consisting primarily of xeric tallgrass prairie and mesic mixed grasslands. 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*), and switchgrass (*Panicum virgatum*), the same species that dominate the plant community on the eastern edge of the Great Plains. Xeric grasslands within the EU occur on the gently sloping pediment areas, and mesic mixed grasslands are found on hillsides where drainage ways become more defined. Wet meadows, short marshlands, short upland shrublands, and riparian woodlands are found along Smart Ditch, chiefly in the eastern portion of the EU.

Grasslands are important to wildlife and grassland conditions within the SWEU are generally good, although weeds and introduced grass species have degraded grasslands in some areas (PTI 1997).

Numerous animal species have been observed at RFETS and the more common ones are expected to be present in the SWEU. Common large and medium-sized mammals likely to live at or frequent the SWEU include the mule deer (*Odocoileus hemionus*), coyote (*Canis latrans*), raccoon (*Procyon lotor*), and desert cottontail (*Sylvilagus audubonii*). The most common reptile observed at RFETS is the western prairie rattlesnake (*Crotalis viridus*). Common bird species include the meadow lark (*Sturnella neglecta*), vesper sparrow (*Pooecetes gramineus*), and grasshopper sparrow (*Ammodramus savannarum*). The most common small mammal species include deer mice (*Peromyscus maniculatus*), prairie voles (*Microtus ochrogaster*), and two different species of harvest mice (*Reithrodontomys sp.*).

More information on the plant communities and animal species that exist within RFETS is provided in Section 2.0 of the RI/FS Report.

1.1.4 Preble's Meadow Jumping Mouse Habitat within Southwest Buffer Zone Exposure Unit

The SWEU supports habitat for the federally protected PMJM (*Zapus hudsonius preblei*). The preferred habitat for the PMJM is the riparian corridors bordering streams, ponds,

and wetlands at RFETS, with an adjacent thin band of upland grasslands. PMJM habitat occurs along Smart Ditch in the northeastern portion of the SWEU (Figure 1.5). Only two captures of PMJM have occurred within Smart Ditch; once on May 5, 1993, and again on August 22, 2001 (2002). These two dates mark the only days during which trapping was conducted. The lack of continuously running water along Smart Ditch is undoubtedly a limiting factor to PMJM abundance.

Sitewide PMJM habitat patches were developed in an effort to characterize habitat discontinuity and provide indications of varying habitat quality. PMJM patches within the SWEU are presented in Figure 1.5. Patches that cross over into the SEEU are considered part of SWEU (Patch #29A). PMJM patches aid in the evaluation of surface soil within PMJM habitat, giving a spatial understanding of areas that may be used by individual or subpopulations of PMJM. More detail on the methodology of creating sitewide PMJM habitat patches can be found in Appendix A, Volume 2, Section 3.2 of the RI/FS Report.

PMJM habitat within the SWEU was divided into two habitat patches, each containing habitat capable of supporting at least one PMJM. The patches vary in size and shape dependent on their location within the Smart Ditch drainage and discontinuity or habitat quality of surrounding patches. The following is a brief discussion of the two patches within the SWEU (Figure 1.5) and the reasons each is considered distinct:

- **Patch #29A and #29B** – This patch is a combination of habitat along Smart Ditch (29A) and a small tributary to the south (29B). Supporting wetlands bridge the gap between the two habitat areas (USFWS 2004) and this hydrological connection provides the basis for considering these areas as a single unit. As previously discussed, PMJM have been captured within this patch. The upper boundary for this patch corresponds to the extent of habitat mapped previously (USFWS 2004), while the lower limit extends into the SEEU and corresponds to the point where contiguous riparian shrubland within this patch gives way to riparian woodlands.

- **Patch #30** – This patch contains a series of short upland shrub areas and alternating areas of short marsh and tall upland shrubs. It is different from the vegetation found in Smart Ditch but is still considered PMJM habitat (USFWS 2004) due to the presence of shrubs and seeps. The upper and lower boundaries of the patch correspond to the extent of habitat mapped previously (USFWS 2004). No PMJM are known to be present in this patch although it has never been trapped.

1.1.5 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 Colorado Department of Public Health and Environment (CDPHE) guidance. Surface soil, subsurface soil, sediment, surface water, and groundwater samples were collected from the SWEU. Surface soil/surface sediment, subsurface

soil/subsurface sediment, surface soil, and subsurface soil are the media evaluated in the HHRA and ERA (Table 1.2).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 1.3 through 1.7. 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 (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 samples with a starting depth less than or equal to 8 feet below ground surface (bgs) are used in the CRA. Subsurface soil 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 SWEU 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 SWEU HHRA and ERA are used 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.

Surface Soil/Surface Sediment

The combined surface soil/surface sediment data set for SWEU consists of up to 22 samples that were analyzed for inorganics (16 samples) and radionuclides (22 samples) (Table 1.2). No samples were analyzed for organics in SWEU surface soil. A discussion of the uncertainties related to the number of organic analyses in surface soil/surface sediment is presented in Section 6.0. The surface soil/surface sediment 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. The surface soil/surface sediment samples were collected in the SWEU during November 1992, December 1993, September 1994, and March and December 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 and composited 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 SWEU is presented in Table 1.3. Detected analytes included representatives from the inorganic and radionuclide analyte groups. A summary of analytes that were either not detected in, or detected in less than 5 percent of, surface soil/surface sediment sample is presented and discussed in Attachment 1.

Subsurface Soil/Subsurface Sediment

The combined subsurface soil/subsurface sediment data set for SWEU consists of up to three samples analyzed for inorganics, one sample for organics, and one sample for radionuclides (Table 1.2). The data include sediment samples collected from a starting depth less than or equal to 8 feet bgs and an ending depth below 0.5 feet bgs. The sampling locations for subsurface soil and subsurface sediment are shown on Figure 1.7. The samples were collected in the SWEU during January and December 2004.

The data summary for subsurface soil/subsurface sediment in the SWEU is presented in Table 1.4. Detected analytes included representatives from the inorganic and radionuclide analyte groups. No organic analytes were detected in subsurface soil/subsurface sediment samples within the SWEU. A summary of analytes that were not detected in subsurface soil/subsurface sediment is presented and discussed in Attachment 1.

Surface Soil

The SWEU surface soil samples within PMJM habitat were analyzed for inorganics (four samples) and radionuclides (up to seven samples). The surface soil data set for the SWEU consists of up to 20 samples that were analyzed for inorganics (14 samples) and radionuclides (20 samples) (Table 1.2). No samples were analyzed for organics in the SWEU surface soil. The surface soil sampling locations for the SWEU are shown on Figure 1.6. The samples were collected in the SWEU during November 1992, December 1993, September 1994, and 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 SWEU surface soil is presented in Table 1.5, while the data summary for the detected analytes for those samples within designated PMJM habitat is presented in Table 1.6. Inorganics and radionuclides were detected in SWEU surface soil samples. A summary of analytes that were not detected in surface soil in the SWEU 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 SWEU consists of up to two samples analyzed for inorganics and one sample for organics (Table 1.2). No samples were analyzed for radionuclides in the SWEU subsurface soil. Subsurface soil sample locations are shown on Figure 1.7. The samples were collected in the SWEU during January 2004.

The data summary for detected analytes in subsurface soil for the SWEU is presented in Table 1.7. Inorganics and organics were detected in SWEU subsurface soil samples. A summary of analytes that were not detected in subsurface soil 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, as well as 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 SWEU 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 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 at the SWEU. Results of the COC selection process are summarized below.

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2.1 Contaminant of Concern Selection for Surface Soil/Surface Sediment

Detected PCOCs in surface soil/surface sediment samples (Table 1.3) 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 toxicological 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 values. The PRG screen in Section 2.1.2 includes essential nutrients for which toxicity criteria are 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 mg/day, are less than the DRIs. Therefore, these PCOCs were not evaluated further 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 (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 in surface soil/surface sediment had an MDC and UCL that exceeded the PRG and was retained as a PCOC.

PRGs were not available for all analytes in surface soil/surface sediment. Analytes without PRGs are listed in 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 1.3).

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 SWEU and background) are provided in Attachment 3. Arsenic is statistically greater than background at the 0.1 significance level, and it is evaluated further in the professional judgment section.

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 SWEU is not considered a COC. The weight of evidence supports the conclusion that arsenic concentrations in surface soil/surface sediment in the SWEU 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 1.4) 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 toxicological factors are 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 SWEU are compared to DRIs in Table 2.4. The estimated daily maximum intakes for these PCOCs, based on the nutrient's MDCs and a subsurface soil/subsurface sediment ingestion rate of 100 milligrams (mg) per day (mg/day), are less than the DRIs. Therefore, the 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 MDCs 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 SWEU were retained for further evaluation in the COC selection process.

A PRG is not available for silica in subsurface soil/subsurface sediment (Table 2.5). The effect of this on the conclusions of the risk assessment 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 are 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 are 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 are 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 surface soil/surface sediment and subsurface soil/subsurface sediment at the SWEU.

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 SWEU 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 SWEU 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 SWEU 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 SWEU 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 for the SWEU 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 SWEU.

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 SWEU 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 (DOE 2005a). Although there are some uncertainties associated with the sampling and analyses conducted for surface soil/surface sediment and subsurface soil/subsurface sediment at the SWEU, data are considered adequate for the characterization of risk at the EU. The environmental samples for the SWEU were collected from 1992 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 22 samples in the SWEU. Although there are no data for organics in surface soil/surface sediment, no known or suspected sources for organic contaminants exist in the SWEU. In subsurface soil/subsurface sediment, there are up to three samples in the SWEU.

Another source of uncertainty in the data is the relationship of detection limits to the PRGs for analytes eliminated as COCs because they were not detected or had a low detection frequency (i.e., less than 5 percent). The detection limits were appropriate for the analytical methods used, and this is examined in greater detail in Attachment 1.

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 SWEU 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 SWEU.

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

PCOCs for the SWEU 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 SWEU and the slightly elevated median value of arsenic in the SWEU 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.

Because no PCOCs in subsurface soil/subsurface sediment were statistically greater than background, no PCOCs were eliminated in subsurface soil/subsurface sediment based on professional judgment in the SWEU.

6.4 Uncertainties Evaluation Summary

Evaluation of the uncertainties associated with the data and the COC screening processes indicates there is reasonable confidence in the conclusions of the SWEU 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 SWEU. ECOIs are defined as any chemical detected in the SWEU 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 SWEU 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 plants 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).

7.1 Data Used in the Ecological Risk Assessment

The following SWEU data are used in the CRA:

- Twenty surface soil samples were collected and analyzed for inorganics (14 samples) and radionuclides (20 samples); and
- Two subsurface soil samples were collected and analyzed for inorganics (two samples) and organics (one sample).

A data summary is provided in Table 1.5 for surface soil, Table 1.6 for surface soil in PMJM habitat, and Table 1.7 for subsurface soil.

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

The SWEU has five sample locations occurring in PMJM habitat (Figure 1.5). The PMJM habitat evaluated for the SWEU includes one sample location from PMJM habitat identified as part of the SEEU.

7.2 Identification of Surface Soil Ecological Contaminants of Potential Concern

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

7.2.1 Comparison with No Observed Adverse Effect Level Ecological Screening Levels

In the first step of the ECOPC identification process, the MDCs of 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 "MDC>ESL" 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 (UT) in Section 10.0 along with the potential impacts to the risk assessment.

PMJM Receptors

The NOAEL ESLs for PMJM receptors were compared to the MDCs of ECOIs in surface soil collected from PMJM habitat (Table 7.3). The MDCs in surface soil that exceed the NOAEL ESLs are identified in Table 7.3 with a "Yes" under the column heading "Retained for Further Analysis?"

Analytes for which a PMJM NOAEL ESL is not available are identified with a "N/A" in Table 7.3 under the column heading "MDC > ESL?" These analytes are discussed in the uncertainty section (Section 10.0) as ECOIs with UT.

7.2.2 Surface Soil Frequency of Detection Evaluation

The ECOPC identification process for non-PMJM receptors involves 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. None of the chemicals detected in surface soil at the SWEU that were retained after the NOAEL ESL screening step had a detection frequency less than 5 percent. Therefore, no ECOIs were excluded based on the detection frequency evaluation for surface soil in the SWEU.

7.2.3 Surface Soil Background Comparisons

The ECOIs retained after the NOAEL ESL screening and the detection frequency evaluation were then compared to site-specific background concentrations where available. The background comparisons are presented in Table 7.4 and Table 7.5 and discussed in Attachment 3. The statistical methods used for the background comparison are discussed 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 7.4. The analytes listed as being retained as ECOIs in Table 7.4 are evaluated further using upper-bound exposure point concentrations (EPCs) in the following section.

PMJM Receptors

The background comparisons for PMJM receptors are conducted differently than for non-PMJM receptors because of their protected status. The results of this comparison are based on their location within PMJM habitat and are presented in Table 7.5. Attachment 3 presents further discussion of the PMJM background analysis. The analytes listed as "Yes" on Table 7.5 are further evaluated in the following sections.

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 then compared to threshold ESLs (tESLs) using upper-bound EPCs specific to small and large home-range receptors. The calculation of EPCs is described in Appendix A, Volume 2 of the RI/FS Report.

Statistical concentrations for each ECOI retained for the tESL screen are presented in Table 7.6. The EPC for 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 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 7.7. Analytes that exceed the limiting tESLs are further evaluated by comparing them to the receptor-specific tESLs (if available) to identify receptors of potential concern. Analytes exceeding the limiting tESLs for small home-range receptors are compared to receptor-specific tESLs in Table 7.8, and analytes exceeding limiting tESLs for large home-range receptors are compared to receptor-specific tESLs in Table 7.9.

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.

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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, boron, chromium, lithium, nickel, and vanadium in surface soil at the SWEU were not considered ECOPCs for non-PMJM receptors and are not further evaluated quantitatively.

PMJM Receptors

Based on the weight-of-evidence, professional judgment described in Attachment 3, nickel and vanadium in surface soil at the SWEU were not considered ECOPCs for PMJM receptors and are not further evaluated quantitatively.

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

Inorganic and radionuclide surface soil ECOIs for non-PMJM receptors in the SWEU 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 SWEU surface soils 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. Chemicals that were retained are identified as ECOPCs.

A summary of the ECOPC screening process for non-PMJM receptors is presented in Table 7.10.

PMJM Receptors

ECOIs in surface soil in PMJM habitat located within the SWEU were evaluated in the ECOPC identification process. ECOIs were removed from further evaluation in the ECOPC identification process based on one of the following: 1) the MDC of the ECOI was less than the NOAEL ESL for PMJM; 2) no NOAEL ESLs were available (these ECOIs are discussed in Section 10.0); 3) the ECOI concentrations within the PMJM habitat in SWEU were not statistically greater than those from background surface soils; or 4) the weight-of-evidence, professional judgment evaluation indicated that the ECOI was not a site-related contaminant of potential concern. The results of the ECOPC identification process for the PMJM are summarized in Table 7.11.

7.3 Identification of Subsurface Soil 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 SWEU are identified on Figure 1.6. A data summary for subsurface soil less than 8 feet deep is presented in Table 1.7.

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 subsurface soil 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 7.12). ECOIs with MDCs greater than the NOAEL ESL for the prairie dog are further evaluated in the ECOPC identification process.

NOAEL ESLs are not available for some analytes, and these are identified as "N/A" in Table 7.12. These constituents are considered ECOIs with UT and are discussed in the uncertainty analysis (Section 10.0).

7.3.2 Subsurface Soil Detection Frequency Evaluation

No detection frequency evaluation was performed for subsurface soils because there are no ECOIs with concentrations greater than the NOAEL ESLs.

7.3.3 Subsurface Soil Background Comparison

The subsurface background comparison was not performed for subsurface soils because there are no ECOIs with concentrations greater than the NOAEL ESLs.

7.3.4 Upper-Bound Exposure Point Concentration Comparisons to Threshold ESLs

The exposure point concentration comparison to tESLs was not performed for subsurface soils because there are no ECOIs with concentrations greater than the NOAEL ESLs.

7.3.5 Subsurface Soil Professional Judgment

The professional judgment step was not performed for subsurface soils because there are no ECOIs with concentrations greater than the NOAEL ESLs.

7.3.6 Summary of Subsurface Ecological Contaminants of Potential Concern

All subsurface soil ECOIs for burrowing receptors in the SWEU were eliminated from further consideration as ECOPCs based on one of the following: 1) the MDC of the ECOI was less than the NOAEL ESL for the burrowing receptor; 2) no ESLs were available

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(these ECOIs are discussed in Section 10.0); 3) the concentration of the ECOI in SWEU subsurface soils was not greater than background subsurface soils; or 4) the upper-bound EPC was less than the tESL. The results of the subsurface soil ECOPC identification process for burrowing receptors are summarized in Table 7.13.

7.4 Summary of Ecological Contaminants of Potential Concern

ECOIs in surface and subsurface soil in the SWEU were evaluated in the ECOPC identification process for non-PMJM receptors, PMJM receptors, and burrowing receptors. No chemicals were identified as ECOPCs for non-PMJM receptors (Table 7.10). No chemicals were identified as ECOPCs for the PMJM (Table 7.11). No chemicals were identified as ECOPCs for burrowing receptors (Table 7.13).

8.0 ECOLOGICAL EXPOSURE ASSESSMENT

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

9.0 ECOLOGICAL TOXICITY ASSESSMENT

The ECOPC identification steps did not identify any ECOPCs for either surface or subsurface soil in the SWEU. Therefore, no toxicity assessment for the SWEU 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 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 in the potential for effects on the population of receptors that could inhabit the SWEU.

Only one IHSS exists within the SWEU (Table 1.1 and Figure 1.2) and it has a regulatory agency-approved NFA. This is documented in the Annual Updates to the HRR as noted in Table 1.1. No ECOPCs were identified for any receptor in either surface or subsurface soil in the SWEU. The ECOPC identification process constitutes a screening level risk assessment. Because the process did not identify any ECOPCs, risks to ecological receptors from site-related contaminants are likely to be negligible in the SWEU.

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 SWEU 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 SWEU ERA.

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 SWEU, 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 Southwest Buffer Zone Area Exposure Unit

Several ECOIs detected in the SWEU do not have adequate toxicity data for the derivation of ESLs (CRA Methodology). These ECOIs are listed in Tables 7.1, 7.3, and 7.12 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. Therefore, while the potential for risk from these ECOPCs is uncertain and will tend to underestimate the overall risk calculated, the magnitude of underestimation is likely to be low.

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

Several analytes in surface soil and subsurface soil were eliminated as ECOIs based on professional judgment. The professional judgment evaluation is intended to identify those ECOIs that have a limited potential for contamination in the SWEU. The weight-of-evidence approach indicates that there is no identified source or pattern of release in the SWEU, and the concentrations of these ECOIs are most likely due to natural variation. The magnitude of underestimation of risk due to the professional judgment evaluation is unknown, but the ECOIs eliminated from further consideration are not considered related to site activities in the SWEU and have very low potential to be transported from historical sources to the SWEU.

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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 risk or overestimate risk, many 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 SWEU is presented below.

11.1 Human Health

The COC screening analyses compared MDCs and UCLs of chemicals and radionuclides in SWEU 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 SWEU and a risk characterization was not performed for this EU.

11.2 Ecological Risk

No ECOPCs were identified in surface soil (non-PMJM receptors or PMJM receptors) or subsurface soil (burrowing receptors). All ECOIs were eliminated from further consideration as ECOPCs based on comparisons of MDCs to NOAEL ESLs, background comparisons, tESL comparisons (non-PMJM receptors only), or professional judgment evaluations. Therefore, potential risks to ecological receptors in the SWEU are likely to be negligible.

12.0 REFERENCES

DOE, 1992. Final Historical Release Report for Rocky Flats Plant, Golden, Colorado. June.

DOE, 2002. 2002 Annual Update to the Historical Release Report, Rocky Flats Environmental Technology Site, Golden, Colorado.

DOE, 2004. Comprehensive Risk Assessment Sampling and Analysis Plan Addendum, #04-01, Rocky Flats Environmental Technology Site, Golden, Colorado. March.

DOE, 2005a. Final Comprehensive Risk Assessment Work Plan and Methodology, Rocky Flats Environmental Technology Site, Golden, Colorado. Revision 1. September.

DOE, 2005b. 2005 Annual Update to the Historical Release Report, Rocky Flats Environmental Technology Site, Golden, Colorado.

DOE, 2005c. Closeout Report for IHSS Group 900-11, PAC SE-1602, East Firing Range and Target Area, Rocky Flats Environmental Technology Site, Golden, Colorado. March.

Interagency Agreement (IAG), 1991. Federal Facility Agreement and Consent Order CERCLA VIII-91-03, RCRA (3008(h)) VIII-91-07 and State of Colorado Docket number 91-01-22-01.

K-H, 2000. 1999 Annual Wildlife Survey for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

K-H, 2002. 2001 Annual Wildlife Survey for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

PTI, 1997. 1997 Annual Vegetation Report for the Rocky Flats Environmental Technology Site. Prepared by PTI Environmental Services for Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado.

Rocky Flats Cleanup Agreement (RFCA), 1996. CERCLA Federal Facility Agreement and RCRA/CHWA Consent Order (CERCLA VIII-96-21; RCRA (3008(h)) VIII-96-01; State of Colorado Docket #96-07-19-0).

Ross, L.G., 1930. A Comparative Study of Daily Water-Intake Among Certain Taxonomic and Geographic Groups Within the Genus Peromyscus. Biol. Bull, 59:326-338.

USFWS, 2004. Rocky Flats National Wildlife Refuge, Final Comprehensive Conservation Plan and Environmental Impact Statement. U.S. Fish and Wildlife Service. September.

TABLES

Table 1.1
SWEU IHSSs

IHSS	OU	PAC	Title	Description	Disposition
--	BZ	000-501	Roadway Spraying	Roadways in the BZ OU were sprayed with waste oils for dust suppression; reverse osmosis brine solutions and footing drain water were also applied.[a]	NFA - 2002 HRR

[a] PAC 000-501 was one of 79 IHSS/PACs proposed for NFA by the NFA Working Group in 1991. The NFA was approved in 2002 (EPA et al, 2002).

Table 1.2
Number of Samples in Each Medium by Analyte Suite

Analyte Suite	Surface Soil/Surface Sediment[a]	Subsurface Soil/Subsurface Sediment[a]	Surface Soil[b]	Surface Soil (PMJM)[b]	Subsurface Soil[b]
Inorganics	16	3	14	4	2
Organics	0	1	0	0	1
Radionuclides	22	1	20	7	0

[a] Used in the HHRA.

[b] Used in the ERA.

Note: The total number of results (samples) in Tables 1.3 through 1.7 may differ from the total number of samples presented in Table 1.2 because not all analyses are necessarily performed for each sample.

Table 1.3

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	Standard Deviation
Inorganics (mg/kg)							
Aluminum	5.00 - 12.0	16	100	11,000	29,000	15,800	4,040
Antimony	0.290 - 1.70	16	12.5	0.390	0.480	0.260	0.190
Arsenic	0.820 - 1.60	16	100	3.30	9.00	7.16	1.43
Barium	0.210 - 0.480	16	100	78.0	210	132	30.7
Beryllium	0.036 - 0.130	16	62.5	0.590	1.30	0.704	0.275
Boron	1.00 - 4.20	16	100	3.00	9.70	6.10	1.84
Cadmium[b]	0.066 - 0.160	16	50.0	0.190	0.710	0.210	0.203
Calcium	7.20 - 28.0	16	100	1,500	8,200	4,050	1,800
Chromium	0.085 - 0.200	16	100	12.0	28.0	15.9	3.62
Cobalt	0.160 - 0.320	16	100	3.70	9.70	6.12	1.52
Copper	0.046 - 0.210	16	100	6.50	19.0	12.9	3.48
Iron	1.40 - 3.60	16	100	10,000	23,000	14,300	3,090
Lead	0.280 - 1.00	16	100	17.0	38.0	26.6	5.88
Lithium	0.410 - 0.810	16	100	7.70	19.0	11.2	2.78
Magnesium	7.70 - 16.0	16	100	1,200	4,800	2,340	809
Manganese	0.180 - 0.420	16	100	83.0	330	228	65.2
Mercury	0.007 - 0.015	16	100	0.027	0.130	0.045	0.026
Molybdenum	0.280 - 0.550	16	93.8	0.500	0.990	0.653	0.196
Nickel	0.200 - 0.550	16	100	7.60	21.0	12.3	3.34
Potassium	36.0 - 100	16	100	1,700	3,900	2,560	605
Selenium	0.820 - 2.00	16	18.8	1.00	1.20	0.602	0.272
Silica	2.10 - 5.60	16	100	650	2,200	982	393
Silver	0.080 - 0.200	16	31.3	0.087	0.160	0.117	0.051
Sodium	130 - 260	16	12.5	320	340	105	88.2
Strontium	0.060 - 0.260	16	100	14.0	79.0	32.4	16.7
Thallium[b]	0.440 - 1.20	16	6.25	0.550	0.550	0.511	0.040
Tin	0.800 - 1.60	16	18.8	1.50	1.70	0.910	0.518
Titanium	0.090 - 0.620	16	100	74.0	260	188	58.1
Vanadium	0.480 - 0.970	16	100	27.0	65.0	36.1	8.56
Zinc	0.460 - 1.40	16	100	23.0	79.0	46.9	15.8
Radionuclides (pCi/g)[c]							
Americium-241	0.082 - 0.258	16	N/A	-0.050	0.100	0.017	0.037
Gross Alpha	20.0 - 30.0	2	N/A	18.0	19.0	18.5	0.707
Gross Beta	20.0 - 20.0	2	N/A	21.0	21.0	21.0	0
Plutonium-239/240	0.003 - 0.221	22	N/A	0.006	0.250	0.057	0.054
Uranium-233/234	0.150 - 0.533	16	N/A	0.413	2.04	0.992	0.432
Uranium-235	0.196 - 0.470	16	N/A	-0.0241	0.188	0.0602	0.0635
Uranium-238	0.152 - 0.393	16	N/A	0.579	1.53	0.930	0.267

[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 detection limit.

[c] All radionuclide values are considered detects.

N/A = Not applicable.

Table 1.4
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	5.10 - 6.50	3	100	12,000	20,000	17,000	4,360
Arsenic	0.850 - 0.880	3	100	2.10	4.60	3.47	1.27
Barium	0.220 - 0.400	3	100	80	180	127	50.3
Beryllium	0.038 - 0.110	3	33.3	1.10	1.10	0.625	0.422
Boron	1.10 - 2.20	3	100	2.40	7.50	5.10	2.56
Cadmium[b]	0.068 - 0.084	3	33.3	0.560	0.560	0.210	0.303
Calcium	7.40 - 15.0	3	100	5,400	7,600	6,730	1,170
Chromium	0.089 - 0.160	3	100	14	20	16.3	3.21
Cobalt	0.170 - 0.200	3	100	5.80	8	6.57	1.24
Copper	0.048 - 0.110	3	100	13	22	17.7	4.51
Iron	1.50 - 1.90	3	100	12,000	14,000	13,300	1,150
Lead	0.290 - 0.530	3	100	9.10	20	13.4	5.82
Lithium	0.430 - 0.530	3	100	12	14	13	1
Magnesium	8.00 - 8.50	3	100	3,100	3,100	3,100	0
Manganese	0.180 - 0.220	3	100	82	230	181	85.4
Mercury	0.007 - 0.008	3	100	0.0160	0.0490	0.0280	0.0182
Molybdenum	0.290 - 0.320	3	33.3	0.690	0.690	0.335	0.307
Nickel	0.210 - 0.290	3	66.7	13	17	11.7	6.11
Potassium	38.0 - 53.0	3	100	2,400	3,000	2,730	306
Silica[b]	2.20 - 4.70	3	100	710	1,800	1,080	624
Sodium	140	3	33.3	150	150	227	83.1
Strontium	0.062 - 0.140	3	100	21	46	31.3	13.1
Titanium[b]	0.092 - 0.320	3	100	140	420	277	140
Uranium	1.50 - 1.60	3	33.3	1.50	1.50	1.02	0.419
Vanadium	0.490 - 0.510	3	100	23	45	34.3	11
Zinc	0.480 - 0.730	3	100	54	190	104	75
Radionuclides (pCi/g)[c]							
Americium-241	0.126	1	N/A	-0.00555	-0.00555	-0.00555	N/A
Plutonium-239/240	0.088	1	N/A	0.0875	0.0875	0.0875	N/A
Uranium-233/234	0.324	1	N/A	1.47	1.47	1.47	N/A
Uranium-235	0.352	1	N/A	0.111	0.111	0.111	N/A
Uranium-238	0.194	1	N/A	1.10	1.10	1.10	N/A

[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 detection limit.

[c] All radionuclide values are considered detects.

N/A = Not applicable.

Table 1.5

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
Inorganics (mg/kg)							
Aluminum	5 - 6.3	14	100	11,000	29,000	15,900	4,330
Antimony	0.29 - 0.37	14	14.3	0.390	0.480	0.207	0.0999
Arsenic	0.83 - 1.1	14	100	5.70	9	7.47	1.05
Barium	0.38 - 0.48	14	100	78	210	130	32.4
Beryllium	0.1 - 0.13	14	57.1	0.590	1.30	0.668	0.276
Boron	1 - 1.3	14	100	3	9.70	5.93	1.76
Cadmium[b]	0.066 - 0.084	14	42.9	0.190	0.350	0.152	0.130
Calcium	7.2 - 9.1	14	100	1,500	7,800	3,690	1,490
Chromium	0.150 - 0.200	14	100	12	28	16	3.88
Cobalt	0.190 - 0.240	14	100	3.70	9.70	5.96	1.47
Copper	0.046 - 0.059	14	100	6.50	19	12.3	3.36
Iron	1.40 - 1.80	14	100	10,000	23,000	14,400	3,160
Lead	0.280 - 0.350	14	100	17	38	27.8	5.18
Lithium	0.500 - 0.630	14	100	7.70	19	11.2	2.96
Magnesium	7.70 - 9.80	14	100	1,200	4,800	2,310	865
Manganese	0.180 - 0.220	14	100	150	330	246	45.4
Mercury	0.007 - 0.009	14	100	0.0270	0.130	0.0426	0.0261
Molybdenum	0.300 - 0.380	14	100	0.500	0.990	0.668	0.131
Nickel	0.200 - 0.250	14	100	7.60	21	12	3.46
Potassium	36.0 - 46.0	14	100	1,700	3,900	2,660	588
Selenium	0.820 - 1.00	14	21.4	1	1.20	0.581	0.268
Silica	4.40 - 5.60	14	100	650	1,200	865	190
Silver	0.080 - 0.100	14	35.7	0.0870	0.160	0.114	0.0449
Sodium[b]	130 - 170	14	7.14	340	340	92.1	71.5
Strontium	0.060 - 0.076	14	100	14	79	31	17.5
Tin	0.860 - 1.10	14	21.4	1.50	1.70	0.858	0.454
Titanium	0.090 - 0.110	14	100	74	260	197	55
Vanadium	0.480 - 0.600	14	100	27	65	36.1	9.19
Zinc	0.460 - 0.590	14	100	23	74	43.5	13.4
Radionuclides (pCi/g)[c]							
Americium-241	0.082 - 0.258	14	N/A	-0.0497	0.0444	0.00992	0.0308
Gross Alpha	20.0 - 30.0	2	N/A	18	19	18.5	0.707
Gross Beta	20	2	N/A	21	21	21	N/A
Plutonium-239/240	0.003 - 0.221	20	N/A	0.00555	0.250	0.0565	0.0560
Uranium-233/234	0.150 - 0.533	14	N/A	0.413	1.28	0.870	0.286
Uranium-235	0.196 - 0.470	14	N/A	-0.0241	0.138	0.0484	0.0560
Uranium-238	0.190 - 0.393	14	N/A	0.579	1.22	0.859	0.193

[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 detection limit.

[c] All radionuclide values are considered detects.

N/A = Not applicable.

Table 1.6
Summary of Detected Analytes in Surface Soil (PMJM Habitat)

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	4.2 - 5.5	4	100	13,000	17,000	15,500	1,915
Arsenic	0.87 - 0.95	4	100	6.30	8.20	7.08	0.818
Barium	0.39 - 0.43	4	100	100	170	138	29.9
Beryllium	0.025 - 0.11	4	75	0.820	0.940	0.771	0.257
Boron	0.6 - 1.1	4	100	4.90	6.40	5.53	0.629
Cadmium	0.07 - 0.076	4	50	0.280	0.340	0.173	0.160
Calcium	4.1 - 7.9	4	100	3,200	5,000	4,275	763
Chromium	0.16 - 0.18	4	100	14.0	21.0	16.8	3.10
Cobalt	0.2 - 0.22	4	100	5.10	8.00	6.90	1.25
Copper	0.049 - 0.053	4	100	12.0	18.0	14.8	2.50
Iron	1.5 - 1.6	4	100	13,000	18,000	16,000	2,449
Lead	0.29 - 0.32	4	100	25.0	28.0	26.5	1.29
Lithium[b]	0.076 - 0.55	4	100	7.90	15.0	11.2	3.05
Magnesium	2.3 - 8.5	4	100	2,100	3,300	2,750	493
Manganese	0.19 - 0.2	4	100	210	330	288	56.8
Mercury	0.006 - 0.0078	4	75	0.0310	0.0400	0.0280	0.0133
Molybdenum	0.31 - 0.34	4	100	0.580	0.960	0.683	0.185
Nickel	0.21 - 0.23	4	100	11.0	17.0	14.5	2.65
Potassium	25 - 40	4	100	2,100	3,900	2,900	783
Silica	4.6 - 5.1	4	100	740	1,200	990	245
Sodium[b]	120 - 150	4	25	340	340	136	136
Strontium	0.063 - 0.068	4	100	32.0	79.0	47.5	21.9
Tin	0.91 - 0.99	4	50	1.50	1.70	1.12	0.570
Titanium	0.094 - 0.1	4	100	74.0	190	141	48.5
Vanadium	0.5 - 0.54	4	100	31.0	48.0	39.5	6.95
Zinc	0.49 - 0.53	4	100	46.0	68.0	56.8	11.4
Radionuclides (pCi/g)[c]							
Americium-241	0.0824 - 0.229	3	N/A	-0.0425	0.381	0.0815	0.200
Gross Alpha	30	1	N/A	19	19	19	N/A
Gross Beta	20	1	N/A	21	21	21	N/A
Plutonium-239/240	0.00295 - 0.221	6	N/A	0.00937	0.250	0.0762	0.0864
Uranium-233/234	0.17 - 0.317	3	N/A	0.737	1.28	0.964	0.262
Uranium-235	0.217 - 0.306	3	N/A	-0.0218	0.125	0.0339	0.0675
Uranium-238	0.149 - 0.302	3	N/A	0.791	1.07	0.936	0.121

[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 detection limit.

[c] All radionuclide values are considered detects.

N/A = Not applicable.

Table 1.7

Summary of Detected Analytes in Subsurface Soil

Analyte	Range of Reported Detection Limit	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation
Inorganics (mg/kg)							
Aluminum	5.10 - 5.30	2	100	12,000	19,000	15,500	4,950
Arsenic	0.860 - 0.880	2	100	2.10	4.60	3.35	1.77
Barium	0.390 - 0.400	2	100	80	120	100	28.3
Boron	1.10 - 1.10	2	100	2.40	5.40	3.90	2.12
Calcium	7.40 - 7.60	2	100	7,200	7,600	7,400	283
Chromium	0.160 - 0.160	2	100	14	15	14.5	0.707
Cobalt	0.190 - 0.200	2	100	5.90	8	6.95	1.48
Copper	0.048 - 0.049	2	100	13	22	17.5	6.36
Iron	1.50 - 1.50	2	100	14,000	14,000	14,000	N/A
Lead	0.290 - 0.290	2	100	9.10	11	10.1	1.34
Lithium[b]	0.510 - 0.530	2	100	12	13	12.5	0.707
Magnesium	8.00 - 8.20	2	100	3,100	3,100	3,100	N/A
Manganese	0.180 - 0.190	2	100	230	230	230	N/A
Mercury	0.0073 - 0.0075	2	100	0.0160	0.0190	0.0175	0.00212
Nickel	0.210 - 0.210	2	50	13	13	9	5.66
Potassium	38.0 - 39.0	2	100	2,800	3,000	2,900	141
Silica[b]	4.60 - 4.70	2	100	710	730	720	14.1
Strontium	0.062 - 0.063	2	100	21	27	24	4.24
Titanium[b]	0.092 - 0.095	2	100	270	420	345	106
Uranium	1.50 - 1.50	2	50	1.50	1.50	1.13	0.530
Vanadium	0.490 - 0.500	2	100	23	35	29	8.49
Zinc	0.480 - 0.490	2	100	54	190	122	96.2

[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 detection limit.

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	8,200	0.820	500-1,200	2,500	No
Magnesium	4,800	0.480	80.0-420	65.0-110	No
Potassium	3,900	0.390	2,000-3,500	N/A	No
Sodium	340	0.0340	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 and 2002.

N/A = Not available.

Table 2.2
PRG Screen for Surface Soil/Surface Sediment

Analyte	PRG[a]	MDC	MDC Exceeds PRG?	UCL[b]	UCL Exceeds PRG?	Retain for Detection Frequency Screen?
Inorganics (mg/kg)						
Aluminum	24,800	29,000	Yes	17,600	No	No
Antimony	44.4	0.480	No	--	--	No
Arsenic	**2.41**	**9**	**Yes**	**7.78**	**Yes**	**Yes**
Barium	2,870	210	No	--	--	No
Beryllium	100	1.30	No	--	--	No
Boron	9,480	9.70	No	--	--	No
Cadmium	91.4	0.710	No	--	--	No
Chromium[c]	28.4	28	No	--	--	No
Cobalt	122	9.70	No	--	--	No
Copper	4,440	19	No	--	--	No
Iron	33,300	23,000	No	--	--	No
Lead	1,000	38	No	--	--	No
Lithium	2,220	19	No	--	--	No
Manganese	419	330	No	--	--	No
Mercury	32.9	0.130	No	--	--	No
Molybdenum	555	0.990	No	--	--	No
Nickel	2,220	21	No	--	--	No
Selenium	555	1.20	No	--	--	No
Silica	N/A	2,200	No	--	--	UT
Silver	555	0.160	No	--	--	No
Strontium	66,700	79	No	--	--	No
Thallium	7.78	0.550	No	--	--	No
Tin	66,700	1.70	No	--	--	No
Titanium	170,000	260	No	--	--	No
Vanadium	111	65	No	--	--	No
Zinc	33,300	79	No	--	--	No
Radionuclides (pCi/g)						
Americium-241	7.69	0.0997	No	--	--	No
Gross Alpha	N/A	19	No	--	--	UT
Gross Beta	N/A	21	No	--	--	UT
Plutonium-239/240	9.80	0.250	No	--	--	No
Uranium-233/234	25.3	2.04	No	--	--	No
Uranium-235	1.05	0.188	No	--	--	No
Uranium-238	29.3	1.53	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 = 95% 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).

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 COC selection step.

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

Table 2.3

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

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		
	Background Data Set			SWEU Data Set					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples[a]	Distribution Recommended by ProUCL	Detects (%)	Test	1-p	Retain as PCOC?
Surface Soil/Surface Sediment									
Arsenic	73	GAMMA	92	16	NORMAL	100	WRS	1.36E-06	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

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	7,600	0.760	500-1,200	2,500	No
Magnesium	3,100	0.310	80.0-420	65.0-110	No
Potassium	3,000	0.300	2,000-3,500	N/A	No
Sodium	150	0.0150	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 and 2002.

N/A = Not available.

Table 2.5
PRG Screen for Subsurface Soil/Subsurface Sediment

Analyte	PRG[a]	MDC	MDC Exceeds PRG?	UCL[b]	UCL Exceeds PRG?	Retain for Detection Frequency Screen?
Inorganics (mg/kg)						
Aluminum	285,000	20,000	--	--	--	No
Arsenic	27.7	4.60	--	--	--	No
Barium	33,000	180	--	--	--	No
Beryllium	1,150	1.10	--	--	--	No
Boron	109,000	7.50	--	--	--	No
Cadmium	1,050	0.560	--	--	--	No
Chromium[c]	327	20	--	--	--	No
Cobalt	1,400	8	--	--	--	No
Copper	51,100	22	--	--	--	No
Iron	383,000	14,000	--	--	--	No
Lead	1,000	20	--	--	--	No
Lithium	25,600	14	--	--	--	No
Manganese	4,820	230	--	--	--	No
Mercury	379	0.0490	--	--	--	No
Molybdenum	6,390	0.690	--	--	--	No
Nickel	25,600	17	--	--	--	No
Silica	N/A	1,800	--	--	--	UT
Strontium	767,000	46	--	--	--	No
Titanium	1.95E+06	420	--	--	--	No
Uranium	3,830	1.50	--	--	--	No
Vanadium	1,280	45	--	--	--	No
Zinc	383,000	190	--	--	--	No
Radionuclides (pCi/g)						
Americium-241	88.4	-0.00555	--	--	--	No
Plutonium-239/240	112	0.0875	--	--	--	No
Uranium-233/234	291	1.47	--	--	--	No
Uranium-235	12.1	0.111	--	--	--	No
Uranium-238	337	1.10	--	--	--	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 = 95% 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).

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 COC selection step.

Table 2.6
Summary of the COC Selection Process

Analyte	MDC Exceeds PRG?	UCL Exceeds PRG?	Detection Frequency > 5%	Exceeds 30X the PRG?	Exceeds Background?	Professional Judgment-Retain?	Retain as COC?
Surface Soil/Surface Sediment							
Aluminum	Yes	No	--	--	--	--	No
Arsenic	Yes	Yes	Yes	N/A	Yes	No	No
Subsurface Soil/ Subsurface Sediment							
None >PRG	No	--	--	--	--	--	No

N/A = Not applicable.

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

Table 6.1
Summary of Detected PCOCs Without PRGs[a]

Analyte	Surface Soil/Surface Sediment	Subsurface Soil/Subsurface Sediment
Inorganics		
Silica[b]	X	X
Radionuclides		
Gross alpha	X	N/A
Gross beta	X	N/A

[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.

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

X = PRG is unavailable.

Table 7.1
Comparison of MDCs in Surface Soil to NOAEL ESLs for Terrestrial Plants, Invertebrates, and Vertebrates in the SWEU

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		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	29,000	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	0.48	5	No	78	No	N/A	N/A	N/A	N/A	N/A	N/A	10	No	0.90	No	19	No	58	No	138	No	13	No	3.85	No	N/A	N/A	Deer Mouse Insectivore	No
Arsenic	9	10	No	60	No	20	No	164	No	1,028	No	2.57	Yes	51	No	9.35	No	13	No	709	No	341	No	293	No	N/A	N/A	Deer Mouse Herbivore	Yes
Barium	210	500	No	330	No	159	Yes	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	Mourning Dove Herbivore	Yes
Beryllium	1.3	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	No	N/A	N/A	Deer Mouse Insectivore	No
Boron	9.7	0.5	Yes	N/A	N/A	30	No	115	No	167	No	62	No	422	No	237	No	314	No	929	No	6,070	No	1,816	No	N/A	N/A	Plant	Yes
Cadmium	0.35	32	No	140	No	28	No	0.71	No	15	No	60	No	1.56	No	198	No	723	No	1,360	No	51	No	10	No	N/A	N/A	Mourning Dove Insectivore	No
Calcium	7,800	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
Chromium[b]	28	1	Yes	0.40	Yes	25	Yes	1.34	Yes	14	Yes	281	No	16	Yes	703	No	1,461	No	4,173	No	250	No	69	No	N/A	N/A	Invertebrate	Yes
Cobalt	9.7	13	No	N/A	N/A	278	No	87	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	Plant	No
Copper	19	100	No	50	No	29	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	Mourning Dove Insectivore	Yes
Iron	23,000	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	38	110	No	1700	No	50	No	12	Yes	96	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	Mourning Dove Insectivore	Yes
Lithium	19	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	4,800	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
Manganese	330	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	0.13	0.3	No	0.1	Yes	0.2	No	0.0001	Yes	1.57	No	0.44	No	0.18	No	3.15	No	7.56	No	8.18	No	8.49	No	37	No	N/A	N/A	Mourning Dove Insectivore	Yes
Molybdenum	0.99	2	No	N/A	N/A	44	No	6.97	No	77	No	8.68	No	1.9	No	27	No	44	No	275	No	29	No	8.18	No	N/A	N/A	Deer Mouse Insectivore	No
Nickel	21	30	No	200	No	44	No	1.24	Yes	13	Yes	16	Yes	0.43	Yes	38	No	124	No	91	No	6.02	Yes	1.86	Yes	N/A	N/A	Deer Mouse Insectivore	Yes
Potassium	3,900	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
Selenium	1.2	1	Yes	70	No	1.61	No	1	Yes	8.48	No	0.87	Yes	0.75	Yes	2.8	No	3.82	No	32	No	12	No	5.39	No	N/A	N/A	Deer Mouse Insectivore	Yes
Silica	1,200	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
Silver	0.16	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	340	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	79	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
Tin	1.7	50	No	N/A	N/A	26.1	No	2.9	No	18.98	No	45	No	3.77	No	81	No	241.78	No	70	No	36.1	No	16.2	No	N/A	N/A	Mourning Dove Insectivore	No
Titanium	260	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	65	2	Yes	N/A	N/A	503	No	274	No	1,514	No	64	Yes	30	Yes	84	No	358	No	341	No	164	No	121	No	N/A	N/A	Plant	Yes
Zinc	74	50	Yes	200	No	109	No	0.65	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	Mourning Dove Insectivore	Yes
Radionuclides (pCi/g)																													
Americium-241	0.0444	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	Terrestrial Receptors	No
Gross Alpha	19	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
Gross Beta	21	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
Plutonium-239/240	0.25	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	Terrestrial Receptors	No
Uranium-233/234	1.28	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	Terrestrial Receptors	No
Uranium-235	0.138	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	Terrestrial Receptors	No
Uranium-238	1.22	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	Terrestrial Receptors	No

[a] Radionuclide ESLs are not receptor-specific. They are considered protective of all terrestrial ecological species.
[b] ESLs for chromium were developed based on available toxicity data and are based on chromium III (birds) and chromium VI (plants, invertebrates, and mammals).
N/A = No ESL available for the ECOI/receptor pair.
UT = Uncertain toxicity; no ESL available (assessed in Section 10).
Bold = Analyte retained for further consideration in the next ECOPC selection step.

Table 7.1
Comparison of MDCs in Surface Soil to NOAEL ESLs for Terrestrial Plants, Invertebrates, and Vertebrates in the SWEU

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[a]		Coyote Insectivore		Terrestrial Receptor		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	29,000	**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	0.48	5	No	78	No	N/A	N/A	N/A	N/A	N/A	N/A	10	No	**0.90**	No	19	No	58	No	138	No	13	No	3.85	No	N/A	N/A	Deer Mouse Insectivore	No
Arsenic	9	10	No	60	No	20	No	164	No	1,028	No	**2.57**	**Yes**	51	No	9.35	No	13	No	709	No	341	No	293	No	N/A	N/A	Deer Mouse Herbivore	**Yes**
Barium	210	500	No	330	No	**159**	**Yes**	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	Mourning Dove Herbivore	**Yes**
Beryllium	1.3	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	No	N/A	N/A	Deer Mouse Insectivore	No
Boron	9.7	**0.5**	**Yes**	N/A	N/A	30	No	115	No	167	No	62	No	422	No	237	No	314	No	929	No	6,070	No	1,816	No	N/A	N/A	Plant	**Yes**
Cadmium	0.35	32	No	140	No	28	No	0.71	No	15	No	60	No	1.56	No	198	No	723	No	1,360	No	51	No	10	No	N/A	N/A	Mourning Dove Insectivore	No
Calcium	7,800	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
Chromium[b]	28	**1**	**Yes**	**0.40**	**Yes**	**25**	**Yes**	**1.34**	**Yes**	**14**	**Yes**	281	No	**16**	**Yes**	703	No	1,461	No	4,173	No	250	No	69	No	N/A	N/A	Invertebrate	**Yes**
Cobalt	9.7	13	No	N/A	N/A	278	No	87	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	Plant	No
Copper	19	100	No	50	No	29	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	Mourning Dove Insectivore	**Yes**
Iron	23,000	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	38	110	No	1700	No	50	No	**12**	**Yes**	96	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	Mourning Dove Insectivore	**Yes**
Lithium	19	**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	4,800	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
Manganese	330	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	0.13	0.3	No	**0.1**	**Yes**	0.2	No	**0.0001**	**Yes**	1.57	No	0.44	No	0.18	No	3.15	No	7.56	No	8.18	No	8.49	No	37	No	N/A	N/A	Mourning Dove Insectivore	**Yes**
Molybdenum	0.99	2	No	N/A	N/A	44	No	6.97	No	77	No	8.68	No	1.9	No	27	No	44	No	275	No	29	No	8.18	No	N/A	N/A	Deer Mouse Insectivore	No
Nickel	21	30	No	200	No	44	No	**1.24**	**Yes**	**13**	**Yes**	**16**	**Yes**	**0.43**	**Yes**	38	No	124	No	91	No	**6.02**	**Yes**	**1.86**	**Yes**	N/A	N/A	Deer Mouse Insectivore	**Yes**
Potassium	3,900	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
Selenium	1.2	**1**	**Yes**	70	No	1.61	No	**1**	**Yes**	8.48	No	**0.87**	**Yes**	**0.75**	**Yes**	2.8	No	3.82	No	32	No	12	No	5.39	No	N/A	N/A	Deer Mouse Insectivore	**Yes**
Silica	1,200	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
Silver	0.16	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	340	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	79	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
Tin	1.7	50	No	N/A	N/A	26.1	No	2.9	No	18.98	No	45	No	3.77	No	81	No	241.78	No	70	No	36.1	No	16.2	No	N/A	N/A	Mourning Dove Insectivore	No
Titanium	260	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	65	**2**	**Yes**	N/A	N/A	503	No	274	No	1,514	No	**64**	**Yes**	**30**	**Yes**	84	No	358	No	341	No	164	No	121	No	N/A	N/A	Plant	**Yes**
Zinc	74	**50**	**Yes**	200	No	109	No	**0.65**	**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	Mourning Dove Insectivore	**Yes**
Radionuclides (pCi/g)																													
Americium-241	0.0444	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	Terrestrial Receptors	No
Gross Alpha	19	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
Gross Beta	21	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
Plutonium-239/240	0.25	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	Terrestrial Receptors	No
Uranium-233/234	1.28	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	Terrestrial Receptors	No
Uranium-235	0.138	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	Terrestrial Receptors	No
Uranium-238	1.22	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	Terrestrial Receptors	No

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

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

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

UT = Uncertain toxicity; no ESL available (assessed in Section 10).

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

Table 7.2
Summary of NOAEL ESL Screening Results for SWEU Surface Soil - Non-PMJM Receptors

Analyte	Terrestrial Plant Exceedance?	Terrestrial Invertebrate Exceedance?	Terrestrial Vertebrate Exceedance?
Inorganics			
Aluminum	**Yes**	UT	UT
Antimony	No	No	No
Arsenic	No	No	**Yes**
Barium	No	No	**Yes**
Beryllium	No	No	No
Boron	**Yes**	UT	No
Cadmium	No	No	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	**Yes**	**Yes**
Molybdenum	No	UT	No
Nickel	No	No	**Yes**
Potassium	UT	UT	UT
Selenium	**Yes**	No	**Yes**
Silica	UT	UT	UT
Silver	No	UT	UT
Sodium	UT	UT	UT
Strontium	UT	UT	No
Tin	No	UT	No
Titanium	UT	UT	UT
Vanadium	**Yes**	UT	**Yes**
Zinc	**Yes**	No	**Yes**
Radionuclides			
Americium-241	UT	UT	No
Gross Alpha	UT	UT	UT
Gross Beta	UT	UT	UT
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 ESL available (assessed in Section 10).

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

Table 7.3
Comparison of MDCs in SWEU Surface Soil with NOAEL ESLs for the PMJM

Analyte	MDC	PMJM NOAEL ESL	MDC > ESL	Retained for Further Analysis?
Inorganics (mg/kg)				
Aluminum	17,000	N/A	N/A	UT
Arsenic	8.2	2.21	**Yes**	**Yes**
Barium	170	743	No	No
Beryllium	0.94	8.16	No	No
Boron	6.4	52.7	No	No
Cadmium	0.28	1.75	No	No
Calcium	5,000	N/A	N/A	UT
Chromium[a]	17	19.3	No	No
Cobalt	7.3	340	No	No
Copper	18	95.0	No	No
Iron	18,000	N/A	N/A	UT
Lead	28	220	No	No
Lithium	12	519	No	No
Magnesium	2,800	N/A	N/A	UT
Manganese	330	388	No	No
Mercury	0.04	0.052	No	No
Molybdenum	0.6	1.84	No	No
Nickel	17	0.510	**Yes**	**Yes**
Potassium	3,100	N/A	N/A	UT
Silica	1,200	N/A	N/A	UT
Sodium	340	N/A	N/A	UT
Strontium	79	833	No	No
Tin	1.7	4.22	No	No
Titanium	190	N/A	N/A	UT
Vanadium	40	21.6	**Yes**	**Yes**
Zinc	68	6.41	**Yes**	**Yes**
Radionuclides (pCi/L)				
Americium-241	-0.00184	3,890	No	No
Gross Alpha	19	N/A	N/A	UT
Gross Beta	21	N/A	N/A	UT
Plutonium-239/240	0.25	6,110	No	No
Uranium-233/234	1.28	4,980	No	No
Uranium-235	0.125	2,770	No	No
Uranium-238	1.07	1,580	No	No

[a] Chromium ESL is based on Chromium VI.

UT = Uncertain toxicity; no ESLs available (assessed in Section 10).

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

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

Table 7.4

Statistical Distributions and Background Comparisons for ECOIs in SWEU Surface Soil - Non-PMJM Receptors

Analyte	Statistical Distribution Testing Results						Background Comparison Test Results		Retain as ECOI?
	Background Data Set			SWEU Data Set					
	Total No. of Samples	Distribution Recommended by ProUCL	Detections (%)	Total No. of Samples	Distribution Recommended by ProUCL	Detections (%)	Test	1-p	
Aluminum	20	NORMAL	100	14	GAMMA	100	WRS	8.27E-05	**Yes**
Arsenic	20	NORMAL	100	14	NORMAL	100	t-Test_N	0.012	**Yes**
Barium	20	NORMAL	100	14	NORMAL	100	t-Test_N	0.002	**Yes**
Boron	N/A	N/A	N/A	14	NORMAL	100	N/A	N/A	**Yes**[a]
Chromium	20	NORMAL	100	14	NONPARAMETRIC	100	WRS	5.79E-05	**Yes**
Copper	20	NONPARAMETRIC	100	14	NORMAL	100	WRS	0.862	No
Lead	20	NORMAL	100	14	NORMAL	100	t-Test_N	0.966	No
Lithium	20	NORMAL	100	14	NORMAL	100	t-Test_N	8.76E-05	**Yes**
Mercury	20	NONPARAMETRIC	40	14	NONPARAMETRIC	100	WRS	1.000	No
Nickel	20	NORMAL	100	14	NONPARAMETRIC	100	WRS	0.020	**Yes**
Selenium	20	NONPARAMETRIC	60	14	NONPARAMETRIC	21	WRS	0.431	No
Vanadium	20	NORMAL	100	14	GAMMA	100	WRS	0.002	**Yes**
Zinc	20	NORMAL	100	14	NORMAL	100	t-Test_N	0.917	No

[a] Statistical comparisons to background cannot be performed. The analyte is retained as an ECOI for further evaluation.

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 7.5
Statistical Distributions and Background Comparisons for ECOIs in SWEU Surface Soil - PMJM Receptors

Analyte	Statistical Distribution Testing Results						Background Comparison		Retain as ECOI?
	Background			SWEU					
	Total No. of Samples	Distribution Recommended by ProUCL	Detections (%)	Total No. of Samples	Distribution Recommended by ProUCL	Detections (%)	Test	1-p	
Arsenic	20	NORMAL	100.0	4	NORMAL	100.00	t-Test_N	0.173	No
Nickel	20	NORMAL	100.0	4	NORMAL	100.00	t-Test_N	0.001	**Yes**
Vanadium	20	NORMAL	100.0	4	NORMAL	100.00	t-Test_N	0.005	**Yes**
Zinc	20	NORMAL	100.0	4	NORMAL	100.00	t-Test_N	0.152	No

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

Table 7.6

Statistical Concentrations in SWEU Surface Soil - Non-PMJM[a]

Analyte	Number of Samples	Mean Concentration	Median	75th Percentile	95th Percentile	95UCL	95UTL	MDC
Inorganics (mg/kg)								
Aluminum	14	15,857	15,500	16,750	21,850	17,892	29,000	29,000
Arsenic	14	7.47	7.40	8.43	8.74	7.97	9.00	9.00
Barium	14	130	130	138	184	145	198	210
Boron	14	5.93	5.55	6.55	8.60	6.76	9.63	9.70
Chromium	14	16.0	15.5	17.0	20.9	17.8	28.0	28.0
Lithium	14	11.2	11.0	12.0	15.8	12.6	17.4	19.0
Nickel	14	12.0	11.0	12.5	18.4	13.7	21.0	21.0
Vanadium	14	36.1	34.5	36.8	48.8	40.3	65.0	65.0

[a] Statistics computed using one-half the reported values for non-detects.

MDC = maximum detected concentration, or in some cases, maximum proxy result.
UCL = 95% upper confidence limit on the mean, unless the MDC<UCL, then the MDC is used as the UCL.
UTL = 95% upper confidence limit on the 90th percentile value, unless the MDC<UCL, then the MDC is used as the UTL.

Table 7.7

Upper-Bound Exposure Point Concentration Comparison to Limiting ESLs - SWEU Surface Soil

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	29,000	50	**Yes**	17,892	N/A	N/A
Arsenic	9.68	9.87	No	7.97	49.9	No
Barium	198	222	No	145	4,770	No
Boron	9.63	0.5	**Yes**	6.76	314	No
Chromium	28.0	0.4	**Yes**	17.8	68.5	No
Lithium	17.4	2	**Yes**	12.6	2,560	No
Nickel	21.0	0.431	**Yes**	13.7	1.86	**Yes**
Vanadium	65.0	2	**Yes**	40.3	121	No

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

[b]Threshold ESL, if available, for the coyote and mule deer receptors.

If tESL was not available, then the NOAEL ESL was used.

N/A = Not applicable; ESL not available.

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

Table 7.8

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	29,000	**50**	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Boron	9.63	**0.5**	N/A	167	30.3	115	62.1	422	237
Chromium	28.0	**1**	**0.4**	**14.2**	**24.6**	**1.34**	281	**15.9**	703
Lithium	17.4	**2**	N/A	N/A	N/A	N/A	1,880	610	3,180
Nickel	21.0	30	200	89.9	320	**7.84**	**16.4**	**0.431**	38.3
Vanadium	65.0	**2**	N/A	1,510	503	274	**63.7**	**29.9**	83.5

[a]Threshold ESL, if available, for that receptor.

N/A = Not applicable; ESL not available.

Bold = Receptors of potential concern.

Table 7.9
Upper-Bound Exposure Point Concentration Comparison to Receptor-Specific ESLs for Large Home Range Receptors

Analyte	Large Home Range Receptor 95th UCL	Receptor-Specific ESLs[a]			
		Mule Deer	Coyote (carnivore)	Coyote (generalist)	Coyote (insectivore)
Inorganics (mg/kg)					
Nickel	13.7	124	90.9	**6.02**	**1.86**

[a]Lowest ESL (threshold if available) for that receptor.
Bold = Receptors of potential concern.

Table 7.10
Summary of ECOPC Screening Steps for Surface Soil - Non-PMJM Receptors

Analyte	Exceed Any NOAEL ESL?	Detection Frequency >5%?	Exceed Background?[a]	Upper-Bound EPC > Threshold ESL?[b]	Professional Judgment Retain?	Retain as ECOPC?	Receptor of Potential Concern?
Inorganics							
Aluminum	Yes	Yes	Yes	Yes	No	No	--
Antimony	No	--	--	--	--	No	--
Arsenic	Yes	Yes	Yes	No	--	No	--
Barium	Yes	Yes	Yes	No	--	No	--
Beryllium	No	--	--	--	--	No	--
Boron	Yes	Yes	N/A	Yes	No	No	--
Cadmium	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	Yes	Yes	No	No	--
Potassium	UT	--	--	--	--	No	--
Selenium	Yes	Yes	No	--	--	No	--
Silica	UT	--	--	--	--	No	--
Silver	No	--	--	--	--	No	--
Sodium	UT	--	--	--	--	No	--
Strontium	No	--	--	--	--	No	--
Tin	No	--	--	--	--	No	--
Titanium	UT	--	--	--	--	No	--
Vanadium	Yes	Yes	Yes	Yes	No	No	--
Zinc	Yes	Yes	No	--	--	No	--
Radionuclides							
Americium-241	No	--	--	--	--	No	--
Gross Alpha	UT	--	--	--	--	No	--
Gross Beta	UT	--	--	--	--	No	--
Plutonium-239/240	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.

[b] If tESL was not available, then the NOAEL ESL was used.

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

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

Table 7.11
Summary of ECOPC Screening Steps for Surface Soil - PMJM

Analyte	Exceed PMJM NOAEL ESL	Exceed Background	Professional Judgment - Retain?	ECOPC
Inorganics				
Aluminum	UT	--	--	No
Arsenic	Yes	No	--	No
Barium	No	--	--	No
Beryllium	No	--	--	No
Boron	No	--	--	No
Cadmium	No	--	--	No
Calcium	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
Molybdenum	No	--	--	No
Nickel	Yes	Yes	No	No
Potassium	UT	--	--	No
Silica	UT	--	--	No
Sodium	UT	--	--	No
Strontium	No	--	--	No
Tin	No	--	--	No
Titanium	UT	--	--	No
Vanadium	Yes	Yes	No	No
Zinc	Yes	No	--	No
Radionuclides				
Americium-241	No	--	--	No
Gross Beta	UT	--	--	No
Plutonium-239/240	No	--	--	No
Uranium-233/234	No	--	--	No
Uranium-238	No	--	--	No

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

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

Table 7.12
Comparison of MDCs in Subsurface Soil to NOAEL ESLs for the Burrowing Receptor

Analyte	MDC	Prairie Dog NOAEL ESL[a]	MDC > ESL?
Inorganics (mg/kg)			
Aluminum	19,000	N/A	UT
Arsenic	4.6	9.35	No
Barium	120	3,220	No
Boron	5.4	237	No
Calcium	7,600	N/A	UT
Chromium[a]	15	703	No
Cobalt	8	2,460	No
Copper	22	838	No
Iron	14,000	N/A	UT
Lead	11	1,850	No
Lithium	13	3,180	No
Magnesium	3,100	N/A	UT
Manganese	230	1,519	No
Mercury	0.019	3.15	No
Nickel	13	38.3	No
Potassium	3,000	N/A	UT
Silica	730	N/A	UT
Strontium	27	3,520	No
Titanium	420	N/A	UT
Uranium	1.5	1,230	No
Vanadium	35	83.5	No
Zinc	190	1,170	No

[a] Chromium ESL is based on Chromium VI.

UT = Uncertain toxicity; no ESLs available (assessed in Section 10).

N/A = ESL not available.

Table 7.13
Summary of ECOPC Screening Steps for Subsurface Soil

Analyte	Exceed NOAEL ESL?	Detection Frequency >5%?	Exceed Background?[a]	Upper Bound EPC > Limiting ESL?	Professional Judgment Retain?	Retain as ECOPC?
Inorganics						
Aluminum	N/A	--	--	--	--	No
Arsenic	No	--	--	--	--	No
Barium	No	--	--	--	--	No
Boron	No	--	--	--	--	No
Calcium	N/A	--	--	--	--	No
Chromium	No	--	--	--	--	No
Cobalt	No	--	--	--	--	No
Copper	No	--	--	--	--	No
Iron	N/A	--	--	--	--	No
Lead	No	--	--	--	--	No
Lithium	No	--	--	--	--	No
Magnesium	N/A	--	--	--	--	No
Manganese	No	--	--	--	--	No
Mercury	No	--	--	--	--	No
Nickel	No	--	--	--	--	No
Potassium	N/A	--	--	--	--	No
Silica	N/A	--	--	--	--	No
Strontium	No	--	--	--	--	No
Titanium	N/A	--	--	--	--	No
Uranium	No	--	--	--	--	No
Vanadium	No	--	--	--	--	No
Zinc	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 step.

N/A = Not applicable; ESL not available (assessed in Section 10.0).

FIGURES

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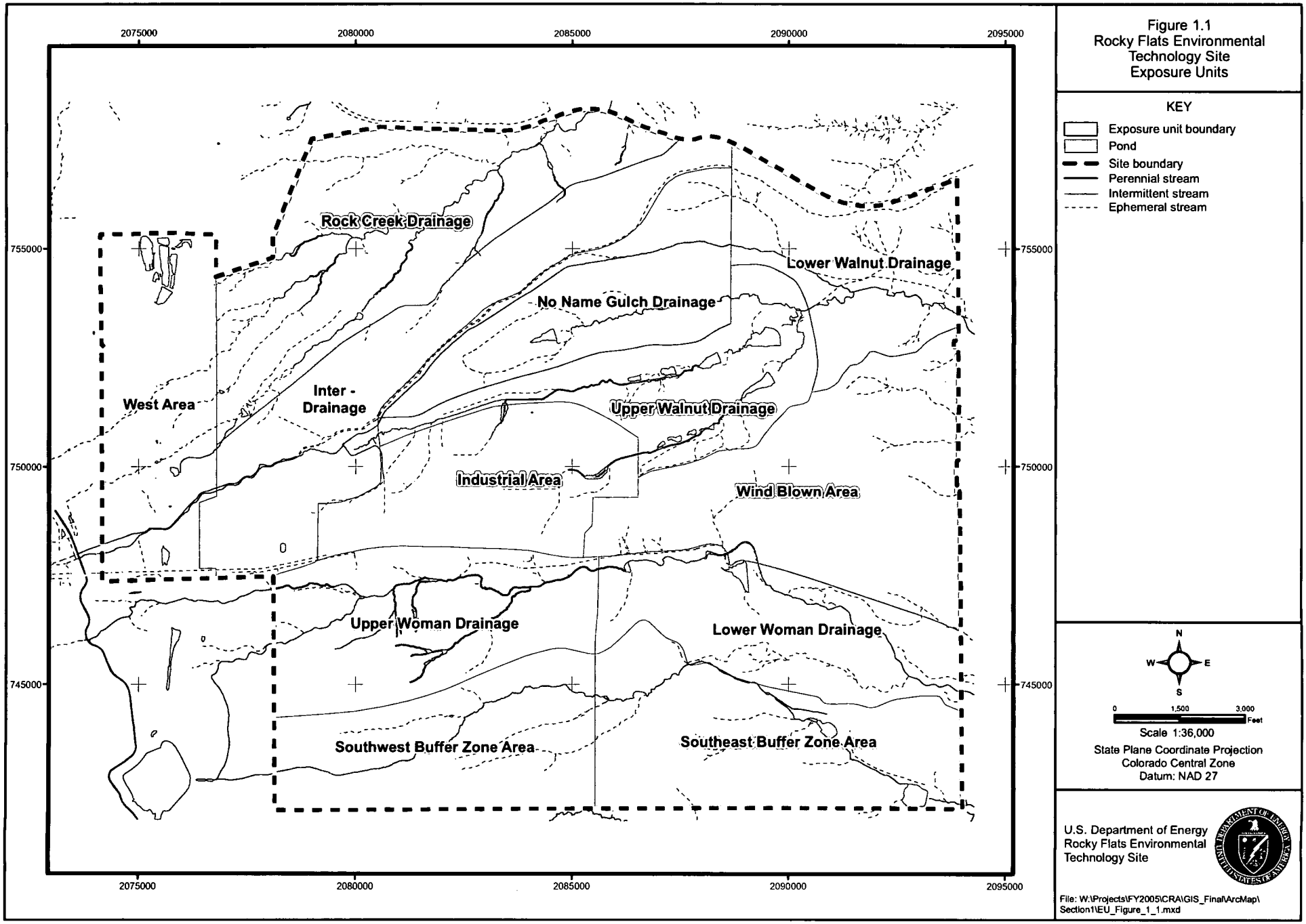

Figure 1.1
Rocky Flats Environmental Technology Site
Exposure Units

KEY

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

N
W E
S

0 1,500 3,000
Feet

Scale 1:36,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

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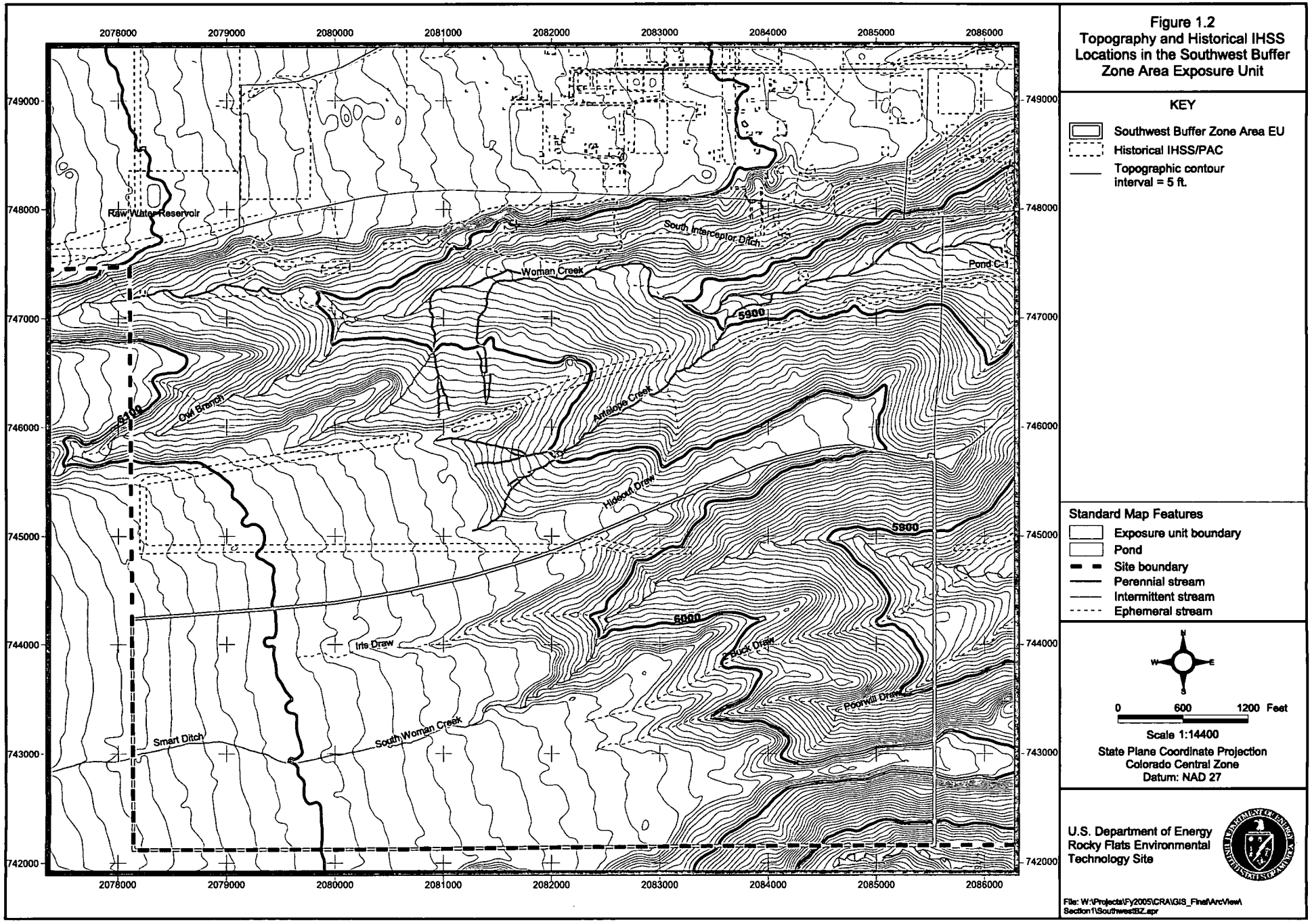

Figure 1.2
Topography and Historical IHSS Locations in the Southwest Buffer Zone Area Exposure Unit

KEY

- Southwest Buffer Zone 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

0 600 1200 Feet

Scale 1:14400

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

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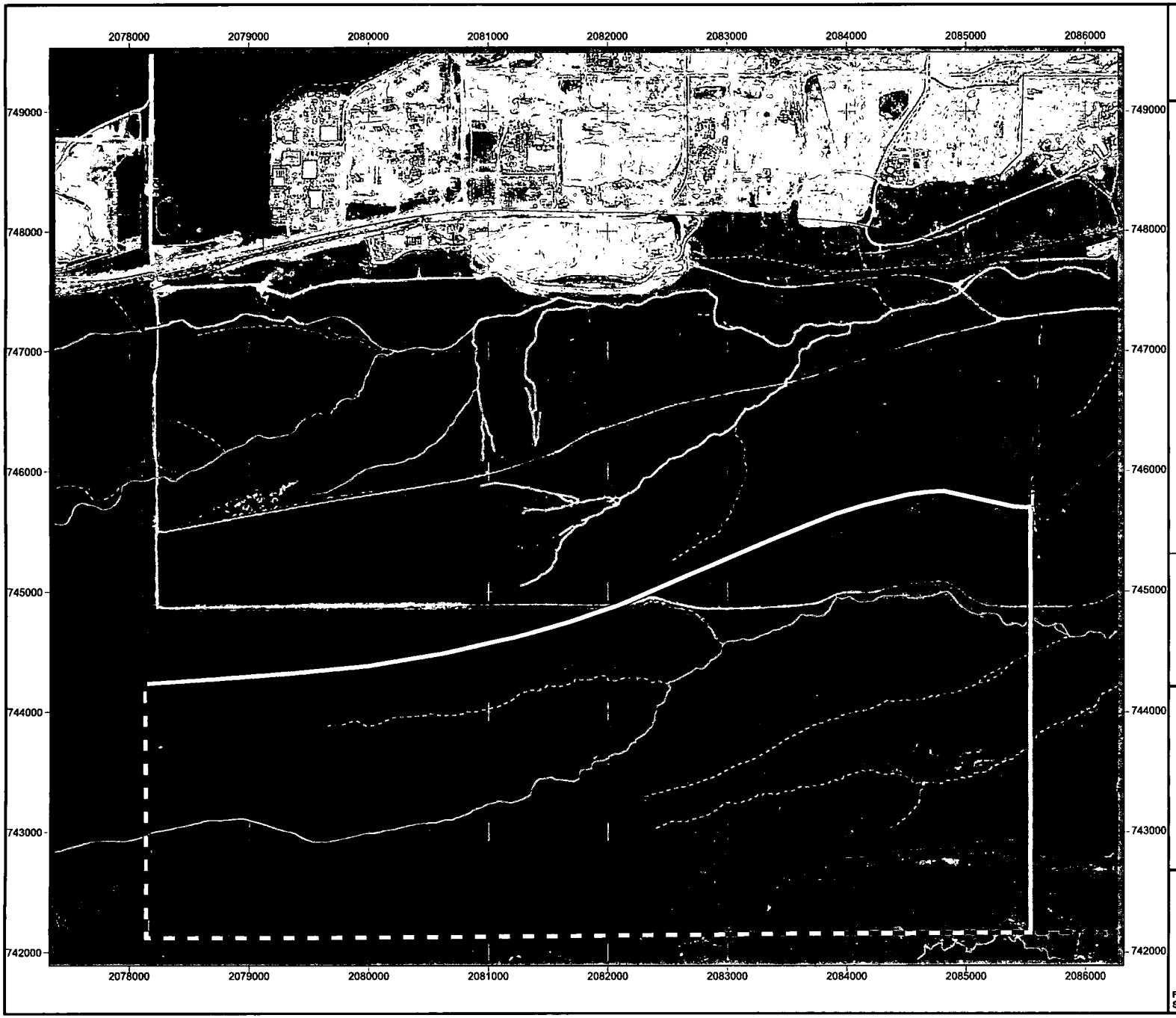

Figure 1.3
Aerial Photograph of the
Southwest Buffer Zone Area
Exposure Unit
July 2005

KEY

Southwest Buffer Zone Area EU

Standard Map Features

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

N
W
E
S

0 600 1200 Feet

Scale 1:14400

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Rocky Flats Environmental
Technology Site

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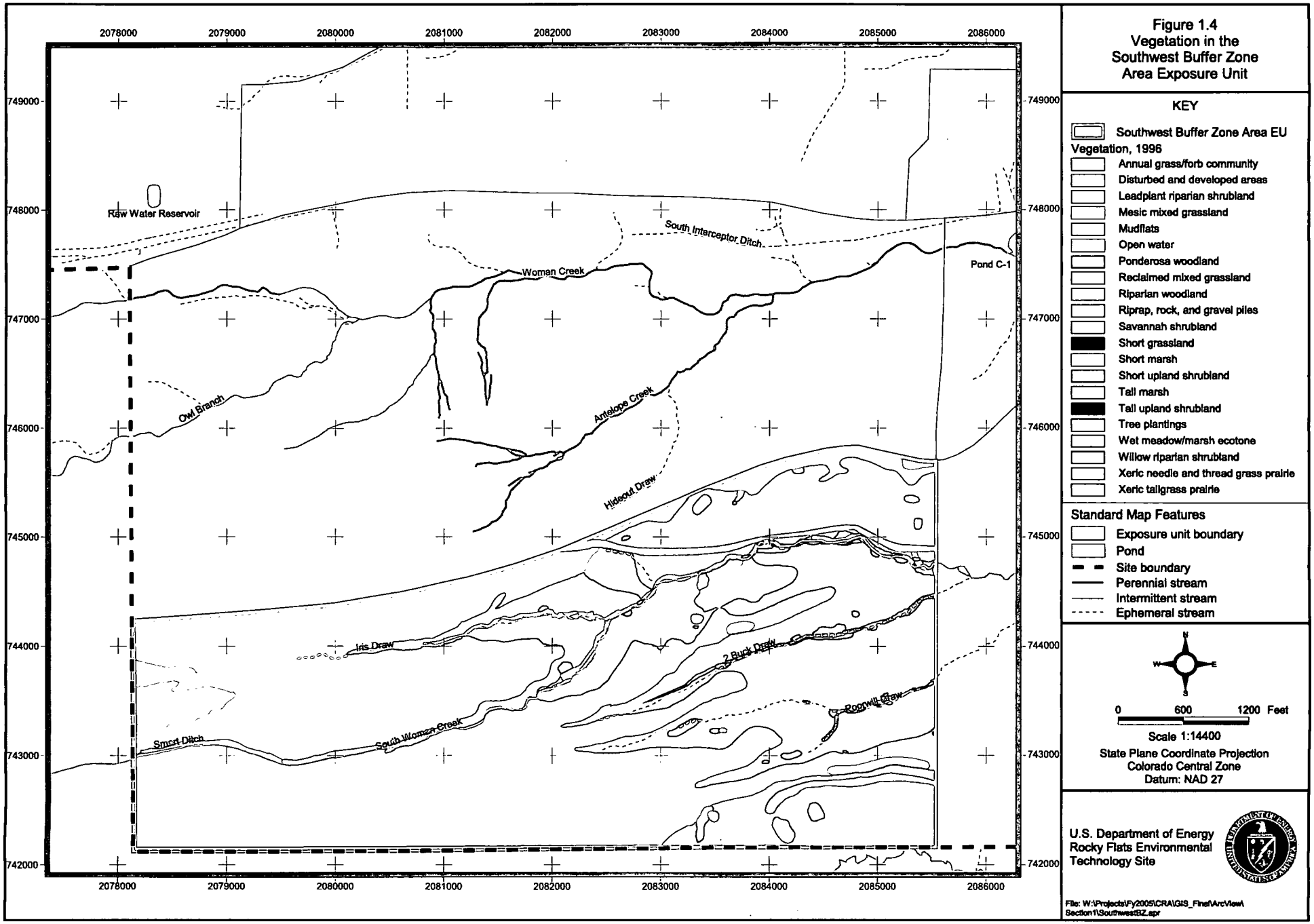

Figure 1.4
Vegetation in the
Southwest Buffer Zone
Area Exposure Unit

KEY

Southwest Buffer Zone 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

0 600 1200 Feet

Scale 1:14400

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Rocky Flats Environmental
Technology Site

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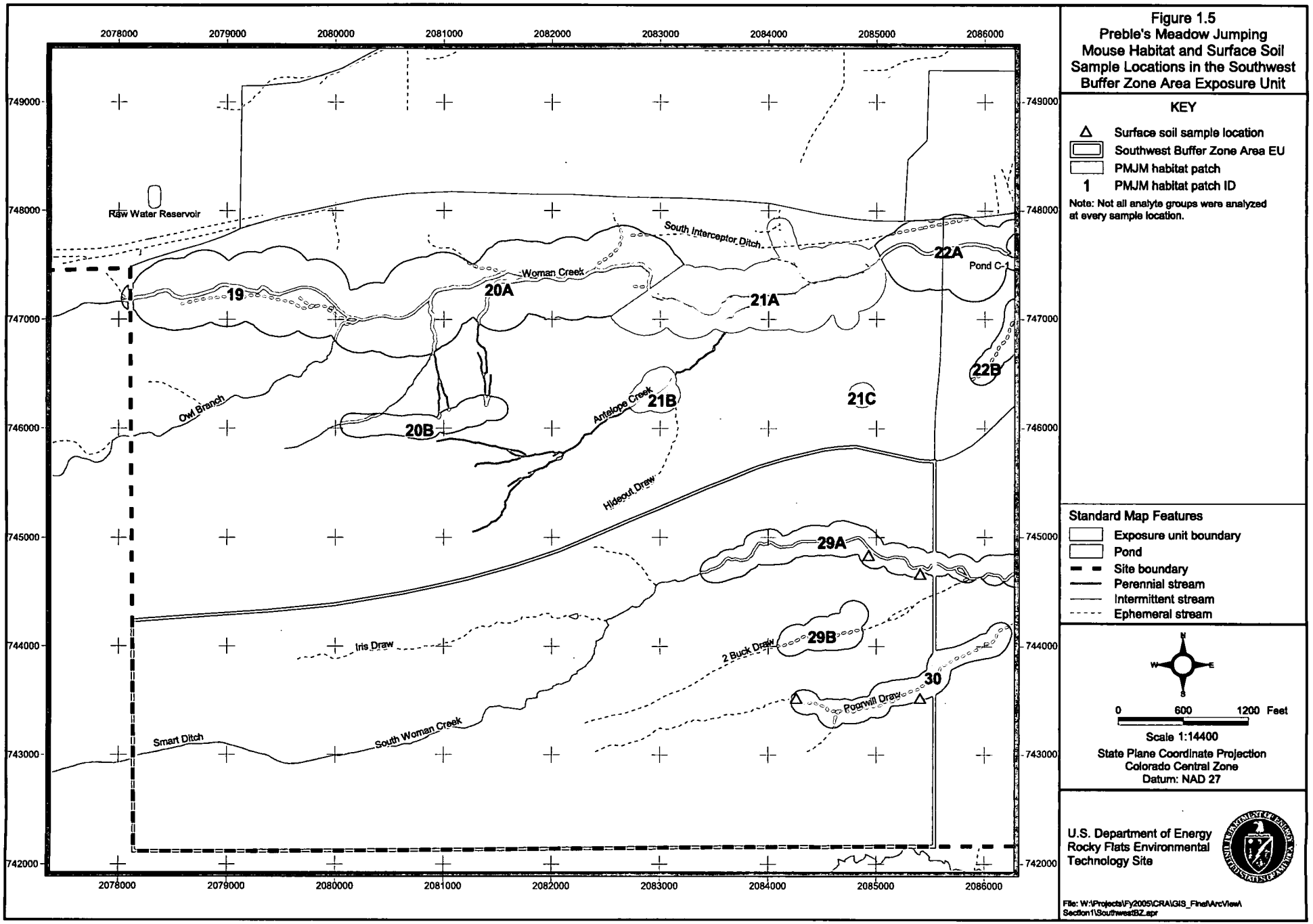

Figure 1.5
Preble's Meadow Jumping Mouse Habitat and Surface Soil Sample Locations in the Southwest Buffer Zone Area Exposure Unit

KEY

- Surface soil sample location
- Southwest Buffer Zone Area EU
- PMJM habitat patch
- 1 PMJM habitat patch ID

Note: Not all analyte groups were analyzed at every sample location.

Standard Map Features

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

N
W
E
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0 600 1200 Feet

Scale 1:14400

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Rocky Flats Environmental Technology Site

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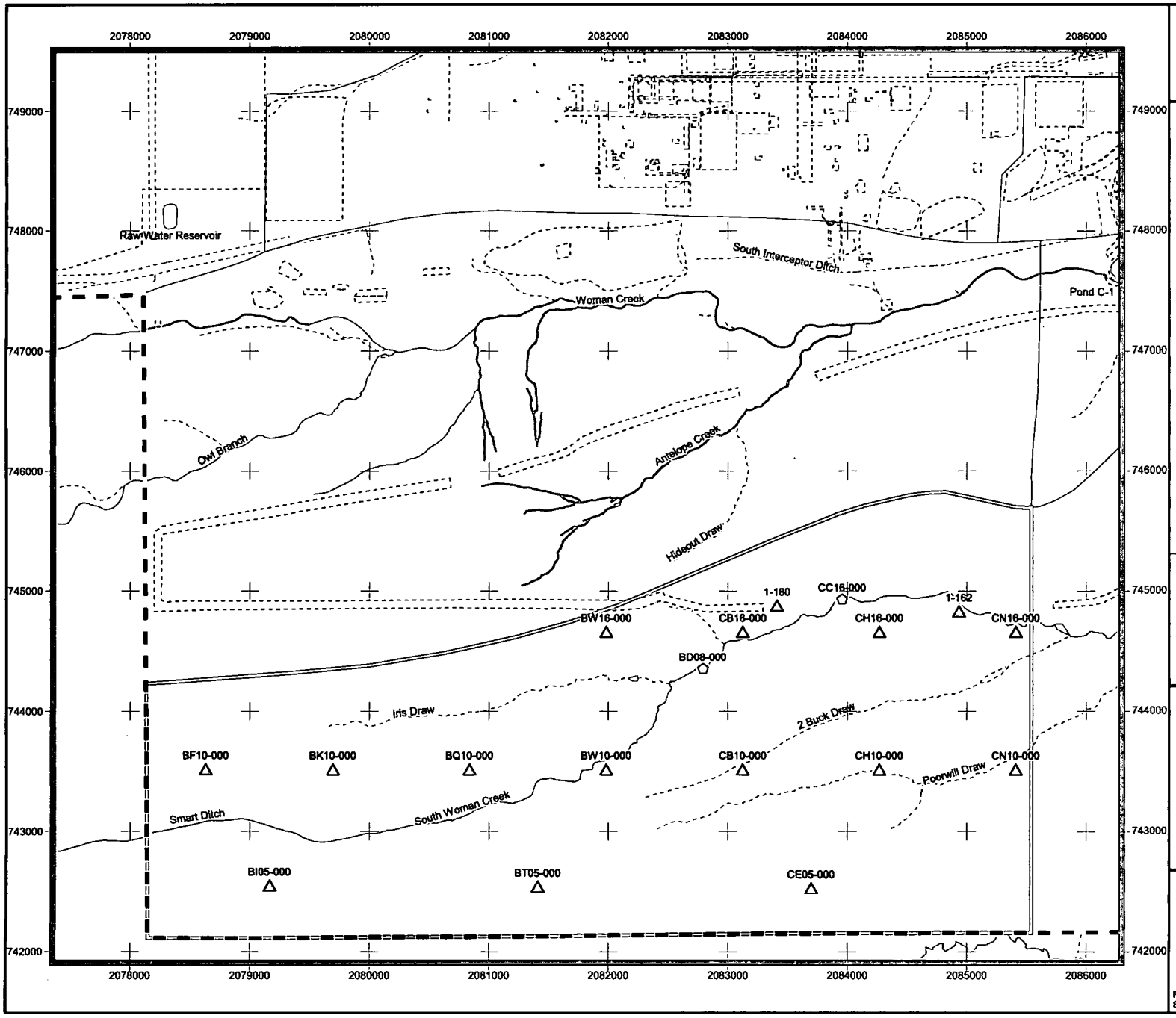

Figure 1.6
Southwest Buffer Zone Area Exposure Unit Surface Soil and Surface Sediment Sample Locations

KEY

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

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

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

N
W E
S

0 600 1200 Feet

Scale 1:14400

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Rocky Flats Environmental Technology Site

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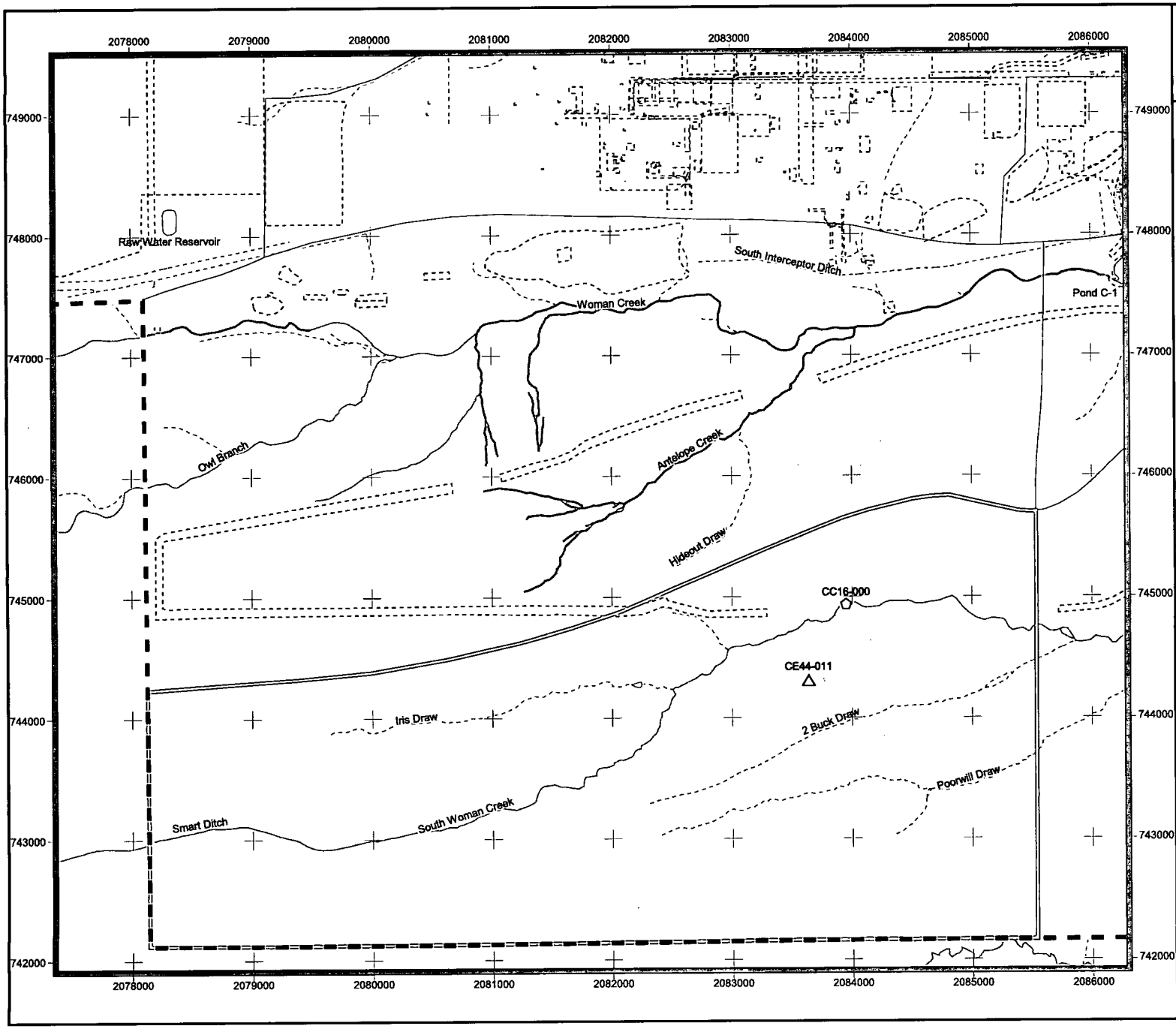

Figure 1.7
Southwest Buffer Zone Area Exposure Unit Subsurface Soil and Subsurface Sediment Sample Locations

KEY

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

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

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

N W E S

0 600 1200 Feet

Scale 1:14400

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

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COMPREHENSIVE RISK ASSESSMENT

SOUTHWEST BUFFER ZONE AREA EXPOSURE UNIT

VOLUME 12: 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
SWEU	Southwest Buffer Zone Area Exposure Unit
TIC	tentatively identified compound
VOC	volatile organic compound
WRW	wildlife refuge worker

1.0 EVALUATION OF DETECTION LIMITS FOR NONDETECTED ANALYTES IN THE SOUTHWEST BUFFER ZONE 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 adverse 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 Southwest Buffer Zone (BZ) Area Exposure Unit (EU) (SWEU) 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

Uranium was the only nondetected analyte in surface soil/surface sediment in SWEU (Table A1.1). The maximum reported result was below the PRG and, therefore, there is very little uncertainty associated with its results.

1.1.2 Subsurface Soil/Subsurface Sediment

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

PRGs were unavailable 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

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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 SWEU suggests there is an acceptable level 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 SWEU.

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 SWEU.

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

1.3.1 Surface Soil

The minimum and maximum reported results for all nondetected analytes in surface soil were below their respective ESLs (Table A1.3). Therefore, there is very little uncertainty associated with the reported results for nondetected analytes in surface soil in the SWEU.

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 unavailable 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 SWEU.

1.4.2 Subsurface Soil

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

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TABLES

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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?[b]
Inorganics (mg/kg)				
Uranium	1.4 - 2.9	16	333	No

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

[b] Value is the maximum reported result for nondetected analytes.

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?[b]
Inorganics (mg/kg)				
Antimony	0.3 - 0.87	3	511	No
Selenium	0.84 - 1.1	3	6,388	No
Silver	0.098 - 0.21	3	6,388	No
Thallium	0.46 - 0.99	3	89.4	No
Tin	0.92 - 2	3	766,500	No
Organics (ug/kg)				
1,2,4-Trichlorobenzene	1.58	1	1.74E+06	No
Hexachlorobutadiene	1.66	1	255,500	No
Naphthalene	1.48	1	1.61E+07	No
1,1,1,2-Tetrachloroethane	1.36	1	1.05E+06	No
1,1,1-Trichloroethane	1.21	1	1.06E+08	No
1,1,2,2-Tetrachloroethane	1.25	1	120,551	No
1,1,2-Trichloro-1,2,2-trifluoroethane	2.05	1	2.74E+10	No
1,1,2-Trichloroethane	1.02	1	322,253	No
1,1-Dichloroethane	1.09	1	3.12E+07	No
1,1-Dichloroethene	1.63	1	199,706	No
1,1-Dichloropropene	1.38	1	N/A	UT
1,2,3-Trichlorobenzene	1.57	1	N/A	UT
1,2,3-Trichloropropane	1.14	1	23,910	No
1,2,4-Trimethylbenzene	1.12	1	1.53E+06	No
1,2-Dibromo-3-chloropropane	2.93	1	34,137	No
1,2-Dibromoethane	1.23	1	403	No
1,2-Dichlorobenzene	1.41	1	3.32E+07	No
1,2-Dichloroethane	1.24	1	152,603	No
1,2-Dichloropropane	1	1	441,907	No
1,3,5-Trimethylbenzene	0.776	1	1.31E+06	No
1,3-Dichlorobenzene	1.55	1	3.83E+07	No
1,3-Dichloropropane	0.868	1	N/A	UT
1,4-Dichlorobenzene	1.22	1	1.05E+06	No
2,2-Dichloropropane	1.15	1	N/A	UT
2-Butanone	11.0	1	5.33E+08	No
2-Chlorotoluene	1.74	1	2.56E+07	No
2-Hexanone	8.79	1	N/A	UT
4-Chlorotoluene	1.02	1	N/A	UT
4-Isopropyltoluene	1.28	1	N/A	UT
4-Methyl-2-pentanone	7.43	1	9.57E+08	No
Acetone	25.5	1	1.15E+09	No
Benzene	0.943	1	270,977	No
Bromobenzene	1.43	1	N/A	UT
Bromochloromethane	1.37	1	N/A	UT
Bromodichloromethane	0.752	1	771,304	No
Bromoform	1.22	1	4.83E+06	No
Bromomethane	1.75	1	241,033	No
Carbon Disulfide	3.04	1	1.88E+07	No
Carbon Tetrachloride	1.29	1	97,124	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?[b]
Chlorobenzene	1.09	1	7.67E+06	No
Chloroethane	4.27	1	1.65E+07	No
Chloroform	0.983	1	90,270	No
Chloromethane	1.53	1	1.32E+06	No
cis-1,2-Dichloroethene	1.37	1	1.28E+07	No
cis-1,3-Dichloropropene	0.958	1	223,462	No
Dibromochloromethane	1.10	1	569,296	No
Dibromomethane	1.21	1	N/A	UT
Dichlorodifluoromethane	2.96	1	2.64E+06	No
Ethylbenzene	0.948	1	6.19E+07	No
Isopropylbenzene	1.42	1	375,823	No
Methylene Chloride	1.42	1	3.13E+06	No
n-Butylbenzene	1.13	1	N/A	UT
n-Propylbenzene	1.26	1	N/A	UT
sec-Butylbenzene	1.19	1	N/A	UT
Styrene	1.15	1	1.59E+08	No
tert-Butylbenzene	1.25	1	N/A	UT
Tetrachloroethene	1.49	1	77,111	No
Toluene	1.44	1	3.56E+07	No
trans-1,2-Dichloroethene	1.53	1	3.30E+06	No
trans-1,3-Dichloropropene	1.07	1	239,434	No
Trichloroethene	0.813	1	20,354	No
Trichlorofluoromethane	1.43	1	1.74E+07	No
Vinyl Chloride	3.22	1	24,948	No
Xylene	2.86	1	1.22E+07	No

[a] No analytes were detected in less than 5 percent of samples.
[b] Value is the maximum reported result for nondetected analytes.
N/A = Not available or not applicable.
UT = Uncertain toxicity.

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?[b]
Inorganics (mg/kg)				
Thallium	0.93 - 1.2	14	1	Yes
Uranium	1.4 - 1.8	14	5	No

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

[b] Value is the maximum reported result for nondetected analytes.

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?[b]
Inorganics (mg/kg)				
Antimony	0.3 - 0.31	2	18.7	No
Beryllium	0.59 - 0.96	2	211	No
Cadmium	0.068 - 0.07	2	198	No
Molybdenum	0.31 - 0.32	2	27.1	No
Selenium	0.84 - 0.87	2	2.80	No
Silver	0.098 - 0.21	2	N/A	UT
Sodium	430 - 630	2	N/A	UT
Thallium	0.96 - 0.99	2	204	No
Tin	0.92 - 1.3	2	80.6	No
Organics (ug/kg)				
1,2,4-Trichlorobenzene	1.58	1	94,484	No
Hexachlorobutadiene	1.66	1	150,894	No
Naphthalene	1.48	1	1.60E+07	No
1,1,1,2-Tetrachloroethane	1.36	1	N/A	UT
1,1,1-Trichloroethane	1.21	1	4.85E+07	No
1,1,2,2-Tetrachloroethane	1.25	1	4.70E+06	No
1,1,2-Trichloro-1,2,2-trifluoroethane	2.05	1	N/A	UT
1,1,2-Trichloroethane	1.02	1	N/A	UT
1,1-Dichloroethane	1.09	1	215,360	No
1,1-Dichloroethene	1.63	1	1.28E+06	No
1,1-Dichloropropene	1.38	1	N/A	UT
1,2,3-Trichlorobenzene	1.57	1	N/A	UT
1,2,3-Trichloropropane	1.14	1	1.17E+06	No
1,2,4-Trimethylbenzene	1.12	1	N/A	UT
1,2-Dibromo-3-chloropropane	2.93	1	N/A	UT
1,2-Dibromoethane	1.23	1	N/A	UT
1,2-Dichlorobenzene	1.41	1	N/A	UT
1,2-Dichloroethane	1.24	1	2.00E+06	No
1,2-Dichloropropane	1	1	3.92E+06	No
1,3,5-Trimethylbenzene	0.776	1	855,709	No
1,3-Dichlorobenzene	1.55	1	N/A	UT
1,3-Dichloropropane	0.868	1	N/A	UT
1,4-Dichlorobenzene	1.22	1	5.93E+06	No
2,2-Dichloropropane	1.15	1	N/A	UT
2-Butanone	11.0	1	4.94E+07	No
2-Chlorotoluene	1.74	1	N/A	UT
2-Hexanone	8.79	1	N/A	UT
4-Chlorotoluene	1.02	1	N/A	UT
4-Isopropyltoluene	1.28	1	N/A	UT
4-Methyl-2-pentanone	7.43	1	859,131	No
Acetone	25.5	1	247,687	No
Benzene	0.943	1	1.10E+06	No
Bromobenzene	1.43	1	N/A	UT
Bromochloromethane	1.37	1	N/A	UT

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?[b]
Bromodichloromethane	0.752	1	381,135	No
Bromoform	1.22	1	198,571	No
Bromomethane	1.75	1	N/A	UT
Carbon Disulfide	3.04	1	410,941	No
Carbon Tetrachloride	1.29	1	736,154	No
Chlorobenzene	1.09	1	413,812	No
Chloroethane	4.27	1	N/A	UT
Chloroform	0.983	1	560,030	No
Chloromethane	1.53	1	N/A	UT
cis-1,2-Dichloroethene	1.37	1	132,702	No
cis-1,3-Dichloropropene	0.958	1	222,413	No
Dibromochloromethane	1.10	1	389,064	No
Dibromomethane	1.21	1	N/A	UT
Dichlorodifluoromethane	2.96	1	59,980	No
Ethylbenzene	0.948	1	N/A	UT
Isopropylbenzene	1.42	1	N/A	UT
Methylene Chloride	1.42	1	209,560	No
n-Butylbenzene	1.13	1	N/A	UT
n-Propylbenzene	1.26	1	N/A	UT
sec-Butylbenzene	1.19	1	N/A	UT
Styrene	1.15	1	1.53E+06	No
tert-Butylbenzene	1.25	1	N/A	UT
Tetrachloroethene	1.49	1	72,494	No
Toluene	1.44	1	1.22E+06	No
trans-1,2-Dichloroethene	1.53	1	1.87E+06	No
trans-1,3-Dichloropropene	1.07	1	222,413	No
Trichloroethene	0.813	1	32,424	No
Trichlorofluoromethane	1.43	1	N/A	UT
Vinyl Chloride	3.22	1	6,494	No
Xylene[c]	2.86	1	111,663	No

[a] No analytes were detected in less than 5 percent of samples.
[b] Value is the maximum reported results for nondetected analytes.
[c] The value for total xylene is used.
N/A = Not available or not applicable.
UT = Uncertain toxicity.

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COMPREHENSIVE RISK ASSESSMENT

SOUTHWEST BUFFER ZONE AREA EXPOSURE UNIT

VOLUME 12: 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
SWEU	Southwest Buffer Zone Area Exposure Unit
TCLP	Toxicity Characteristic Leaching Procedure
TIC	tentatively identified compound
V&V	verification and validation
VOC	volatile organic compound

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EXECUTIVE SUMMARY

This document provides an assessment of the quality of the data used in the Southwest Buffer Zone (BZ) Area Exposure Unit (EU) (SWEU) 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 88 to 100 percent of the SWEU 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 SWEU V&V data, approximately 14 percent was qualified as estimated and/or undetected. Approximately 3 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 SWEU 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). 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 SWEU are of sufficient quality for use in the CRA.

1.0 INTRODUCTION

The Southwest Buffer Zone (BZ) Area Exposure Unit (EU) (SWEU) 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 SWEU 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).

[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.

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- Representativeness of the data was verified through review of:
  - 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/Corrective Measures Study (CMS)-Feasibility Study (RI/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 4,500 specific analytical records exist in the SWEU CRA data set, some 95 percent of which (4,279 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 V&V findings (except "R"-flagged data) and data that have no flags as a result of V&V are used in the SWEU 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 SWEU 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-one 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. Five 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 approximately 4 percent of all V&V data, have been removed from the data used in the SWEU CRA because the validator has

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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 are not calculated as outlined in the CRA Methodology for target sample/field duplicate analyte pairs where one or both of the results are less than five times the RL.

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 Metals – Soil

Blank, LCS, matrix, 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 blank contamination and expired instrument detection limit (IDL) studies. While the importance of these QC parameters should not be overlooked, it is also important to note that the data were qualified as usable, although estimated.

3.2 Metals – Water

Blank, calibration, documentation, instrument setup, LCS, matrix, sensitivity, and other observations resulted in V&V qualifications associated with this analyte group/matrix combination. The percentage of all observations is low with the exception of those records qualified due to transcription errors and blank contamination. Transcription errors, however, have no impact on data quality because all issues have previously been evaluated and corrected. While the importance of blank analyses should not be overlooked, it is also important to note that the data were qualified as usable.

3.3 Pesticides – Water

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

3.4 Radionuclides – Soil

LCS and other observations resulted in V&V qualifications related to this analyte group/matrix combination. While the percentage of the data qualified because one of the QC samples did not meet method requirements is high, is it important to note that the data were qualified as usable.

3.5 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 and other QC analyses including continuing calibration verifications, LCSs, and MS/MSDs 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 16 percent of the V&V data for this analyte group/matrix combination were rejected, 98 percent of all associated data underwent V&V. This leaves less than 1 percent of the data for this analyte group/matrix combination that may have been rejected if a review had been performed.

3.6 Semi-Volatile Organic Compounds (SVOCs) – Water

Documentation and LCS issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of observations all is low and within method expectations.

3.7 Volatile Organic Compounds (VOCs) – Soil

Calibration issues resulted in V&V observations related to this analyte group/matrix combination. The percentage of observations is low within method expectations.

3.8 Volatile Organic Compounds – Water

Blank, confirmation, documentation, holding time, and LCS 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 they were added by the reviewer. Validator-added records, however, have no effect on data quality as all issues have previously been evaluated and corrected.

3.9 Wet Chemistry Parameters – Soil

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

3.10 Wet Chemistry Parameters – Water

Blank, calibration, documentation, holding time, matrix, 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 SWEU CRA, approximately 95 percent underwent the V&V process. Of that 95 percent, 81 percent was qualified as having no QC issues and approximately 14 percent was qualified as estimated or undetected (Table A2.8). The remaining 5 percent of the V&V data are made up of records qualified with additional flags indicating acceptable data such as "A," "E," or "P." Approximately 3 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 4 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 19 percent of the SWEU 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 3 percent was noted for observations related to precision. Of that 3 percent, 96 percent was qualified for issues related to sample matrices and the remaining 4 percent was qualified for issues related to result confirmation or instrument setup. No LCS or instrument 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, 41 percent was noted for accuracy-related observations. Of that 41 percent, 79 percent was noted for laboratory practice-related observations, while sample-specific accuracy observations make up the other 21 percent. Although the percentage of data with noted accuracy issues is 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 51 percent was noted for observations related to representativeness. Of that 51 percent, 87 percent was qualified for blank observations, 4 percent for failure to observe allowed holding times, 2 percent for sensitivity issues, and 4 percent for documentation issues. Instrument setup, LCS, and other observations make up the remaining 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 4 percent of the overall data were rejected, the use of non-V&V data for the SWEU 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 (%)
Dioxins and Furans	WATER	7	7	100.00
Herbicide	WATER	5	5	100.00
Metal	SOIL	570	570	100.00
Metal	WATER	1,618	1,833	88.27
PCB	WATER	7	7	100.00
Pesticide	WATER	22	22	100.00
Radionuclide	SOIL	91	95	95.79
Radionuclide	WATER	336	344	97.67
SVOC	SOIL	3	3	100.00
SVOC	WATER	103	103	100.00
VOC	SOIL	61	61	100.00
VOC	WATER	1,206	1,206	100.00
Wet Chemistry	SOIL	19	19	100.00
Wet Chemistry	WATER	231	239	96.65
	Total	**4,279**	**4,514**	**94.79%**

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
51	Nonverifiable laboratory results and/or unsubmitted data

Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
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
110	Laboratory control sample recovery criteria were not met
111	Laboratory duplicate sample precision criteria were not met

Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
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
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)

Table A2.3
V&V Reason Code Definitions

Validation Reason Code	Description
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

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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
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 (%)
Metal	SOIL	Blanks	Calibration verification blank contamination	No	38	570	6.67
Metal	SOIL	Blanks	Calibration verification blank contamination	Yes	8	570	1.40
Metal	SOIL	LCS	Low level check sample recovery criteria were not met	No	31	570	5.44
Metal	SOIL	LCS	Low level check sample recovery criteria were not met	Yes	16	570	2.81
Metal	SOIL	Matrices	LCS/LCSD precision criteria were not met	Yes	13	570	2.28
Metal	SOIL	Matrices	Predigestion MS recovery criteria were not met	No	13	570	2.28
Metal	SOIL	Matrices	Predigestion MS recovery criteria were not met	Yes	18	570	3.16
Metal	SOIL	Matrices	Predigestion MS recovery was < 30 percent	Yes	5	570	0.88
Metal	SOIL	Matrices	Serial dilution criteria were not met	Yes	9	570	1.58
Metal	SOIL	Other	IDL is older than 3 months from date of analysis	No	118	570	20.70
Metal	SOIL	Other	IDL is older than 3 months from date of analysis	Yes	362	570	63.51
Metal	WATER	Blanks	Calibration verification blank contamination	No	4	1,618	0.25
Metal	WATER	Blanks	Method, preparation, or reagent blank contamination	No	175	1,618	10.82
Metal	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	36	1,618	2.22
Metal	WATER	Blanks	Negative bias indicated in the blanks	No	23	1,618	1.42
Metal	WATER	Blanks	Negative bias indicated in the blanks	Yes	5	1,618	0.31
Metal	WATER	Calibration	Calibration correlation coefficient did not meet requirements	No	13	1,618	0.80
Metal	WATER	Calibration	Calibration correlation coefficient did not meet requirements	Yes	2	1,618	0.12
Metal	WATER	Documentation Issues	Key data fields incorrect	No	5	1,618	0.31
Metal	WATER	Documentation Issues	Key data fields incorrect	Yes	15	1,618	0.93
Metal	WATER	Documentation Issues	Transcription error	No	331	1,618	20.46
Metal	WATER	Instrument Set-up	AA duplicate injection precision criteria were not met	No	2	1,618	0.12
Metal	WATER	LCS	CRDL check sample recovery criteria were not met	No	3	1,618	0.19
Metal	WATER	LCS	CRDL check sample recovery criteria were not met	Yes	9	1,618	0.56
Metal	WATER	LCS	LCS recovery criteria were not met	Yes	2	1,618	0.12
Metal	WATER	LCS	Low level check sample recovery criteria were not met	No	3	1,618	0.19
Metal	WATER	LCS	Low level check sample recovery criteria were not met	Yes	2	1,618	0.12
Metal	WATER	Matrices	Duplicate sample precision criteria were not met	Yes	5	1,618	0.31
Metal	WATER	Matrices	Post-digestion MS did not meet control criteria	No	19	1,618	1.17
Metal	WATER	Matrices	Post-digestion MS did not meet control criteria	Yes	1	1,618	0.06
Metal	WATER	Matrices	Predigestion MS recovery criteria were not met	No	30	1,618	1.85
Metal	WATER	Matrices	Predigestion MS recovery criteria were not met	Yes	19	1,618	1.17
Metal	WATER	Matrices	Serial dilution criteria were not met	No	1	1,618	0.06
Metal	WATER	Matrices	Serial dilution criteria were not met	Yes	38	1,618	2.35
Metal	WATER	Other	IDL is older than 3 months from date of analysis	No	19	1,618	1.17
Metal	WATER	Other	IDL is older than 3 months from date of analysis	Yes	10	1,618	0.62
Metal	WATER	Sensitivity	IDL changed due to a significant figure discrepancy	No	14	1,618	0.87
Pesticide	WATER	Calibration	Continuing calibration verification criteria were not met	No	1	22	4.55
Radionuclide	SOIL	LCS	LCS recovery criteria were not met	Yes	2	91	2.20
Radionuclide	SOIL	Other	QC sample does not meet method requirements	No	33	91	36.26
Radionuclide	SOIL	Other	QC sample does not meet method requirements	Yes	22	91	24.18
Radionuclide	WATER	Blanks	Method, preparation, or reagent blank contamination	No	8	336	2.38
Radionuclide	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	25	336	7.44
Radionuclide	WATER	Calibration	Calibration counting statistics did not meet criteria	No	3	336	0.89
Radionuclide	WATER	Calibration	Continuing calibration verification criteria were not met	No	18	336	5.36
Radionuclide	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	56	336	16.67
Radionuclide	WATER	Documentation Issues	Record added by the validator	Yes	9	336	2.68
Radionuclide	WATER	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	81	336	24.11
Radionuclide	WATER	Documentation Issues	Transcription error	No	62	336	18.45
Radionuclide	WATER	Documentation Issues	Transcription error	Yes	16	336	4.76
Radionuclide	WATER	Holding Times	Holding times were exceeded	No	1	336	0.30
Radionuclide	WATER	Holding Times	Holding times were exceeded	Yes	5	336	1.49
Radionuclide	WATER	Holding Times	Holding times were grossly exceeded	No	1	336	0.30
Radionuclide	WATER	Instrument Set-up	Resolution criteria were not met	No	1	336	0.30

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	Instrument Set-up	Transformed spectral index external site criteria were not met	No	3	336	0.89
Radionuclide	WATER	LCS	Expected LCS value not submitted/verifiable	No	2	336	0.60
Radionuclide	WATER	LCS	Expected LCS value not submitted/verifiable	Yes	5	336	1.49
Radionuclide	WATER	LCS	LCS recovery > +/- 3 sigma	No	12	336	3.57
Radionuclide	WATER	LCS	LCS recovery > +/- 3 sigma	Yes	6	336	1.79
Radionuclide	WATER	LCS	LCS recovery criteria were not met	No	1	336	0.30
Radionuclide	WATER	LCS	LCS recovery criteria were not met	Yes	5	336	1.49
Radionuclide	WATER	LCS	LCS relative percent error criteria not met	No	5	336	1.49
Radionuclide	WATER	LCS	LCS relative percent error criteria not met	Yes	20	336	5.95
Radionuclide	WATER	Matrices	Recovery criteria were not met	Yes	3	336	0.89
Radionuclide	WATER	Matrices	Replicate analysis was not performed	No	8	336	2.38
Radionuclide	WATER	Matrices	Replicate analysis was not performed	Yes	9	336	2.68
Radionuclide	WATER	Matrices	Replicate precision criteria were not met	No	7	336	2.08
Radionuclide	WATER	Matrices	Replicate precision criteria were not met	Yes	27	336	8.04
Radionuclide	WATER	Matrices	Replicate recovery criteria were not met	No	1	336	0.30
Radionuclide	WATER	Matrices	Replicate recovery criteria were not met	Yes	1	336	0.30
Radionuclide	WATER	Other	Sample results were not validated due to re-analysis	No	1	336	0.30
Radionuclide	WATER	Other	See hard copy for further explanation	No	6	336	1.79
Radionuclide	WATER	Other	See hard copy for further explanation	Yes	31	336	9.23
Radionuclide	WATER	Sensitivity	Incorrect reported activity or MDA	Yes	3	336	0.89
Radionuclide	WATER	Sensitivity	MDA exceeded the RDL	No	3	336	0.89
Radionuclide	WATER	Sensitivity	MDA exceeded the RDL	Yes	9	336	2.68
Radionuclide	WATER	Sensitivity	MDA was calculated by reviewer	No	6	336	1.79
Radionuclide	WATER	Sensitivity	MDA was calculated by reviewer	Yes	160	336	47.62
SVOC	WATER	Documentation Issues	Transcription error	No	1	103	0.97
SVOC	WATER	LCS	LCS recovery criteria were not met	No	2	103	1.94
VOC	SOIL	Calibration	Continuing calibration verification criteria were not met	No	2	61	3.28
VOC	SOIL	Calibration	Independent calibration verification criteria not met	No	1	61	1.64
VOC	WATER	Blanks	Method, preparation, or reagent blank contamination	No	11	1,206	0.91
VOC	WATER	Confirmation	Results were not confirmed	Yes	1	1,206	0.08
VOC	WATER	Documentation Issues	Record added by the validator	No	99	1,206	8.21
VOC	WATER	Documentation Issues	Transcription error	No	33	1,206	2.74
VOC	WATER	Holding Times	Holding times were exceeded	No	6	1,206	0.50
VOC	WATER	LCS	LCS recovery criteria were not met	No	38	1,206	3.15
Wet Chemistry	SOIL	Matrices	Predigestion MS recovery criteria were not met	Yes	3	19	15.79
Wet Chemistry	SOIL	Matrices	Predigestion MS recovery was < 30 percent	Yes	10	19	52.63
Wet Chemistry	SOIL	Other	IDL is older than 3 months from date of analysis	Yes	16	19	84.21
Wet Chemistry	WATER	Blanks	Method, preparation, or reagent blank contamination	No	1	231	0.43
Wet Chemistry	WATER	Blanks	Negative bias indicated in the blanks	No	1	231	0.43
Wet Chemistry	WATER	Calibration	Calibration correlation coefficient did not meet requirements	Yes	2	231	0.87
Wet Chemistry	WATER	Documentation Issues	Record added by the validator	No	6	231	2.60
Wet Chemistry	WATER	Documentation Issues	Record added by the validator	Yes	3	231	1.30
Wet Chemistry	WATER	Documentation Issues	Transcription error	Yes	4	231	1.73
Wet Chemistry	WATER	Holding Times	Holding times were exceeded	No	7	231	3.03
Wet Chemistry	WATER	Holding Times	Holding times were exceeded	Yes	3	231	1.30
Wet Chemistry	WATER	Holding Times	Holding times were grossly exceeded	No	5	231	2.16
Wet Chemistry	WATER	Holding Times	Holding times were grossly exceeded	Yes	3	231	1.30
Wet Chemistry	WATER	Matrices	Predigestion MS recovery criteria were not met	No	1	231	0.43
Wet Chemistry	WATER	Matrices	Predigestion MS recovery criteria were not met	Yes	6	231	2.60
Wet Chemistry	WATER	Matrices	Predigestion MS recovery was < 30 percent	Yes	1	231	0.43
Wet Chemistry	WATER	Other	IDL is older than 3 months from date of analysis	Yes	1	231	0.43
Wet Chemistry	WATER	Other	Lab results not verified due to unsubmitted data	Yes	1	231	0.43
Wet Chemistry	WATER	Other	Result obtained through dilution	Yes	1	231	0.43

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

Analyte Group	Matrix	Total No. of Rejected Records	Total No. of Records	Percent Rejected (%)
Dioxins and Furans	WATER	0	7	0.00
Herbicide	WATER	0	6	0.00
Metal	SOIL	31	1,102	2.81
Metal	WATER	69	2,600	2.65
PCB	WATER	0	7	0.00
Pesticide	WATER	0	23	0.00
Radionuclide	SOIL	0	97	0.00
Radionuclide	WATER	98	616	15.91
SVOC	SOIL	0	3	0.00
SVOC	WATER	10	113	8.85
VOC	SOIL	0	61	0.00
VOC	WATER	58	1,819	3.19
Wet Chemistry	SOIL	0	77	0.00
Wet Chemistry	WATER	8	422	1.90
	Total	**274**	**6,953**	**3.94%**

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	0	30	0.00	5.26
Metal	WATER	1	174	0.57	9.49
Radionuclide	SOIL	0	6	0.00	6.32
Wet Chemistry	SOIL	0	1	0.00	5.26
Wet Chemistry	WATER	0	21	0.00	8.79

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

Analyte Group	Matrix	No. of GRA Data Records Qualified	Total No. of V&V GRA Records	Detect?	Percent Qualified (%)
Metal	SOIL	70	570	No	12.28
Metal	SOIL	64	570	Yes	11.23
Metal	WATER	262	1,618	No	16.19
Metal	WATER	113	1,618	Yes	6.98
Pesticide	WATER	1	22	No	4.55
Radionuclide	WATER	2	336	No	0.60
Radionuclide	WATER	5	336	Yes	1.49
SVOC	WATER	2	103	No	1.94
VOC	SOIL	3	61	No	4.92
VOC	WATER	55	1,206	No	4.56
Wet Chemistry	SOIL	13	19	Yes	68.42
Wet Chemistry	WATER	15	231	No	6.49
Wet Chemistry	WATER	15	231	Yes	6.49
	Total	**620**	**4,279**		**14.49%**

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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	29	433	6.70
Metal	WATER	2	516	0.39
	Total	**31**	**949**	**3.27%**

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

COMPREHENSIVE RISK ASSESSMENT

SOUTHWEST BUFFER ZONE AREA EXPOSURE UNIT

VOLUME 12: ATTACHMENT 3

Statistical Analyses and Professional Judgment

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ACRONYMS AND ABBREVIATIONS

CDPHE	Colorado Department of Public Health and Environment
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
IHSS	Individual Hazardous Substance Site
MDC	maximum detected concentration
mg/kg	milligrams per kilogram
NCP	National Contingency Plan
NOAEL	no observed adverse effect level
PAC	Potential Area of Concern
PCOC	potential contaminant of concern
PMJM	Preble's meadow jumping mouse
PRG	preliminary remediation goal
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study

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SWEU	Southwest Buffer Zone Area Exposure Unit
tESL	threshold ESL
UCL	upper confidence limit
UTL	upper tolerance limit
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 Southwest Buffer Zone (BZ) Area Exposure Unit (EU) (SWEU) at the Rocky Flats Environmental Technology Site (RFETS). The methods used to perform the statistical analysis and to develop the professional judgment sections are described in Section 2.2.5 (HHRA) and Section 2.3.4 (ERA) of 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) and follow the Final Comprehensive Risk Assessment (CRA) Work Plan and Methodology (DOE 2005a).

2.0 RESULTS OF STATISTICAL COMPARISONS TO BACKGROUND FOR THE SOUTHWEST BUFFER ZONE 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 SWEU 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 A3.2.17.[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 and ECOIs for surface soil with concentrations in the SWEU that are statistically greater than background (or background comparisons are not performed) are carried through to the professional judgment step of the COC/ECOPC selection processes. ECOIs (for non-PMJM receptors) with concentrations in the SWEU that are statistically greater than background (or background comparisons are not performed) are carried

[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 SWEU 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.

through to the upper-bound exposure point concentration comparison step of the ECOPC selection processes.

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 SWEU surface soil/surface sediment data set, the maximum detected concentrations (MDC) for aluminum 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 aluminum did not exceed the PRG. Consequently, aluminum was not evaluated further.

The MDCs and UCLs for arsenic exceeded the PRGs for the SWEU data set; thus, arsenic was carried forward into the statistical background comparison step. The results of the statistical comparison of the SWEU surface soil/surface sediment data to background data for arsenic are presented in Table A3.2.1 and the summary statistics for background and SWEU surface soil/surface sediment data are shown in Table A3.2.2.

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

Analytes Statistically Greater than Background at the 0.1 Significance Level

- Arsenic

Background Comparison Not Performed[1]

- Not Applicable

2.2 Subsurface Soil/Subsurface Sediment Data Used in the HHRA

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

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

For the SWEU surface soil data set, the MDCs for aluminum, arsenic, barium, boron, chromium, copper, lead, lithium, mercury, nickel, selenium, vanadium, and zinc exceeded a non-Preble's meadow jumping mouse (PMJM) no observed adverse effect level (NOAEL) ecological screening level (ESL) and, consequently, these analytes were carried forward into the statistical background comparison step. The results of the statistical comparison of the SWEU surface soil data to background data are presented in Table A3.2.3 and the summary statistics for background and SWEU surface soil data are shown in Table A3.2.4.

The results of the statistical comparisons of the SWEU surface soil for non-PMJM receptors to background data indicate the following:

Analytes Statistically Greater than Background at the 0.1 Significance Level

- Aluminum
- Arsenic
- Barium
- Chromium
- Lithium
- Nickel
- Vanadium

Analytes Not Statistically Greater than Background at the 0.1 Significance Level

- Copper
- Lead
- Mercury
- Selenium
- Zinc

Background Comparison not Performed[1]

- Boron

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

The MDCs for arsenic, nickel, vanadium, and zinc exceed the ESLs for the PMJM receptor for the SWEU surface soil data set (i.e., samples within the PMJM habitat areas) and were carried forward into the background comparison step. The results of the statistical comparison of the SWEU surface soil (PMJM) data to background data are presented in Table A3.2.5 and the summary statistics for background and SWEU surface soil data are shown in Table A3.2.6.

The results of the statistical comparisons of the SWEU surface soil for PMJM receptors to background data indicate the following:

Analytes Statistically Greater than Background at the 0.1 Significance Level

- Nickel
- Vanadium

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Analytes Not Statistically Greater than Background at the 0.1 Significance Level

- Arsenic
- Zinc

Background Comparison not Performed[1]

- Not Applicable.

2.5 Subsurface Soil Data used in the ERA

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

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

ECOIs in surface soil and subsurface soil (non-PMJM receptors only) with concentrations that are statistically greater than background or for which background comparisons could not be performed are evaluated further by comparing the exposure point concentration (EPC) to the threshold ESL (tESL). 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.

ECOIs in surface soil for PMJM receptors are not screened against tESLs. They are carried forward to the professional judgment evaluation.

3.1 ECOIs in Surface Soil

Arsenic and barium in surface soil (non-PMJM receptors) were eliminated from further consideration because their EPCs are not greater than the tESLs.

Aluminum, boron, chromium, lithium, nickel, and vanadium for soil surface (non-PMJM receptors) have EPCs greater than the tESLs and 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 SWEU. 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 background and other background data sets[3], and risk potential. 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 is included in the discussion.

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

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

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

[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.

[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.

GW

- Lithium
- Nickel
- Vanadium

- Surface soil for PMJM receptors (ERA)
  - Nickel
  - Vanadium

The following sections provide the professional judgment evaluations, by analyte and 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.

4.1.1 Summary of Process Knowledge

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

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 a potential to have been released into 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 the SWEU.

4.1.3 Pattern Recognition

Surface Soil (Non-PMJM)

Except for one sample (04F0740-004, Location Number = CH16-000), the probability plot for the natural log-transformed data set for aluminum (Figure A3.4.1) suggests the presence of a single population, which is indicative of background conditions. Sample 04F0740-004 is located in the northeastern portion of SWEU, south of South Woman Creek. This sample is not located near any historical Individual Hazardous Substance Sites (IHSSs) or Potential Areas of Concern (PACs), and was collected approximately 1,000 feet southeast of the eastern edge of PAC 000-501, on the other side of the South Woman Creek Drainage. There is no known contaminant source or release mechanism that would impact the area where this site is located. This anomalous sample contains the

highest aluminum concentration (29,000 milligrams per kilogram [mg/kg]) and is also the same anomalous sample identified in the other analytes, except boron, evaluated in this section.

4.1.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Aluminum was detected in each of the 14 surface soil samples collected within SWEU. Aluminum concentrations in surface soil samples at the SWEU range from 11,000 to 29,000 mg/kg, with a mean concentration of 15,857 mg/kg and a standard deviation of 4,330 mg/kg. Background aluminum concentrations range from 4,050 to 17,100 mg/kg, with a mean concentration of 10,202 mg/kg and a standard deviation of 3,256 mg/kg (Table A3.2.4).

The reported range for aluminum in surface soils of Colorado and bordering states (Table A3.4.1) is 10 to 100,000 mg/kg, with an arithmetic mean of 45,900 mg/kg and a standard deviation of 26,900 mg/kg (Shacklette and Boerngen 1984). Aluminum concentrations reported in surface soil samples at the SWEU (11,000 to 29,000 mg/kg) are well within this range.

4.1.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The MDC for aluminum in the SWEU (29,000 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (50 mg/kg). However, the 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 SWEU show a distribution similar to sitewide background concentrations and there are no historical records of a source area in the SWEU. Therefore, it is unlikely that the aluminum concentrations in surface soil within the SWEU could present potential risk concerns for wildlife populations.

4.1.6 Conclusion

The weight of evidence presented above shows that aluminum concentrations in SWEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge; the spatial distribution analysis; and the presence of a single data population indicative of naturally occurring aluminum. In addition, the aluminum concentrations in SWEU surface soil for non-PMJM receptors 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 SWEU and, therefore, is not further evaluated quantitatively.

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4.2 Arsenic

Arsenic had concentrations that were considered to be statistically greater than background in surface soil/surface sediment for the HHRA evaluation of the SWEU data set. Therefore, arsenic was carried forward to the professional judgment step. The lines of evidence used to determine if arsenic should be retained as a COC 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 SWEU 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 SWEU surface soil/surface sediment reflect variations in naturally occurring arsenic.

4.2.3 Pattern Recognition

Surface Soil/ Surface Sediment

The probability plot for the natural log-transformed data set for arsenic in the combined surface soil and surface sediment within the SWEU (Figure A3.4.2) is a classical "S"-shaped single population calculated on a limited number of samples (n=16) that do not adequately define the lower asymptotic suite of samples. The sample with the lowest arsenic concentration (05F0011-22) has an arsenic concentration of only 3.3 mg/kg, while the sample with the next lowest concentration (04F0731-002) contains 5.7 mg/kg. On the uppermost part of the probability plot, the four samples with the highest arsenic concentrations (04F0731-005, 04F0740-006, 04F0740-001, and 04F0731-003) are defining an upper asymptotic limb with arsenic concentrations of 8.5, 8.6, 8.6, and 9.0 mg/kg, respectively. The limited differences in arsenic concentrations for these four samples support this single background population with an upper arsenic concentration less than 10 mg/kg.

4.2.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil/Surface Sediment

Arsenic was detected in each of the 16 surface soil/surface sediment samples collected in the SWEU. Arsenic concentrations at SWEU range from 3.30 to 9.0 mg/kg, with a mean concentration of 7.16 mg/kg and a standard deviation of 1.43 mg/kg. Arsenic concentrations in the background data set range from 0.27 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).

The ranges of the SWEU and background data sets overlap. In addition, the MDC for the SWEU does not exceed the background MDC.

Arsenic concentrations reported in surface soil/surface sediment samples at the SWEU 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 9.0 mg/kg and the UCL is 7.78 mg/kg. Even though the UCL of 7.78 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 SWEU 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 the arsenic MDC of 9.0 mg/kg in SWEU surface soil/surface sediment within the SWEU does not exceed the background MDC of 9.60 mg/kg and the arsenic concentrations in surface soil/surface sediment within the SWEU appear to represent naturally occurring arsenic levels, this risk is unassociated with arsenic releases from RFETS.

4.2.6 Conclusion

The weight of evidence presented above shows that arsenic concentrations in SWEU surface soil/surface sediment are unlikely to be a result of historical site-related activities based on process knowledge, the spatial distribution analysis; and the presence of a single data population indicative of naturally occurring arsenic. In addition, the concentrations of arsenic in SWEU surface soil/surface sediment are well within regional background levels and are unlikely to result in risks to humans significantly above background risks. Arsenic is not considered a COC in surface soil/surface sediment for the SWEU and, therefore, 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.

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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 SWEU surface soil (non-PMJM) reflect variations in naturally occurring boron.

4.3.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log-transformed data set for boron (Figure A3.4.3) indicates the presence of a single population, which is indicative of background conditions.

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 (Shacklette and Boerngen 1984). Boron concentrations reported in surface soil samples at the SWEU (3.0 to 9.7 mg/kg, with a mean concentration of 5.93 mg/kg and a standard deviation of 1.76 mg/kg) (Table A3.2.4) are well within the range for boron in surface soil in Colorado and the bordering states (Table A3.4.1).

4.3.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The MDC for boron in SWEU (9.7 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (0.5 mg/kg). All other NOAEL ESLs were considerably 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 SWEU. 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 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 SWEU.

4.3.6 Conclusion

The weight of evidence presented above shows that boron concentrations in SWEU surface soil (non-PMJM receptors) are not likely to be a result of historical site-related activities based on process knowledge, the spatial distribution analysis; and the presence of a single data population indicative of naturally occurring boron. In addition, boron concentrations in SWEU surface soil for non-PMJM receptors are well within regional background levels and are unlikely to result in risk concerns for wildlife populations. Review of the source data for the ESL indicates that the ESL is questionable in its ability to predict risk. Boron is not considered an ECOPC in surface soil for the SWEU and, therefore, is not further evaluated quantitatively.

4.4 Chromium

Chromium 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 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 an 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 the SWEU.

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 the potential for chromium to be an 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 the SWEU.

4.4.3 Pattern Recognition

Surface Soil (Non-PMJM)

The probability plot for the natural log-transformed data set for chromium (Figure A3.4.4), with the exception for one sample (04F0740-004, CH16-000), shows the presence of a single population. This result is indicative of background conditions. The anomalous sample (04F0740-004, CH16-000) contains the highest chromium concentration (28 mg/kg) and is also the same anomalous sample identified in the other analytes, except boron, evaluated in this section.

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4.4.4 Comparison to RFETS Background and Other Background Data Sets

Chromium was detected in each of the 14 surface soil samples collected in the SWEU. Chromium concentrations at the SWEU range from 12.0 to 28.0 mg/kg, with a mean concentration of 16.0 mg/kg and a standard deviation of 3.88 mg/kg. Background chromium concentrations range from 5.5 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 bordering states is 3 to 500 mg/kg (Table A3.4.1), with an arithmetic mean of 48.2 mg/kg and standard deviation of 41 mg/kg. Chromium concentrations reported in surface soil samples at the SWEU (12 to 28.0 mg/kg and mean concentration of 16.0 mg/kg) are well within this range.

4.4.5 Risk Potential for Plants and Wildlife

The UTL for chromium in the SWEU (28 mg/kg) exceeded the NOAEL ESL for six receptor groups, terrestrial invertebrates (0.4 mg/kg), terrestrial plants (1 mg/kg), herbivorous mourning dove (25.0 mg/kg), insectivorous mourning dove (1.34 mg/kg), American kestrel (14.0 mg/kg), and the insectivorous deer mouse (15.9 mg/kg). With the exception of the herbivorous mourning dove ESL of 25.0 mg/kg, all of the ESLs exceeded by the UTL of 28 mg/kg are less than the MDC in background soils (16.9 mg/kg), indicating that they may be overly conservative because risks are not typically expected at background concentrations. The ESLs for all other non-PMJM receptors were greater than the site background MDC and range from 281.3 to 4,173 mg/kg.

4.4.6 Conclusion

The weight of evidence presented above shows that chromium concentrations in SWEU surface soil (non-PMJM receptors) are unlikely to be a result of historical site-related activities based on process knowledge, the spatial distribution analysis; and the presence of a single data population indicative of naturally occurring chromium. In addition, the chromium concentrations in SWEU surface soil (non-PMJM receptors) are well within regional background levels. Chromium is not considered an ECOPC in surface soil for the SWEU and, therefore, is not further evaluated quantitatively.

4.5 Lithium

Lithium had 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 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 SWEU is low due to

localized documented historical source areas remote from the SWEU. 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 SWEU 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 A3.4.5) shows that, except for one sample (04F0740-004, CH16-000), the lithium concentrations in surface soil in the SWEU reflect the presence of a single population. This result is indicative of background conditions. The anomalous sample (04F0740-004, CH16-000) contains the highest lithium concentration (19 mg/kg) and is also the same anomalous sample identified in the other analytes, except boron, evaluated in this section.

4.5.4 Comparison to RFETS Background and Other Background Data Sets

Lithium was detected in each of the 14 surface soil for non-PMJM receptor samples collected at the SWEU and concentrations ranged from 7.7 to 19.0 mg/kg, with a mean concentration of 11.2 and a standard deviation of 2.96 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, presented in Table A3.4.1 shows that background concentrations range from 5 to 130 mg/kg, with an arithmetic mean of 25.3 mg/kg and a standard deviation of 14.4 mg/kg (Shacklette and Boerngen 1984). Lithium concentrations reported in surface soil samples at the SWEU (7.7 to 19.0 mg/kg) are well within this range.

4.5.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL for lithium in the SWEU (17.4 mg/kg) exceeds the NOAEL ESL for only one receptor group, terrestrial plants (2 mg/kg). The UTL did not exceed the available NOAEL ESLs for any other receptor group (ESLs were not available for avian receptors due to lack of toxicity information). The NOAEL ESL for terrestrial plants is lower than the minimum detection of lithium in background surface soil. The authors of the document from which the terrestrial plant NOAEL ESL was selected (Efroymson et al 1997) placed a low confidence rating on the value. Other studies reported in Efroymson et al. (1997) report no observed adverse effects at 25 mg/kg, which is greater than the

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MDC. Lithium concentrations greater than the background in the SWEU are most likely due to local variations in natural sources. It is unlikely that lithium poses a risk potential to non-PMJM receptors in the SWEU.

4.5.6 Conclusion

The weight of evidence presented above shows that lithium concentrations in SWEU surface soil (non-PMJM receptors) are unlikely to be a result of historical site-related activities based on process knowledge, the spatial distribution analysis; and the presence of a single data population indicative of naturally occurring lithium. In addition, the lithium concentrations in SWEU surface soil (non-PMJM receptors) 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 SWEU and, therefore, is not further evaluated quantitatively.

4.6 Nickel

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

4.6.1 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 nickel to be an ECOPC in the SWEU is low due to localized documented historical source areas remote from the SWEU.

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 nickel concentrations in SWEU surface soil (non-PMJM) reflect variations in naturally occurring nickel.

Surface Soil (PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that nickel concentrations in SWEU surface soil (PMJM habitat) reflect variations in naturally occurring nickel.

4.6.3 Pattern Recognition

Surface Soil (Non-PMJM and PMJM)

The probability plot for the natural log-transformed data set for nickel (Figure A3.4.6) shows that, with the exception of perhaps one sample (04F0740-004, CH16-000), nickel concentrations in surface soil in the SWEU reflect the presence of a single population. This result is indicative of background conditions. Over half (eight) of the analytical values for nickel represent a detection limit as illustrated by the horizontal line at approximately natural logarithm 2.4 on the probability plot. The potentially anomalous sample (04F0740-004, CH16-000) contains the highest nickel concentration (21 mg/kg) and is also the same anomalous sample identified in the other analytes, except boron, evaluated in this section. Unlike the other analytes, the nickel concentration for this sample is only slightly above the normal distribution line. Other distribution defining methods would probably find the nickel distribution to be lognormal.

4.6.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Nickel was detected in each of the 14 surface soil (non-PMJM) samples collected in the SWEU. Nickel concentrations in surface soil at the SWEU range from 7.6 to 21.0 mg/kg, with a mean concentration of 12.0 mg/kg and a standard deviation of 3.46 mg/kg. Background concentrations of nickel range from 3.8 to 14 mg/kg, with a mean of 9.6 mg/kg and a standard deviation of 2.59 mg/kg (Table A3.2.4).

Table A3.4.1 presents the reported range for nickel in surface soil within Colorado and the bordering states and shows that nickel concentrations range from less than 5 to 700 mg/kg, with an arithmetic mean of 18.8 mg/kg and a standard deviation of 39.8 mg/kg (Shacklette and Boerngen 1984). Nickel concentrations reported in surface soil samples at the SWEU for non-PMJM receptors (7.6 to 21 mg/kg) are well within this range.

Surface Soil (PMJM)

Nickel was detected in each of the four surface soil (PMJM receptors) samples collected in the SWEU. Nickel concentrations in surface soil (PMJM receptor) at the SWEU range from 11.0 to 17.0 mg/kg, with a mean concentration of 14.5 mg/kg and a standard deviation of 2.65 mg/kg. Background concentrations of nickel range from 3.8 to 14 mg/kg, with a mean of 9.6 mg/kg and a standard deviation of 2.59 mg/kg (Table A3.2.6). Nickel concentrations reported in surface soil (PMJM) samples at the SWEU (11.0 to 17 mg/kg) are well within regional background concentrations of nickel in surface soil (Table A3.4.1).

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4.6.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL of nickel in the SWEU (21 mg/kg) exceeds the NOAEL ESL for six receptor groups, insectivorous mourning dove (1.24 mg/kg), insectivorous deer mouse (0.43 mg/kg), insectivorous coyote (1.86 mg/kg), generalist coyote (6.0 mg/kg), American kestrel (13.1 mg/kg), and herbivorous deer mouse (16.4 mg/kg). All of these ESLs (except the herbivorous deer mouse are less than the MDC in background soils (14 mg/kg), indicating that they may be overly conservative since risks are not typically expected at background concentrations.

Surface Soil (PMJM)

The MDC of nickel in PMJM habitat (17 mg/kg) also exceeded the PMJM NOAEL ESL (0.5 mg/kg). The MDC exceeded the maximum detected background concentration at all four samples in PMJM habitat (three samples within SWEU and one sample within the Southeast Buffer Zone Area EU [SEEU]). The PMJM ESL is lower than all background concentrations. Since risks are not typically expected at background concentrations, the ESL may be overly conservative.

4.6.6 Conclusion

The weight of evidence presented above shows that nickel concentrations in SWEU surface soil (non-PMJM receptors) are unlikely to be a result of historical site-related activities based on process knowledge, the spatial distribution analysis; and the presence of a single data population indicative of naturally occurring nickel. In addition, nickel concentrations in SWEU surface soil are well within regional background levels.

4.7 Vanadium

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

4.7.1 Summary of Process Knowledge

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

4.7.2 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 vanadium concentrations in SWEU surface soil (non-PMJM) reflect variations in naturally occurring vanadium.

Surface Soil (PMJM)

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, the spatial trend analysis indicates that vanadium concentrations in SWEU surface soil (in PMJM habitat) reflect variations in naturally occurring vanadium.

4.7.3 Pattern Recognition

Surface Soil (Non-PMJM and PMJM)

The probability plot for the natural log for the transformed data set for vanadium (Figure A3.4.7) indicates that, with the exception of one sample (04F0740-004, CH16-000), the vanadium concentrations in surface soil in the SWEU shows the presence of a single population. This result is indicative of background conditions. This anomalous sample (04F0740-004, CH16-000) contains the highest vanadium concentration (65 mg/kg) and is also the same anomalous sample identified in the other analytes, except boron, evaluated in this section.

4.7.4 Comparison to RFETS Background and Other Background Data Sets

Surface Soil (Non-PMJM)

Vanadium was detected in each of the 14 surface soil (non-PMJM) samples collected in the SWEU. Vanadium concentrations in surface soil at the SWEU range from 27.0 to 65.0 mg/kg, with a mean concentration of 36.1 mg/kg and a standard deviation of 9.19 mg/kg. Background concentrations of vanadium range from 10.8 to 45.8 mg/kg, with a mean of 27.7 mg/kg and a standard deviation of 7.68 mg/kg (Table A3.2.4).

Vanadium concentrations at the SWEU are well within the range of reported literature values. Table A3.4.1 presents the reported range for vanadium in surface soil of Colorado and bordering states and shows that concentrations range from 7 to 300 mg/kg, with a mean concentration of 73 mg/kg and a standard deviation of 41.7 mg/kg (Table A3.4.1). Vanadium concentrations reported in surface soil samples at the SWEU (27.0 to 65.0 mg/kg) are well within this range.

Surface Soil (PMJM)

Vanadium was detected in each of the four surface soil (PMJM) samples collected in the SWEU. Vanadium concentrations in surface soil for PMJM receptors at the SWEU range from 31.0 to 48.0 mg/kg, with a mean concentration of 39.5 mg/kg and a standard deviation of 6.95 mg/kg. Background concentrations of vanadium range from 10.8 to

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45.8 mg/kg, with a mean of 27.7 mg/kg and a standard deviation of 7.68 mg/kg (Table A3.2.6).Vanadium concentrations reported in surface soil (PMJM) samples at the SWEU (31.0 to 48 mg/kg) are well within regional background concentrations of vanadium in surface soil (Table A3.4.1).

4.7.5 Risk Potential for Plants and Wildlife

Surface Soil (Non-PMJM)

The UTL (65 mg/kg) exceeds the NOAEL ESL for three receptor groups, terrestrial plants (2 mg/kg), the insectivorous deer mouse (29.9 mg/kg) and the herbivorous deer mouse (64.0 mg/kg). The NOAEL ESLs for all other non-PMJM receptors were greater than or almost equal to the UTL and range from 84.0 to 1,514 mg/kg. The plant NOAEL ESL is lower than all background concentrations of vanadium, indicating that they may be overly conservative because risks are not typically expected at background concentrations. The ESL for the deer mouse (insectivore) is also less than the MDC in background soils (45.8 mg/kg) and approximately equal to the mean background concentration (27.7 mg/kg). The UTL of 65.0 mg/kg is just slightly above the herbivorous deer mouse ESL of 34.0 mg/kg.

Surface Soil (PMJM)

All four samples in PMJM habitat (three samples within SWEU and one sample within SEEU) had concentrations greater than the NOAEL ESL of 21.6 mg/kg for the PMJM. Only one of four samples had a concentration that exceeded the maximum background of 45.8 mg/kg (Table A3.2.6).

4.7.6 Conclusion

The weight of evidence presented above shows that vanadium concentrations in SWEU surface soil are unlikely to be a result of historical site-related activities based on process knowledge; the spatial distribution analysis; and the presence of a single data population indicative of naturally occurring vanadium. In addition, vanadium concentrations in SWEU surface soil samples are well within regional background levels. Vanadium is not considered an ECOPC in surface soil for the SWEU and, therefore, is not further evaluated quantitatively.

5.0 REFERENCES

DOE, 2005a. Final Comprehensive Risk Assessment Work Plan and Methodology, Rocky Flats Environmental Technology Site, Golden, Colorado. Revision 1. September.

Efroymson, R.A., M.E. Will, G.W. Suter II, and A.C. Wooten, 1997a. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants. 1997 Revision, ES/ER/TM-85/R3. Oak Ridge National Laboratory, Oak Ridge, Tennessee.

Efroymson, R.A., M.E. Will, and G.W. Suter, 1997b. Toxicological Benchmarks for Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision. ES/ER/TM-126/R2. Oak Ridge National Laboratory, Environmental Sciences Division.

EPA, 2003. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). OSWER 9285.7-55. Office of Solid Waste and Emergency Response. December.

EPA, 2005. Guidance for Developing Ecological Soil Screening Levels (Eco-SSLs). Attachment 4-1 Update. Office of Solid Waste and Emergency Response, February.

Kabata-Pendias, A., and H. Pendias, 1992. Trace Elements in Soils and Plants. Second Edition. CRC Press, Boca Raton, Florida. 365 pp

Shacklette, H.T., and J.G. Boerngen, 1984. Element Concentrations in Soils and Other Surface Materials of the Contiguous United States. Professional Paper 1270. U.S. Geological Survey, Washington, D.C.

TABLES

Table A3.2.1

Statistical Distributions and Comparison to Background for SWEU Surface Soil/Surface Sediment[a]

Analyte	Statistical Distribution Testing Results						Background Comparison Results		
	Background Data Set			SWEU Data Set					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1-p	Statistically Greater than Background?
Surface Soil/Surface Sediment									
Arsenic	**73**	**GAMMA**	**92**	**16**	**NORMAL**	**100**	**WRS**	**1.36E-06**	**Yes**

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

WRS = Wilcoxon Rank Sum Text

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

Table A3.2.2

Summary Statistics for SWEU Surface Soil/Surface Sediment[a,b]

Analyte	Units	Background					SWEU				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Inorganics											
Arsenic	mg/kg	73	0.27	9.6	3.42	2.55	16	3.3	9	7.16	1.43

[a] No background samples were collected from the SWEU.

[b] Statistics are computed using one-half the reported value for nondetects.

Table A3.2.3
Statistical Distributions and Comparison to Background for SWEU Surface Soil (Non-PMJM)

Analyte	Statistical Distribution Testing Results						Background Comparison Results		
	Background Data Set			SWEU Data Set					
	Total No. of Samples	Distribution Recommended by ProUCL	Detections (%)	Total No. of Samples	Distribution Recommended by ProUCL	Detections (%)	Test	1-p	Statistically Greater than Background?
Aluminum	20	NORMAL	100	14	GAMMA	100	WRS	8.27E-05	**Yes**
Arsenic	20	NORMAL	100	14	NORMAL	100	t-Test_N	0.012	**Yes**
Barium	20	NORMAL	100	14	NORMAL	100	t-Test_N	0.002	**Yes**
Boron	N/A	N/A	N/A	14	NORMAL	100	N/A	N/A	N/A
Chromium	20	NORMAL	100	14	NONPARAMETRIC	100	WRS	5.79E-05	**Yes**
Copper	20	NONPARAMETRIC	100	14	NORMAL	100	WRS	0.862	No
Lead	20	NORMAL	100	14	NORMAL	100	t-Test_N	0.966	No
Lithium	20	NORMAL	100	14	NORMAL	100	t-Test_N	8.76E-05	**Yes**
Mercury	20	NONPARAMETRIC	40	14	NONPARAMETRIC	100	WRS	1.000	No
Nickel	20	NORMAL	100	14	NONPARAMETRIC	100	WRS	0.020	**Yes**
Selenium	20	NONPARAMETRIC	60	14	NONPARAMETRIC	21	WRS	0.431	No
Vanadium	20	NORMAL	100	14	GAMMA	100	WRS	0.002	**Yes**
Zinc	20	NORMAL	100	14	NORMAL	100	t-Test_N	0.917	No

N/A = Not applicable.
Bolded entries indicate ECOIs retained for further consideration in the upper-bound EPC comparison step.

Table A3.2.4

Summary Statistics for SWEU Surface Soil (Non-PMJM)[a,b]

Analyte	Units	Background					SWEU				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Inorganics											
Aluminum	mg/kg	20	4,050	17,100	10,202	3,256	14	11,000	29,000	15,857	4,330
Arsenic	mg/kg	20	2.3	9.6	6.09	2.00	14	5.7	9	7.47	1.05
Barium	mg/kg	20	45.7	134	102	19.4	14	78	210	130	32.4
Boron	mg/kg	N/A	N/A	N/A	N/A	N/A	14	3	9.7	5.93	1.76
Chromium	mg/kg	20	5.5	16.9	11.2	2.78	14	12	28	16.0	3.88
Copper	mg/kg	20	5.20	16.0	13.0	2.58	14	6.50	19.0	12.3	3.36
Lead	mg/kg	20	8.60	53.3	33.5	10.5	14	17.0	38.0	27.8	5.18
Lithium	mg/kg	20	4.8	11.6	7.66	1.89	14	7.7	19	11.2	2.96
Mercury	mg/kg	20	0.090	0.120	0.072	0.031	14	0.027	0.130	0.043	0.026
Nickel	mg/kg	20	3.8	14	9.60	2.59	14	7.6	21	12.0	3.46
Selenium	mg/kg	20	0.680	1.40	0.628	0.305	14	1.00	1.20	0.581	0.268
Vanadium	mg/kg	20	10.8	45.8	27.7	7.68	14	27	65	36.1	9.19
Zinc	mg/kg	20	21.1	75.9	49.8	12.2	14	23.0	74.0	43.5	13.4

[a] No background samples were collected from the SWEU.

[b] Statistics are computed using one-half the reported value for nondetects.

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.
Bolded entries indicate ECOIs retained for further consideration in the upper-bound EPC comparison step.

Table A5.2.5

Statistical Distributions and Comparison to Background SWEU Surface Soil (PMJM)

Analyte	Statistical Distribution Testing Results:						Background Comparison		
	Background			SWEU					
	Total No. of Samples	Distribution Recommended by ProUCL	Detections (%)	Total No. of Samples	Distribution Recommended by ProUCL	Detections (%)	Test	1-p	Statistically Greater than Background?
Arsenic	20	NORMAL	100.0	4	NORMAL	100.00	t-Test_N	0.173	No
Nickel	20	NORMAL	100.0	4	NORMAL	100.00	t-Test_N	0.001	**Yes**
Vanadium	20	NORMAL	100.0	4	NORMAL	100.00	t-Test_N	0.005	**Yes**
Zinc	20	NORMAL	100.0	4	NORMAL	100.00	t-Test_N	0.152	No

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

Table A3.2.6

Summary Statistics for SWEU Surface Soil (PMJM)

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)							
Arsenic	0.87 - 0.95	4	100	6.30	8.20	7.08	0.818
Nickel	0.21 - 0.23	4	100	11.0	17.0	14.5	2.65
Vanadium	0.5 - 0.54	4	100	31.0	48.0	39.5	6.95
Zinc	0.49 - 0.53	4	100	46.0	68.0	56.8	11.4

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

Table A3.4.1

Summary of Element Concentrations in Colorado and Bordering States Soils

Analyte	Total Number of Results	Number of Nondetects	Detection Frequency (%)	Minimum Detected Value (mg/kg)	Maximum Detected Value (mg/kg)	Range of Detected Values (mg/kg)	Average Detected Value (mg/kg)	Standard Deviation (mg/kg)
Aluminum	335		100%	10.0	100,000	10 - 100,000	45,900	26,900
Antimony	84	71	15%	1.04	2.53	1.038 - 2.531	0.647	0.378
Arsenic	307	2	99%	1.22	97.0	1.224 - 97	6.90	7.64
Barium	342		100%	100	3,000	100 - 3,000	642	330
Beryllium	342	219	36%	1.00	7.00	1 - 7	0.991	0.876
Boron	342	114	67%	20.0	150	20 - 150	27.9	19.7
Bromine	85	42	51%	0.504	3.52	0.5038 - 3.522	0.681	0.599
Calcium	342		100%	0.055	32.0	0.055 - 32	3.09	4.13
Carbon	85		100%	0.300	10.0	0.3 - 10	2.18	1.92
Cerium	291	244	16%	150	300	150 - 300	90.0	38.4
Chromium	342		100%	3.00	500	3 - 500	48.2	41.0
Cobalt	342	39	89%	3.00	30.0	3 - 30	8.09	5.03
Copper	342		100%	2.00	200	2 - 200	23.1	17.7
Fluorine	264	7	97%	10.0	1,900	10 - 1900	394	261
Gallium	340	3	99%	5.00	50.0	5 - 50	18.3	8.90
Germanium	85		100%	0.578	2.15	0.5777 - 2.146	1.18	0.316
Iodine	85	18	79%	0.516	3.49	0.516 - 3.487	1.07	0.708
Iron	342		100%	3,000	100,000	3,000 - 100,000	21,100	13,500
Lanthanum	341	115	66%	30.0	200	30 - 200	39.8	28.8
Lead	342	25	93%	10.0	700	10 - 700	24.8	41.5
Lithium	307		100%	5.00	130	5 - 130	25.3	14.4
Magnesium	342		100%	300	100,000	300 - 100,000	8,890	8,080
Manganese	342		100%	70.0	2,000	70 - 2,000	414	272
Mercury	309	3	99%	0.010	4.60	0.01 - 4.6	0.077	0.276
Molybdenum	340	328	4%	3.00	7.00	3 - 7	1.59	0.522
Neodymium	256	198	23%	70.0	300	70 - 300	47.1	31.7
Nickel	342	12	96%	5.00	700	5 - 700	18.8	39.8
Niobium	335	123	63%	10.0	100	10 - 100	11.4	8.68
Phosphorus	249		100%	40.0	4,497	40 - 4497	399	397
Potassium	341		100%	1,900	63,000	1,900 - 63,000	18,900	6,980
Rubidium	85		100%	35.0	140	35 - 140	75.8	25.0
Scandium	342	51	85%	5.00	30.0	5 - 30	8.64	4.69
Selenium	309	60	81%	0.102	4.32	0.1023 - 4.3183	0.349	0.415
Silicon	85		100%	149,340	413,260	149340 - 413260	302,000	61,500
Sodium	335		100%	500	70,000	500 - 70,000	10,400	6,260
Strontium	342		100%	10.0	2,000	10 - 2,000	243	212
Sulfur	85	71	16%	816	47,760	816 - 47,760	1,250	5,300
Thallium	76		100%	2.45	20.8	2.45 - 20.79	9.71	3.54
Tin	85	3	96%	0.117	5.00	0.117 - 5.001	1.15	0.772
Titanium	342		100%	500	7,000	500 - 7,000	2,290	1,350
Uranium	85		100%	1.11	5.98	1.11 - 5.98	2.87	0.883
Vanadium	342		100%	7.00	300	7 - 300	73.0	41.7
Ytterbium	330	3	99%	1.00	20.0	1 - 20	3.33	2.06
Yttrium	342	7	98%	10.0	150	10 - 150	26.9	18.1
Zinc	330		100%	10.0	2,080	10 - 2,080	72.4	159
Zirconium	342		100%	30.0	1,500	30 - 1,500	220	157

[a] The western U.S. background data set (Shacklette and Boerngen 1984) is composed of background values from Colorado, as well as all states bordering Colorado (Arizona, Kansas, Nebraska, New Mexico, Oklahoma, Utah, and Wyoming). See Section 4.0.

[b] The element was measured at a concentration greater than the upper determination limit for the technique.

[c] Average and standard deviation values were calculated using one-half the reported value for nondetects.

FIGURES

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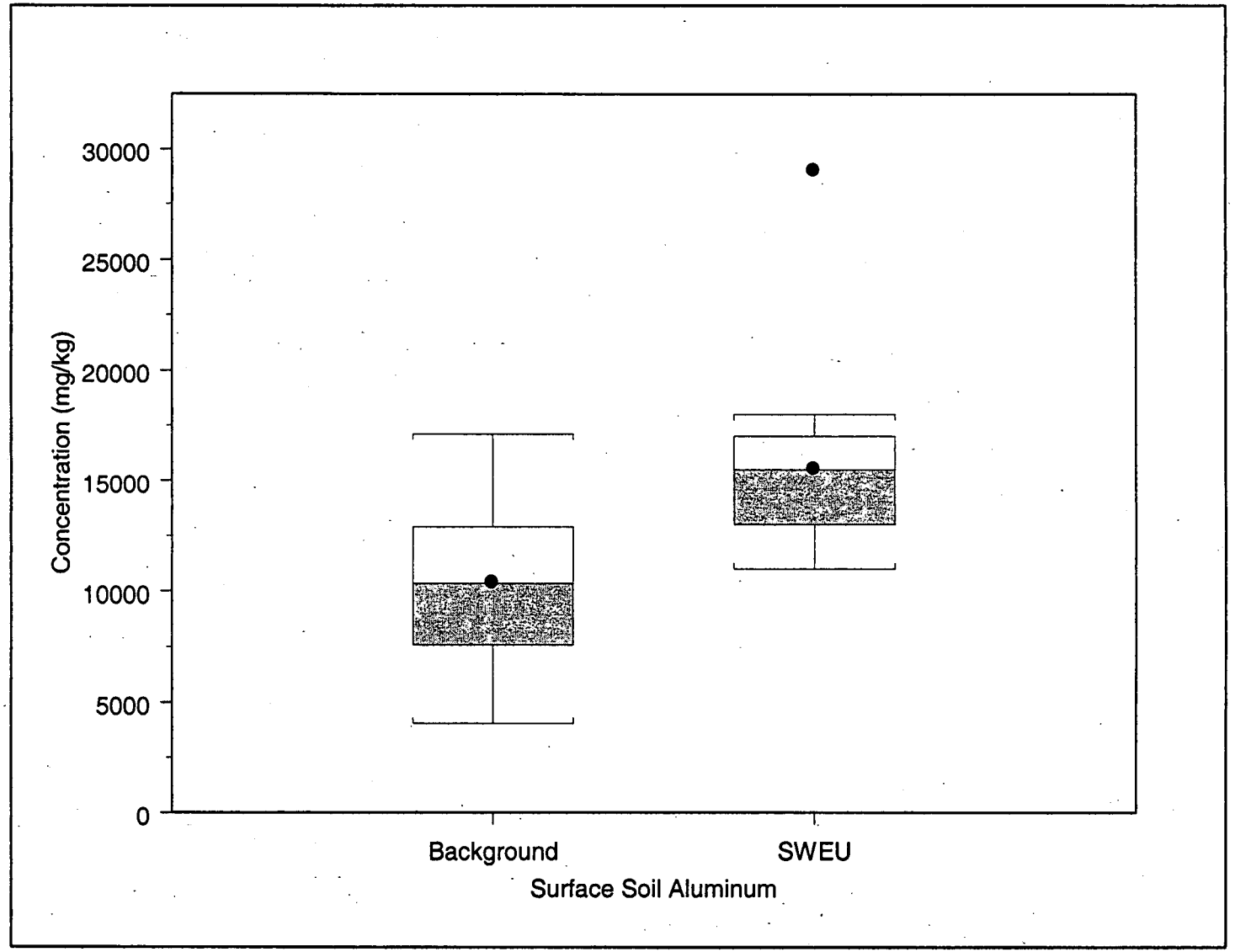
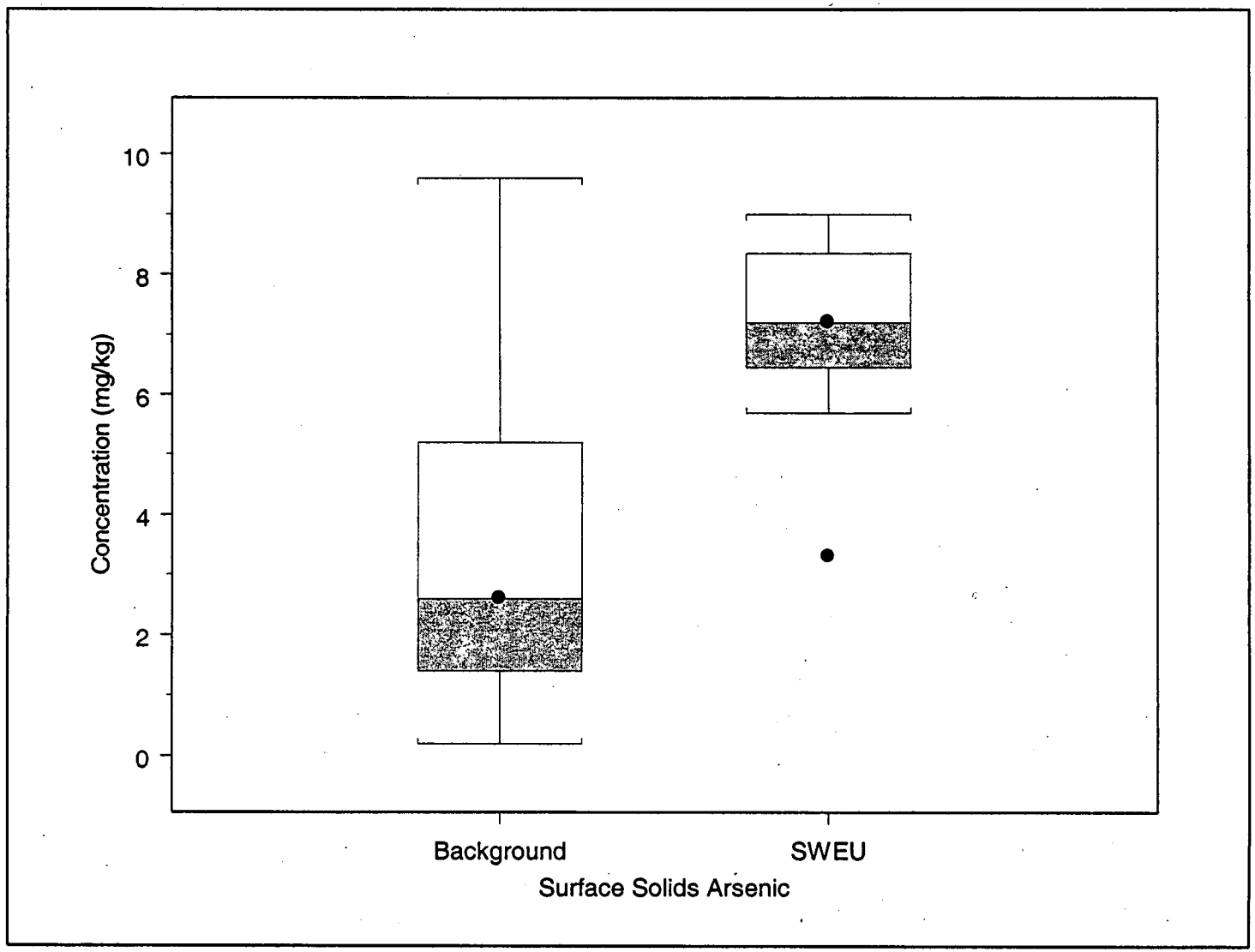
Figure A3.2.1
SWEU Surface Soil Box Plots for Aluminum



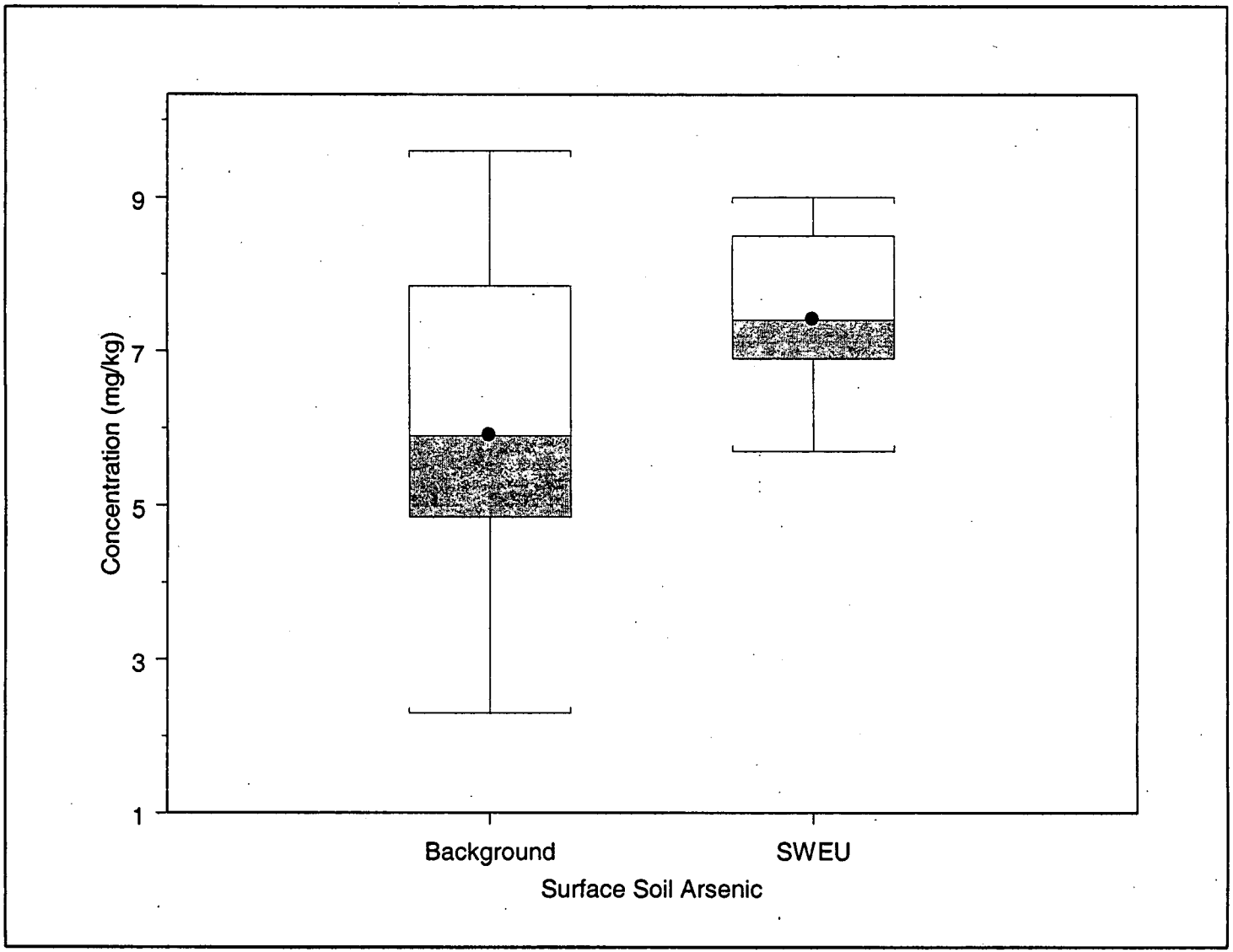
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.2
SWEU Surface Soil/ Surface Sediment Box Plots for Arsenic



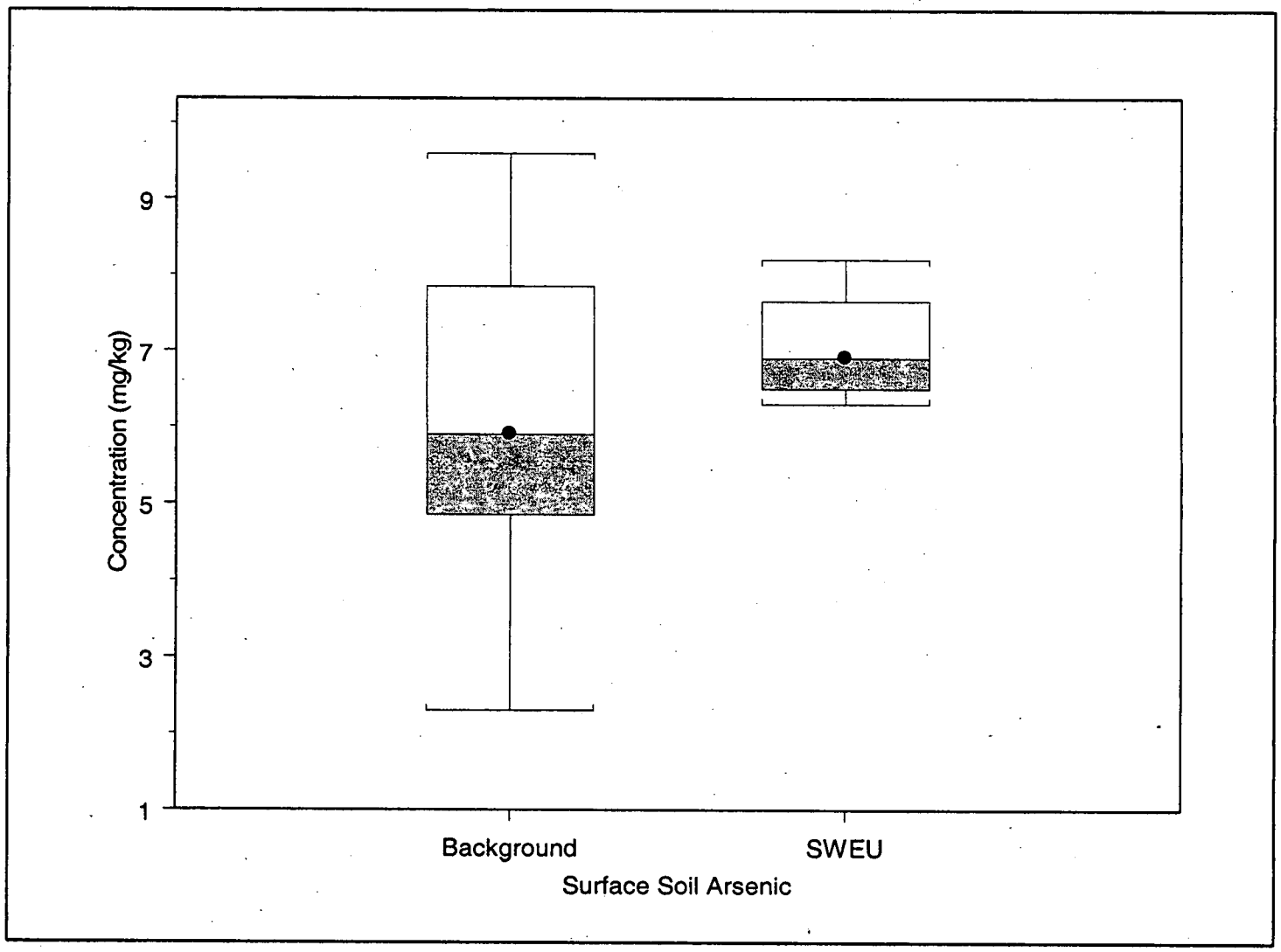
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.3
SWEU Surface Soil Box Plots for Arsenic



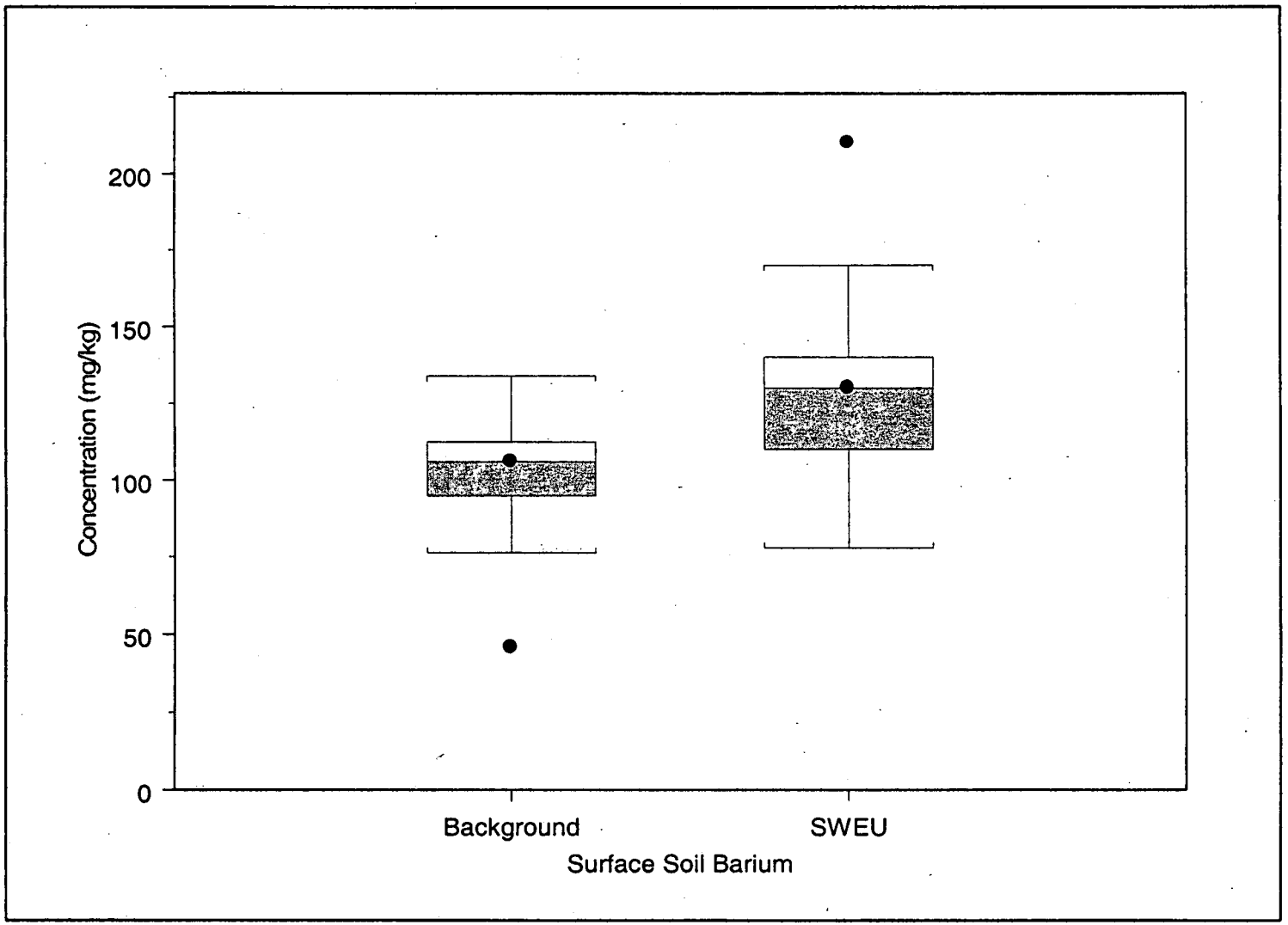
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure 3.2.4
SWEU Surface Soil in PMJM Habitat Box Plots for Arsenic



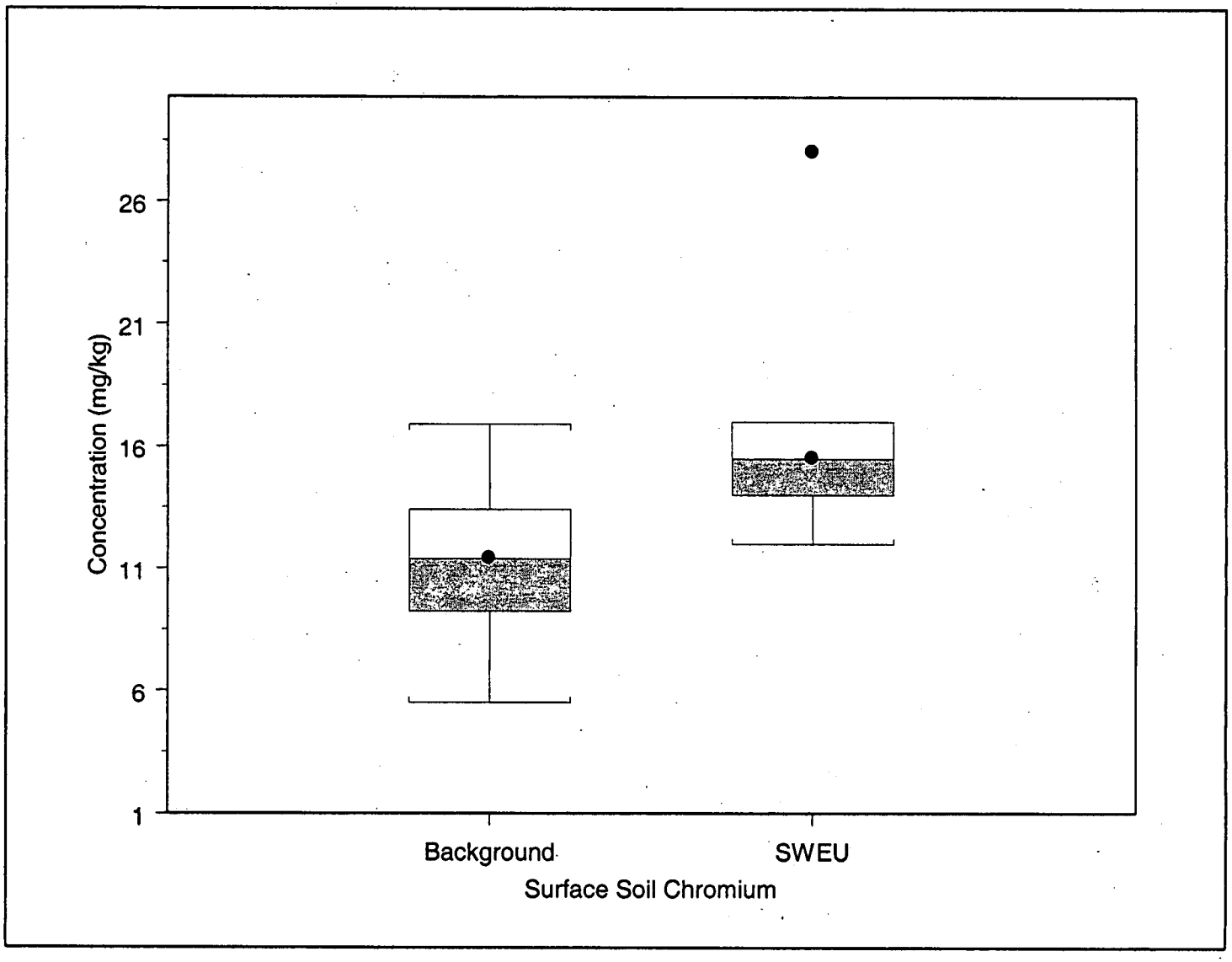
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure A3.2.5
SWEU Surface Soil Box Plots for Barium



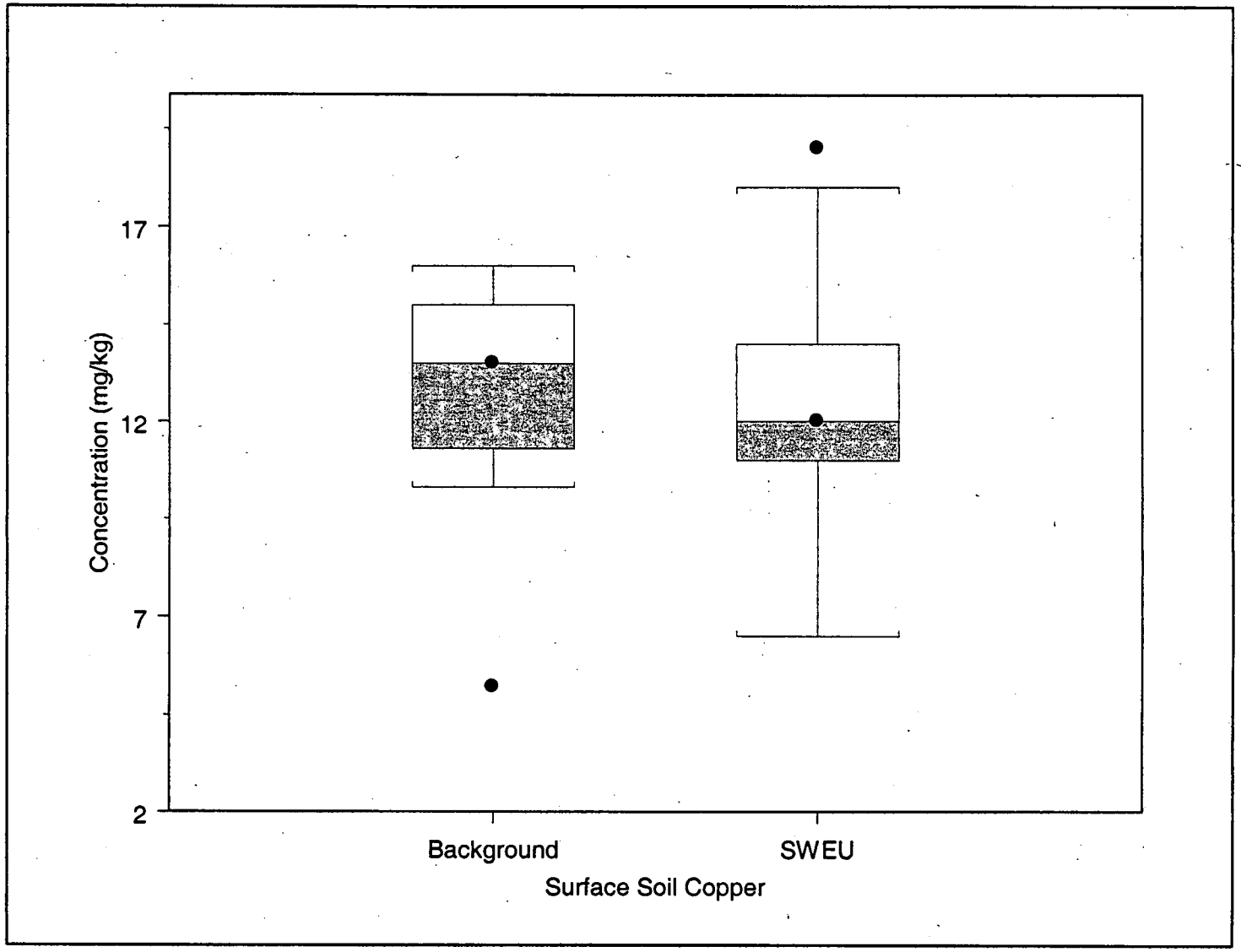
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.6
SWEU Surface Soil Box Plots for Chromium



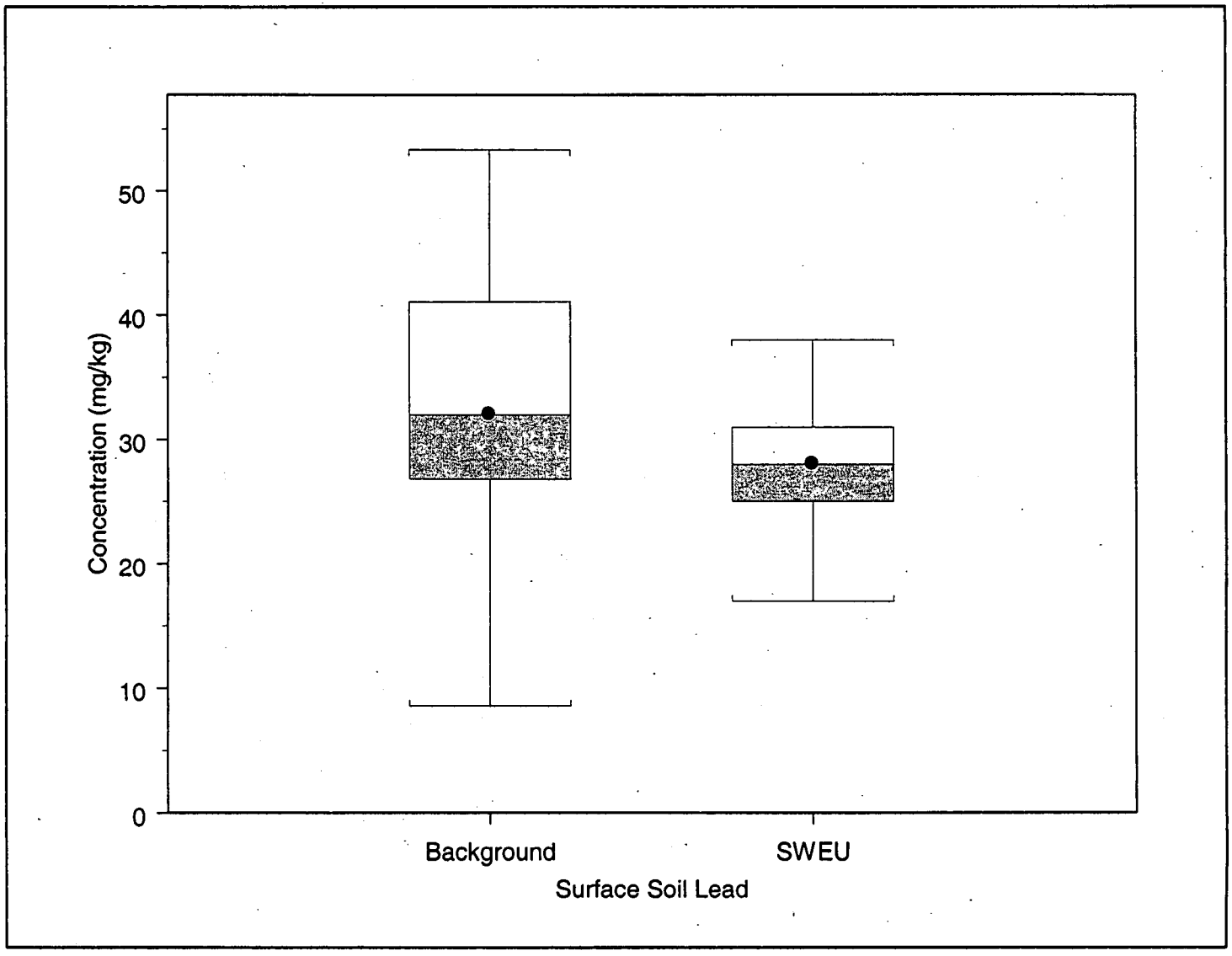
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.7
SWEU Surface Soil Box Plots for Copper



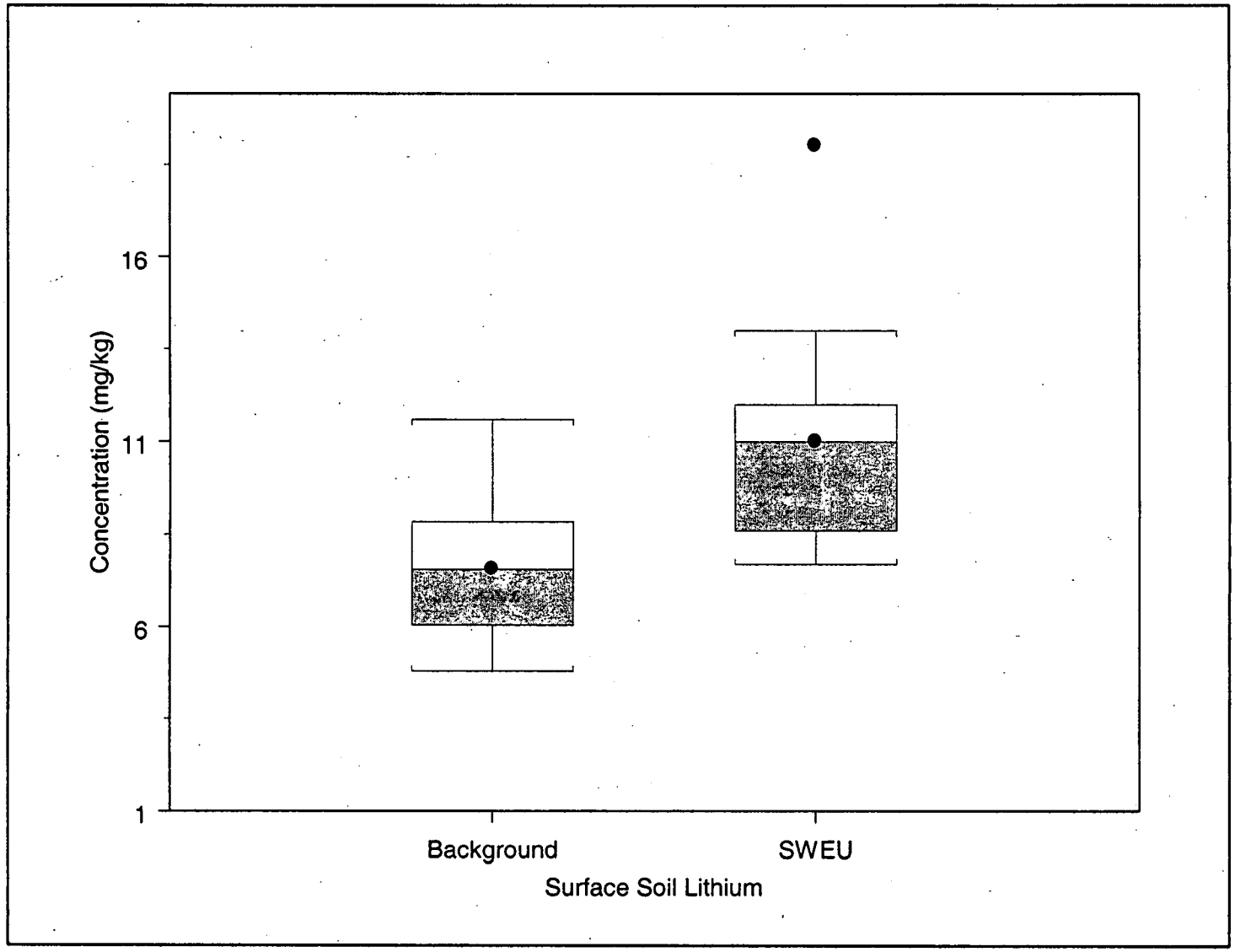
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure 3.2.8
SWEU Surface Soil Box Plots for Lead



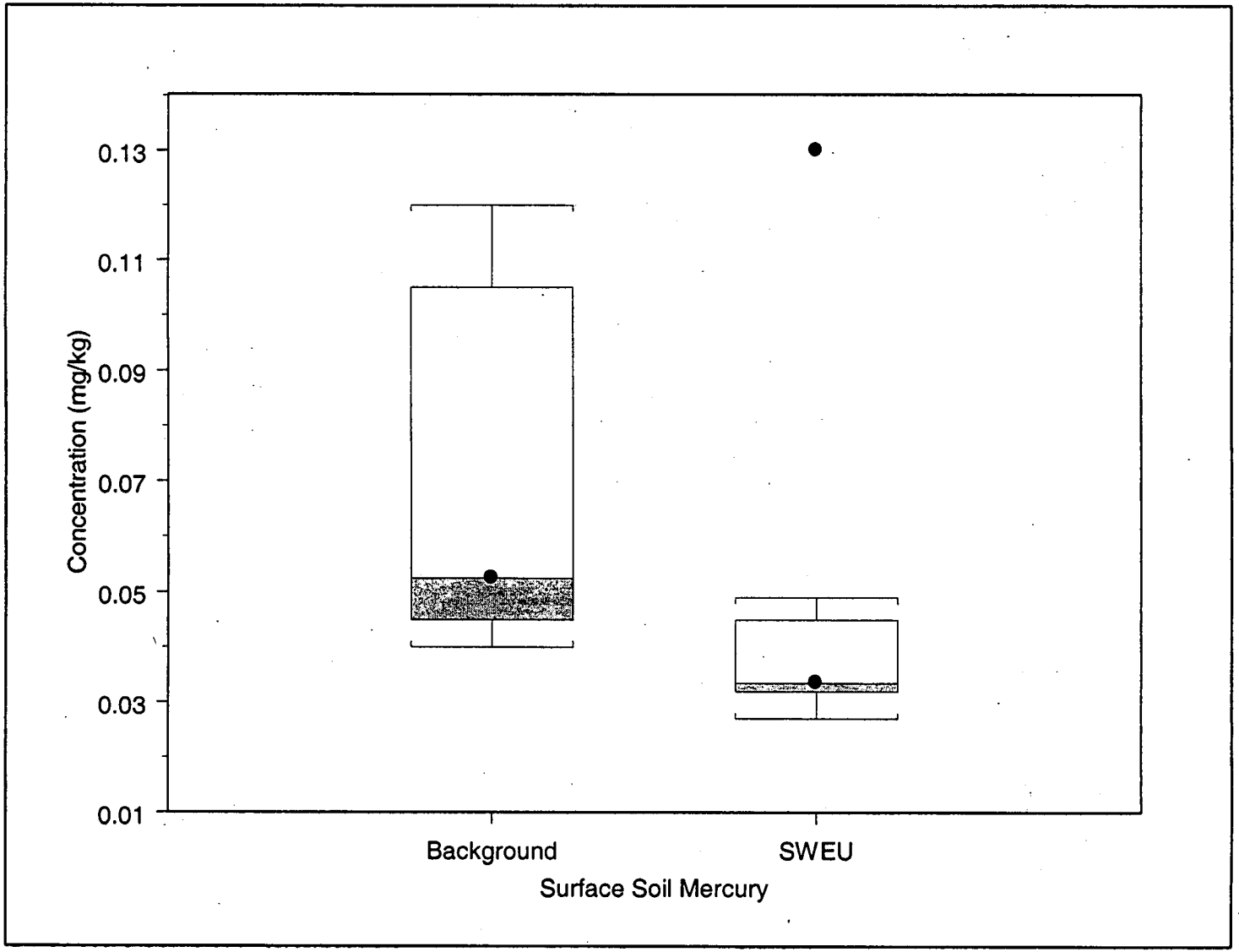
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure 3.2.9
SWEU Surface Soil Box Plots for Lithium



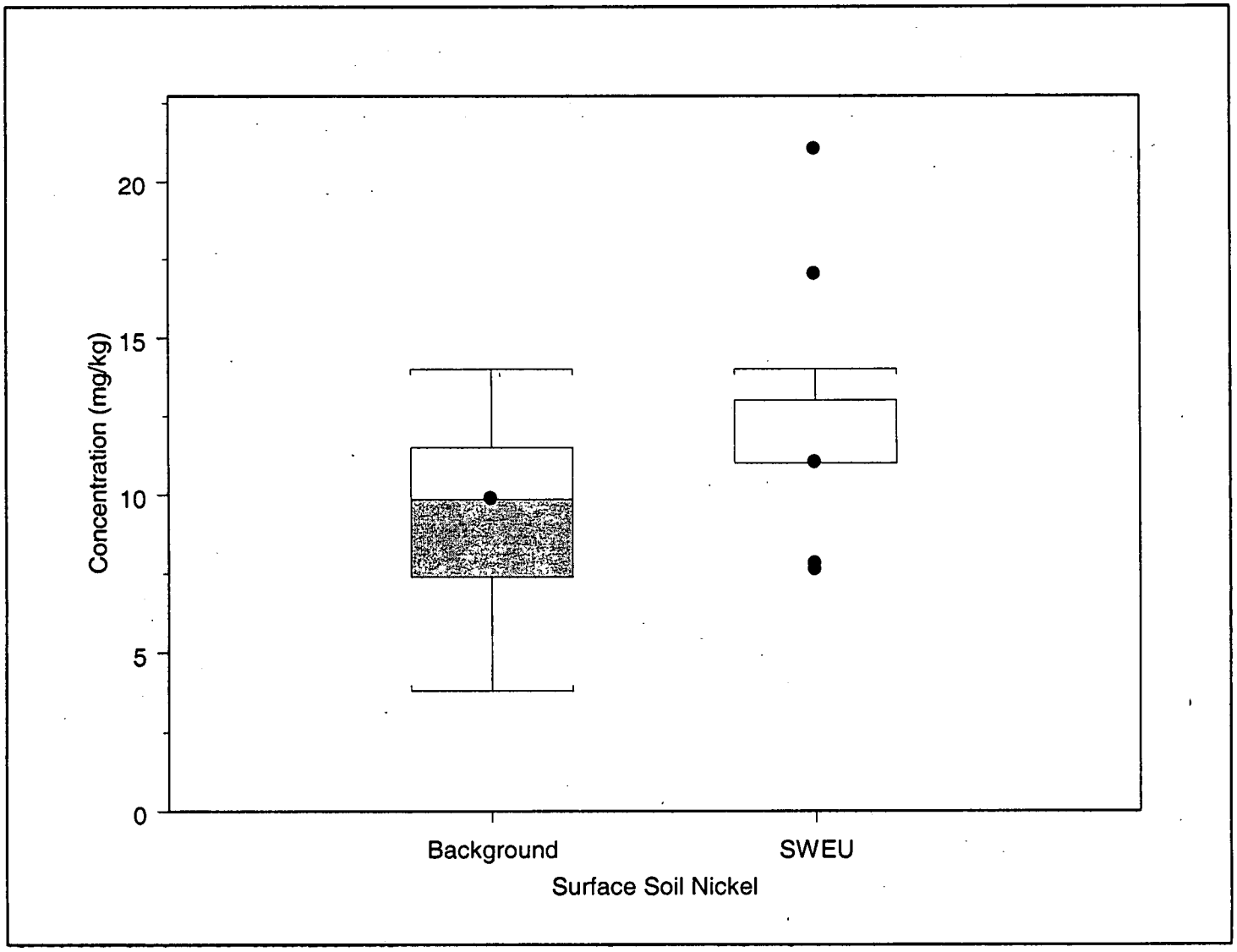
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure 3.2.10
SWEU Surface Soil Box Plots for Mercury



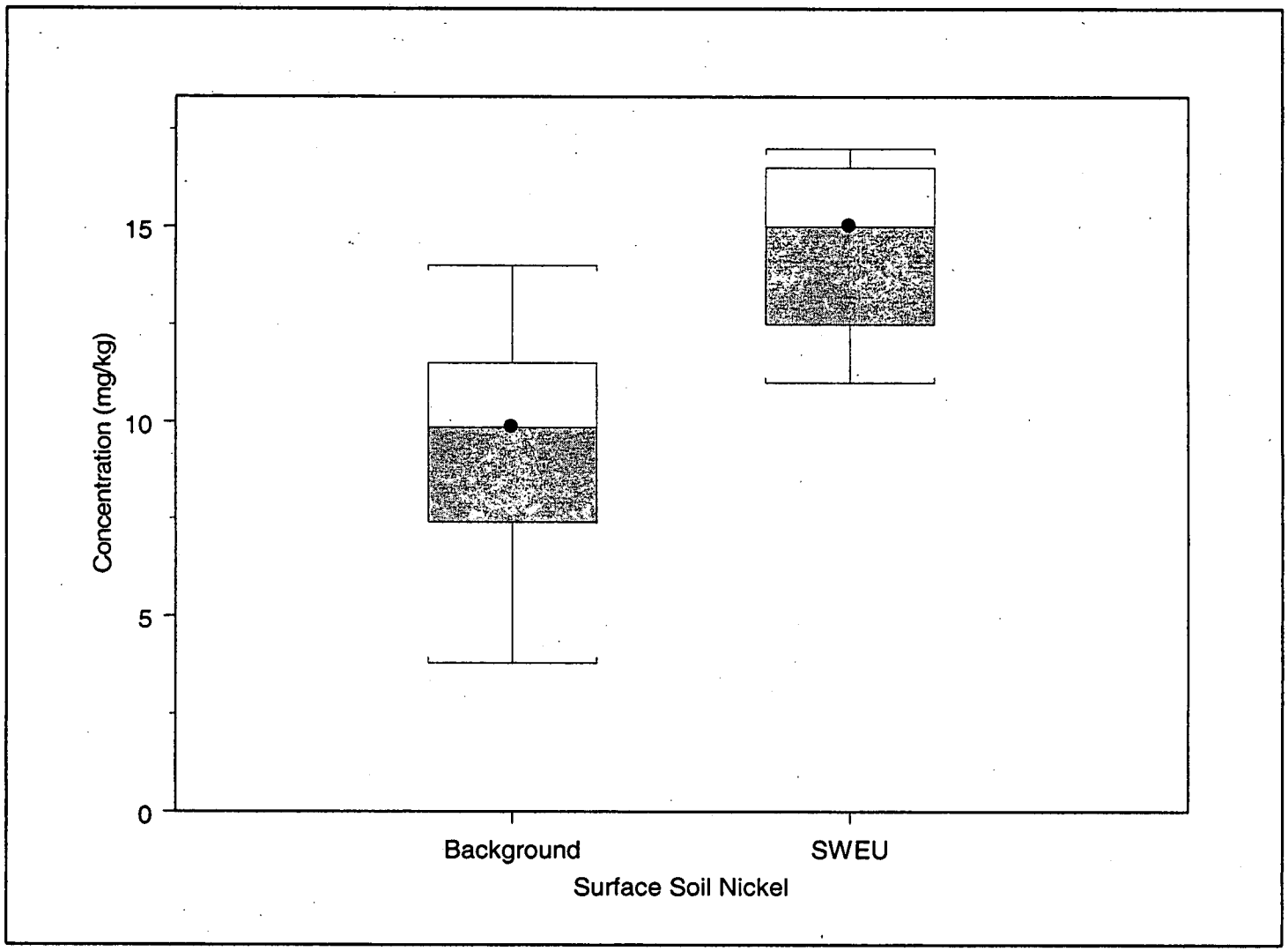
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure 3.2.11
SWEU Surface Soil Box Plots for Nickel



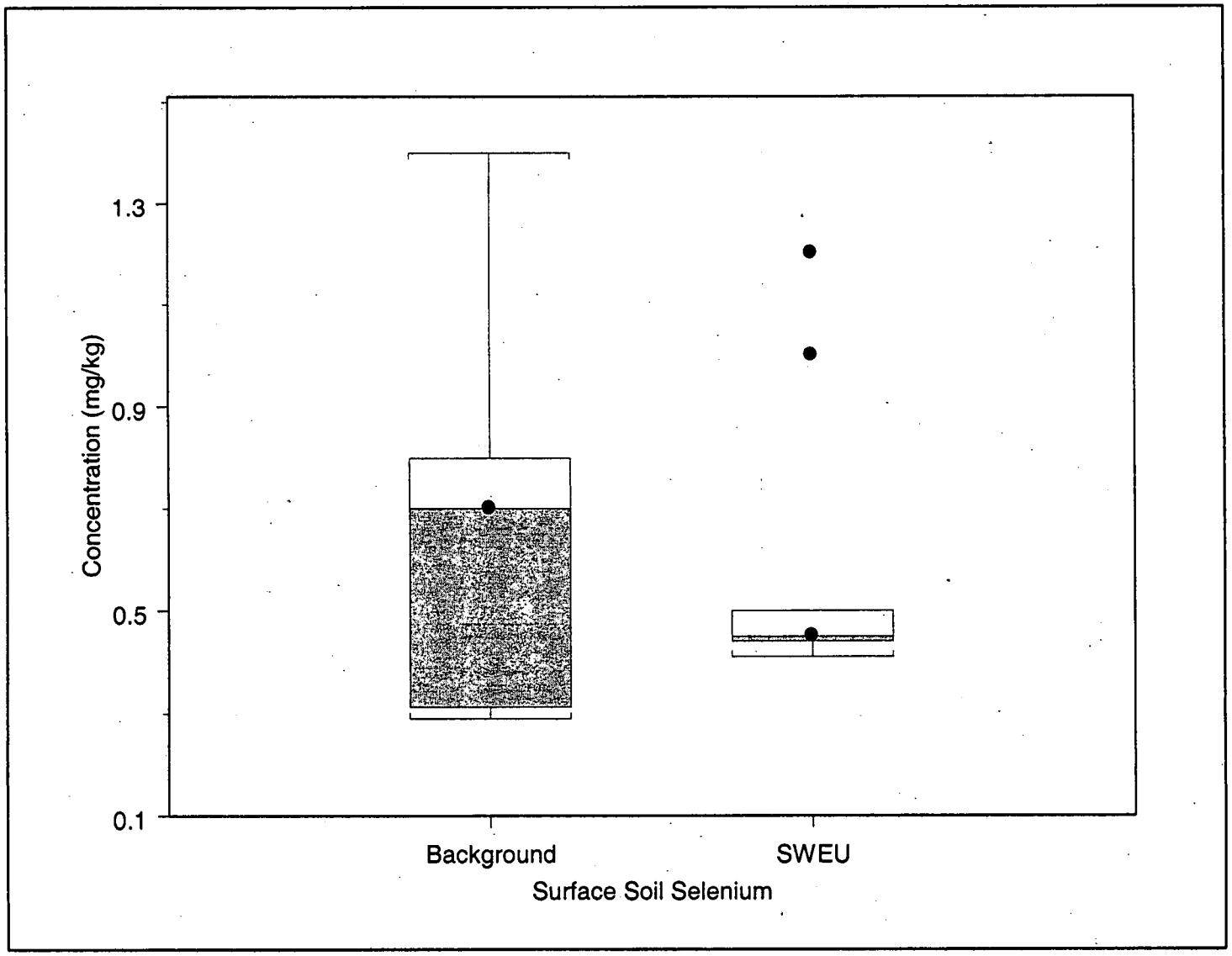
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure 3.2.12
SWEU Surface Soil in PMJM Habitat Box Plots for Nickel



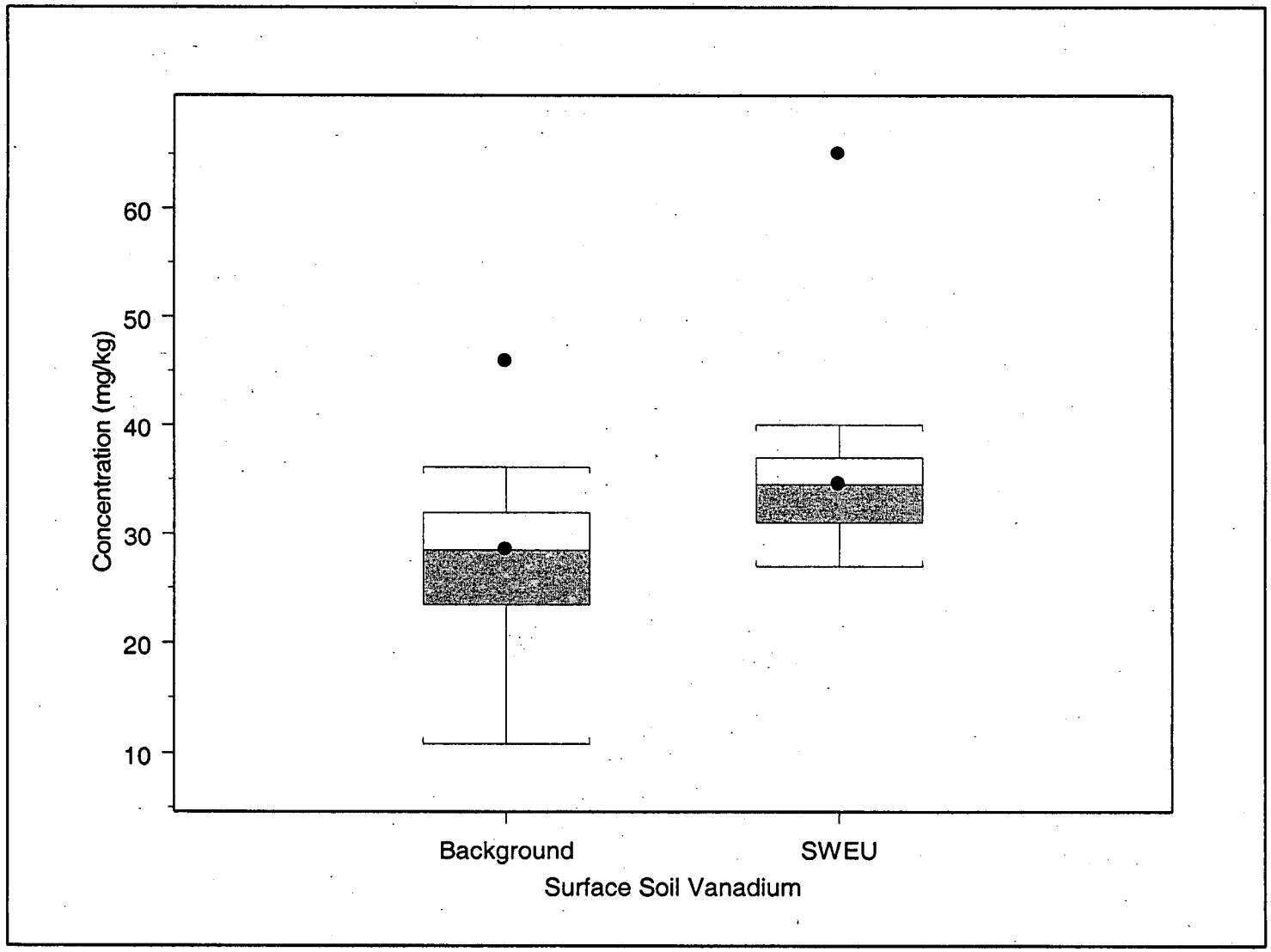
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure 7.3.2.13
SWEU Surface Soil Box Plots for Selenium



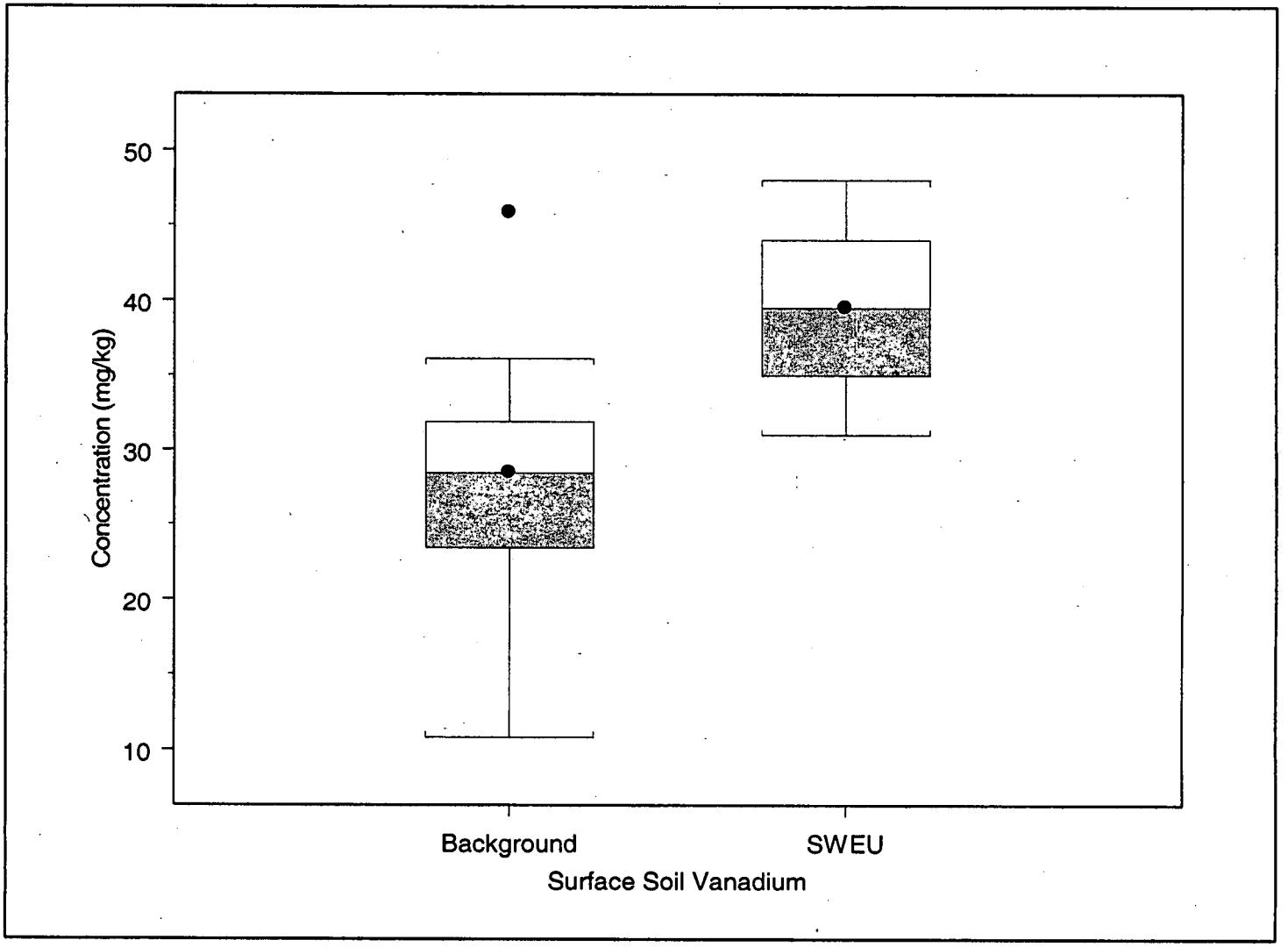
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure A3.2.14
SWEU Surface Soil Box Plots for Vanadium



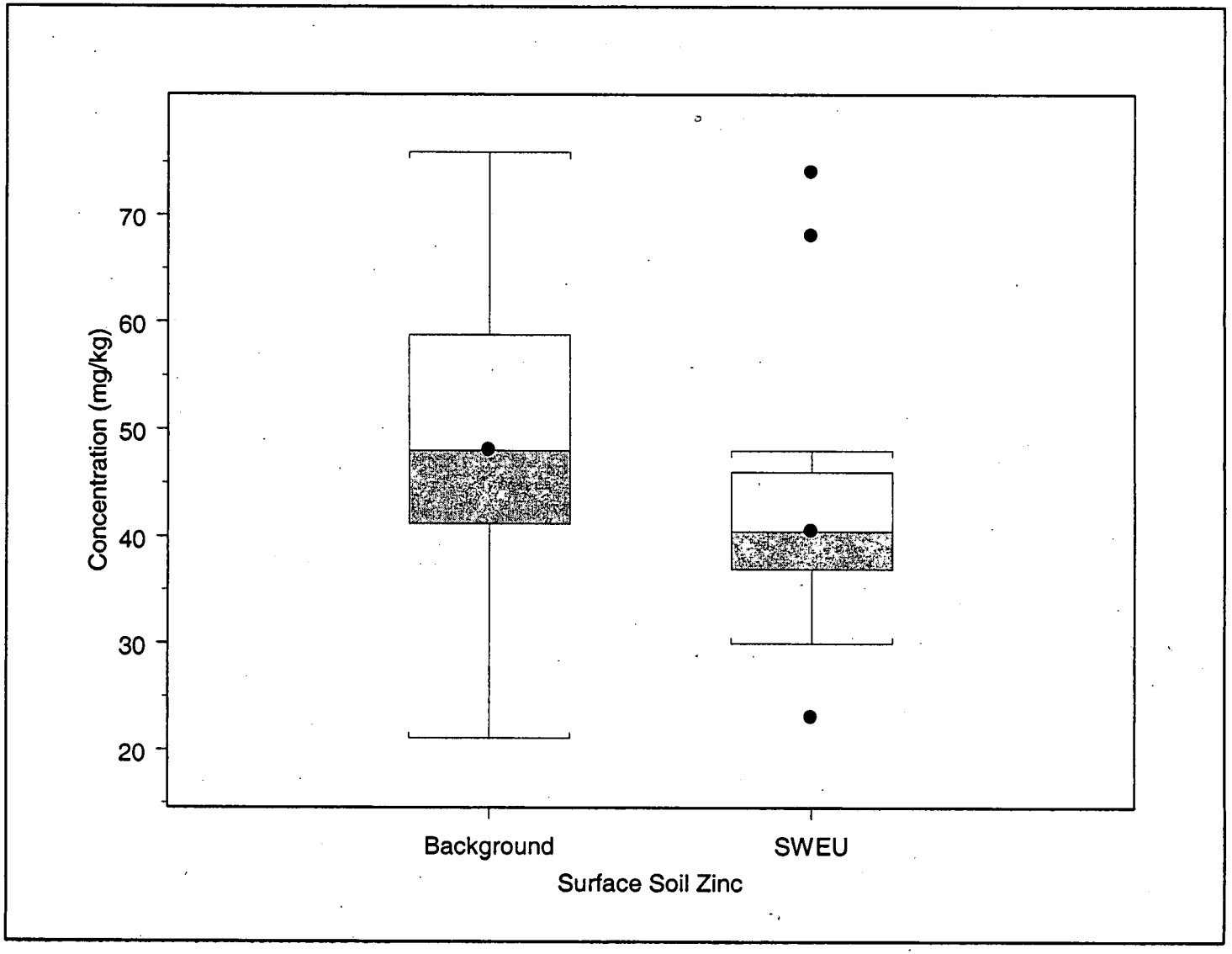
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range

Figure 3.2.15
SWEU Surface Soil in PMJM Habitat Box Plots for Vanadium



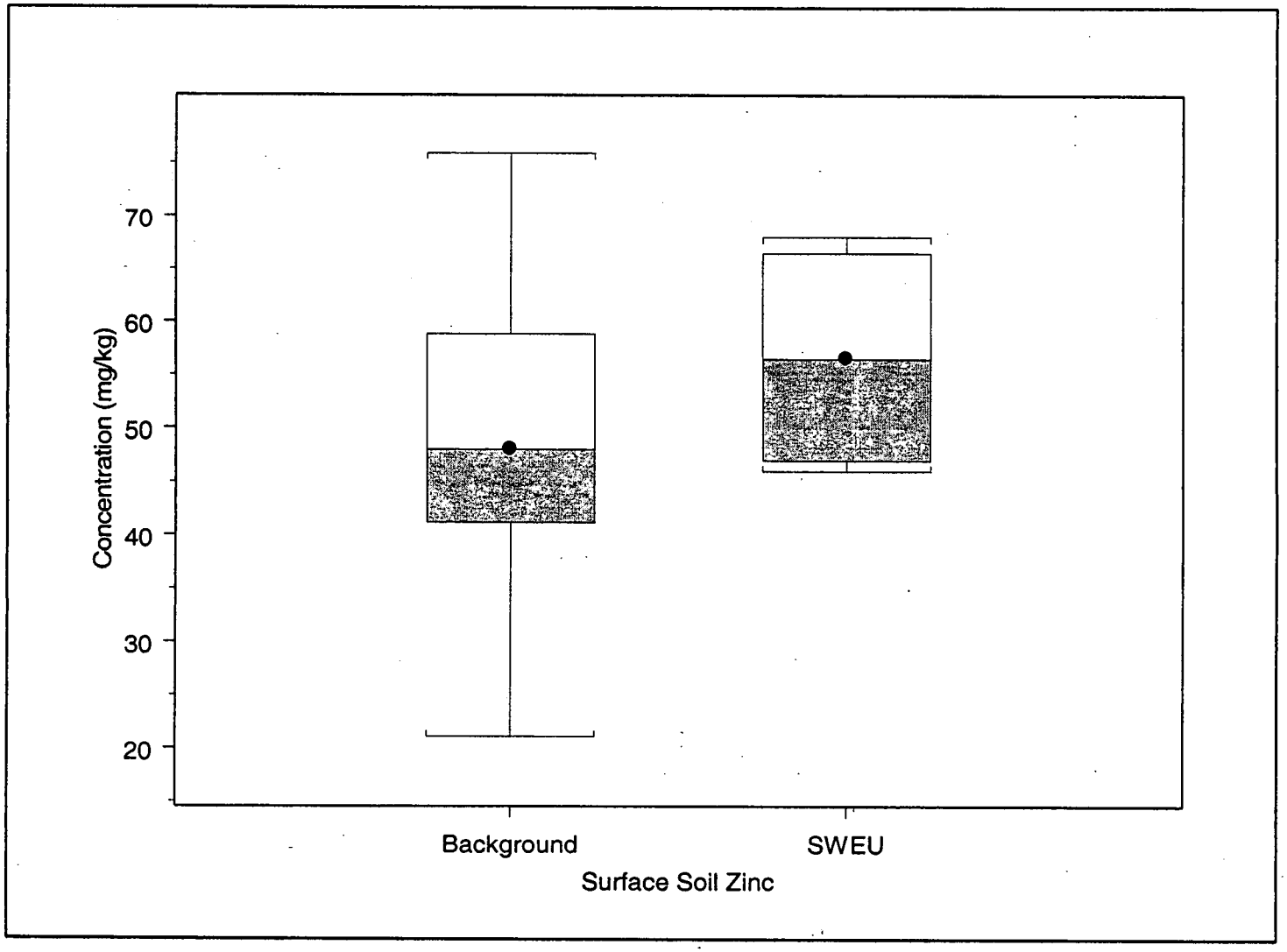
Box Plot Reference Points - 1) Line inside of box is median, 2) Lower edge of box is 25th percentile, 3) Upper edge of box is 75th percentile, 4) Lower and upper whiskers are drawn to the nearest values not beyond 1.5 times the inter-quartile range.

Figure 3.2.16
SWEU Surface Soil Box Plots 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 6.2.17
SWEU Surface Soil in PMJM Habitat Box Plots 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.

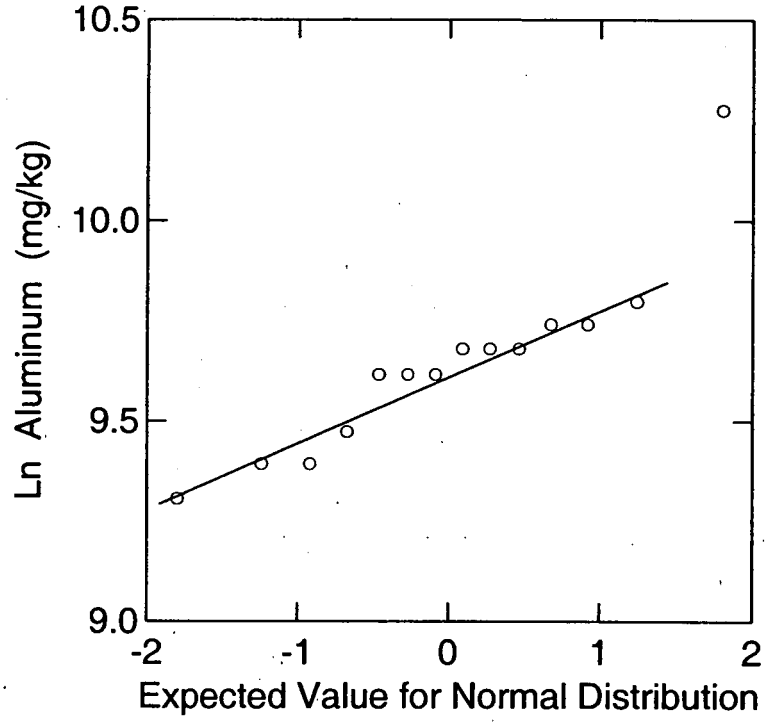


Figure A3.4.1. Probability Plot for Aluminum Concentrations (Natural Logarithm) in SWEU Surface Soil

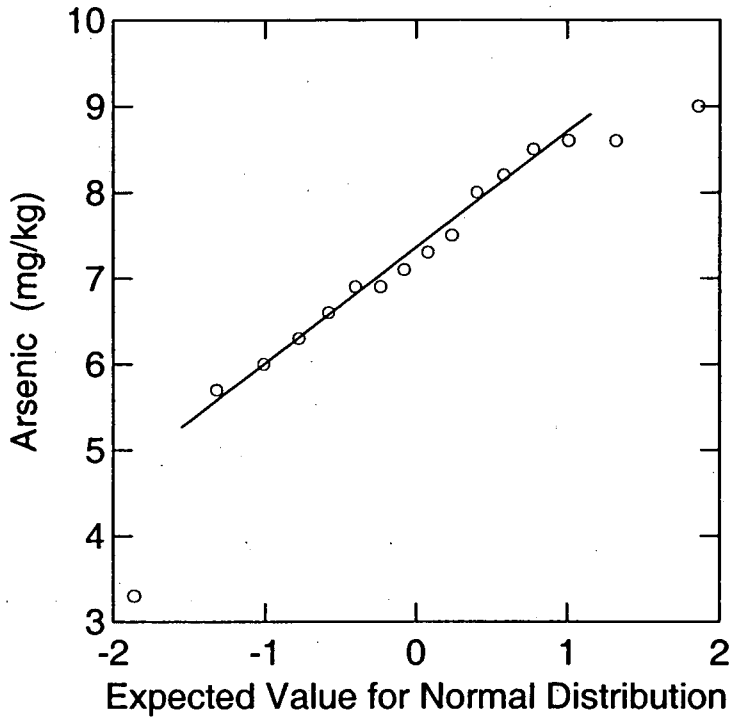


Figure A3.4.2. Probability Plot for Arsenic Concentrations (Natural Logarithm) in SWEU Surface Soil/Surface Sediment

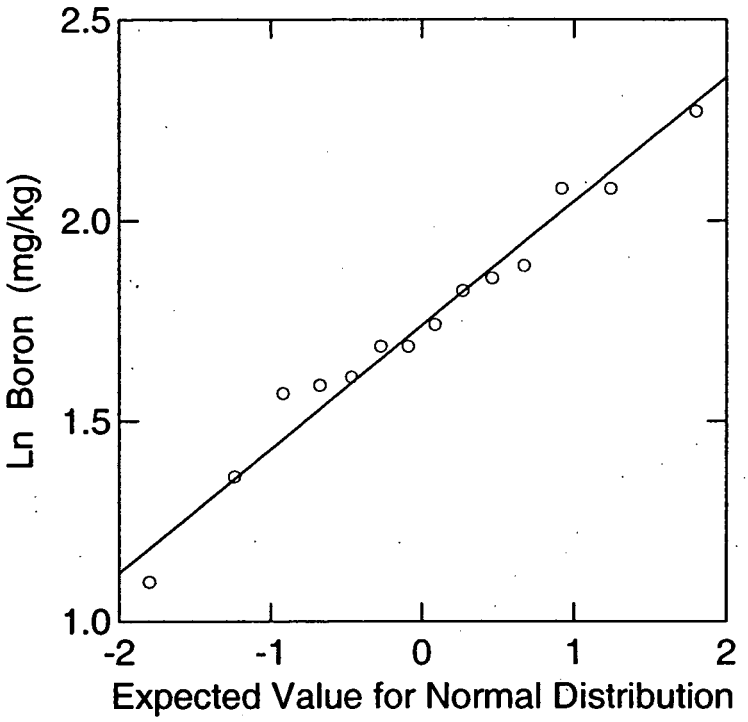


Figure A3.4.3. Probability Plot for Boron Concentrations (Natural Logarithm) in SWEU Surface Soil

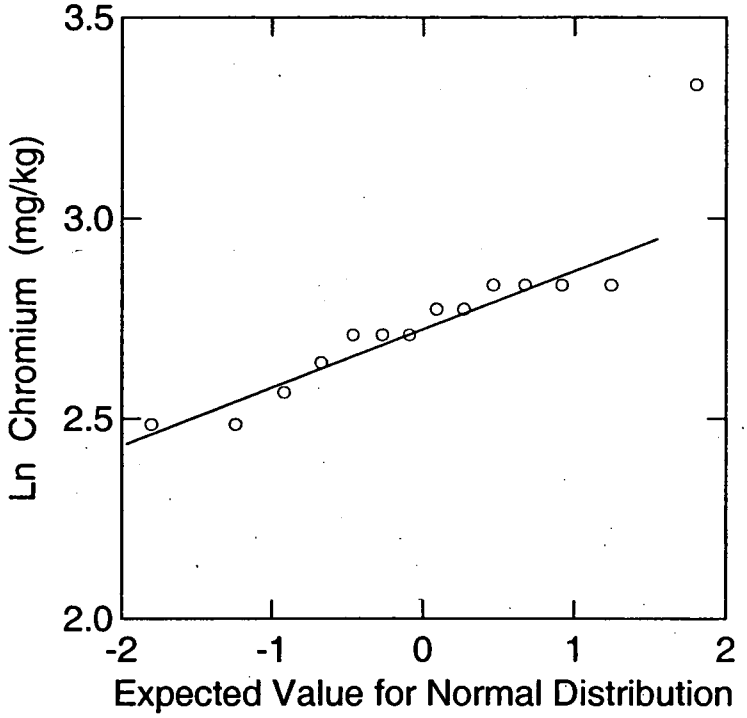


Figure A3.4.4. Probability Plot for Chromium Concentrations (Natural Logarithm) in SWEU Surface Soil

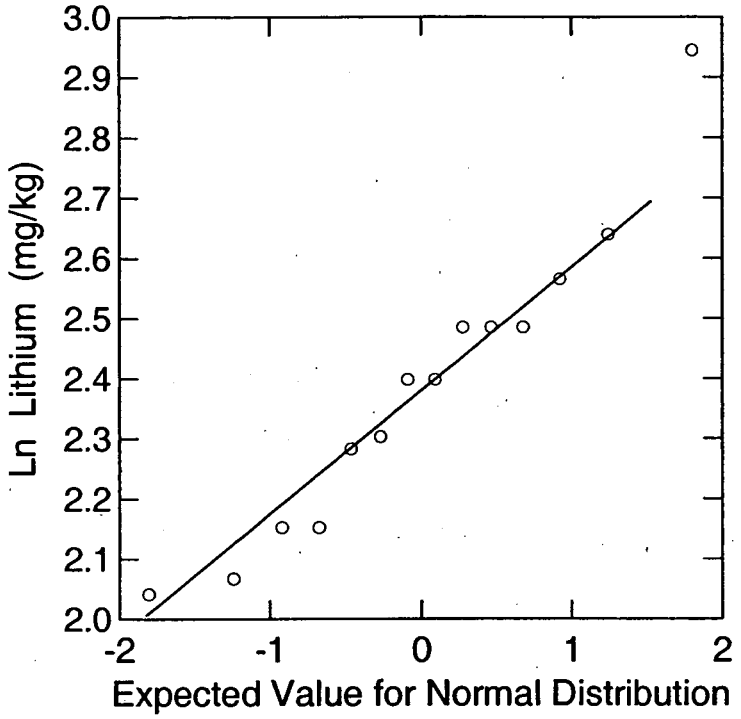


Figure A3.4.5. Probability Plot for Lithium Concentrations (Natural Logarithm) in SWEU Surface Soil

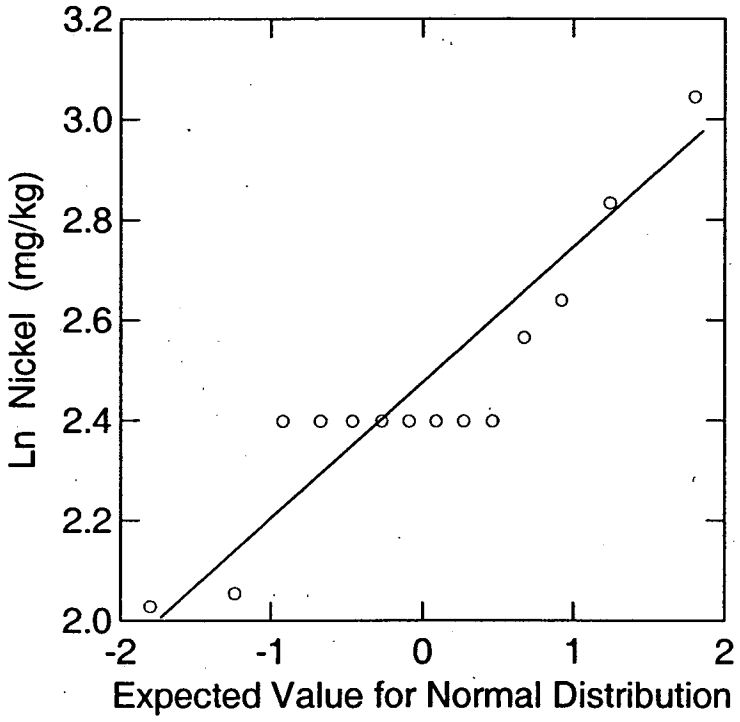


Figure A3.4.6. Probability Plot for Nickel Concentrations (Natural Logarithm) in SWEU Surface Soil

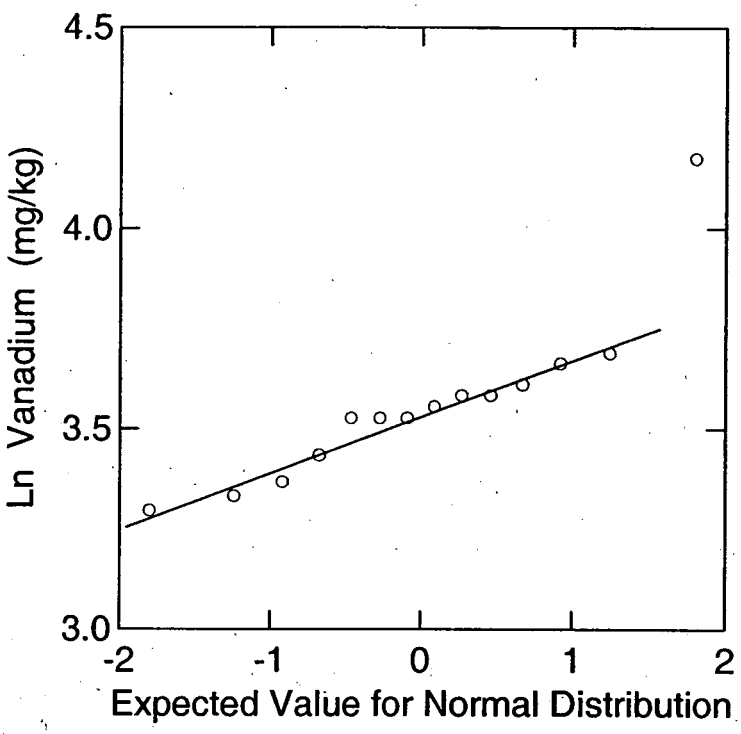


Figure A3.4.7. Probability Plot for Vanadium Concentrations (Natural Logarithm) in SWEU Surface Soil

COMPREHENSIVE RISK ASSESSMENT

SOUTHWEST BUFFER ZONE AREA EXPOSURE UNIT

VOLUME 12: ATTACHMENT 4

CRA Analytical Data Set CD