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COMPREHENSIVE RISK ASSESSMENT

VOLUME 3

Risk Assessment for the West Area Exposure Unit

FEBRUARY 1, 2005

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COMPREHENSIVE RISK ASSESSMENT

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ACRONYMS

AI	adequate intake
AL	action level
BZ	Buffer Zone
CAD/ROD	Corrective Action Decision/Record of Decision
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
CSF	cancer slope factor
DAF	dermal absorption factor
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DQA	Data Quality Assessment
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
HI	hazard index
HQ	hazard quotient
IA	Industrial Area
IAG	Interagency Agreement
IHSS	Individual Hazardous Substance Site
K-H	Kaiser-Hill Company, L.L.C.
LCS	laboratory control sample
LOAEL	lowest observed adverse effect level

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MDC	maximum detected concentration
MDL	method detection limit
MS	matrix spike
MSD	matrix spike duplicate
NA	not applicable
NC	not calculated
ND	not detected
NOAEL	no observed adverse effect level
OU	Operable Unit
PAC	Potential Area of Concern
PAH	polyaromatic hydrocarbon
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCOC	potential contaminant of concern
PMJM	Preble's meadow jumping mouse
PRG	preliminary remediation goal
QC	quality control
RDA	recommended daily allowance
RDI	recommended daily intake
RfD	reference dose
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
RL	reporting limit
RPD	relative percent difference
SCM	site conceptual model
SEP	Solar Evaporation Ponds
SMDP	scientific management decision point
tESL	threshold ecological screening level
UCL	upper confidence limit
UL	upper limit daily intake
UT	uncertain toxicity
VOC	volatile organic compound
WAEU	West Area Exposure Unit

WRS test	Wilcoxon Rank Sum test
WRV	wildlife refuge visitor
WRW	wildlife refuge worker

UNIT DESCRIPTIONS

kg	kilogram
µg/kg	micrograms per kilogram (may be found as ug/kg)
µg/L	micrograms per liter
mg	milligram
mg/day	milligrams per day
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
ml/day	milliliters per day
L/day	liters per day
pCi	picocurie
pCi/g	picocuries per gram
pCi/L	picocuries per liter

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1.0 WEST AREA EXPOSURE UNIT

The purpose of the Comprehensive Risk Assessment (CRA) is to assess human health and ecological risks[1] posed by organics, metals, and radionuclides remaining at the Rocky Flats Environmental Technology Site (RFETS) following accelerated actions. This report presents the Human Health Risk Assessment (HHRA) and Ecological Risk Assessment (ERA) for the 468-acre West Area Exposure Unit (EU) (WAEU) at RFETS (Figure 1.1).

The HHRA and ERA methods and selection of receptors are described in detail in the approved Final CRA Work Plan and Methodology (DOE 2004a), hereafter referred to as the CRA Methodology. The anticipated future land use of RFETS is a wildlife refuge. Consequently, two human receptors are evaluated consistent with this land use: a wildlife refuge worker (WRW) and a wildlife refuge visitor (WRV). 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 RFETS.

1.1 West Area Exposure Unit Description

This section provides a brief description of the WAEU, including its location at RFETS, historical activities in the area, topography, surface water features, vegetation, and ecological resources. A more detailed description of these features and additional information regarding the geology, hydrology, and soil types at RFETS is included in the Site Physical Characteristics Summary Report, Section 2, of the Draft Remedial Investigation/Feasibility Study (RI/FS) Report (in preparation), and Volume 2 of this CRA.

1.1.1 Exposure Unit Characteristics and Location

The WAEU is located on the western perimeter of RFETS and consists of 468 acres (Figure 1.1). It has several distinguishing features as noted:

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

The WAEU is bound by the Rock Creek Drainage and Inter-Drainage EUs to the east and the U.S. Department of Energy (DOE) National Wind Technology Center to the north (Figure 1.1). Land to the west and south of the WAEU, outside the RFETS boundary, is

[1] In this document, the term "risk" is used to refer to the combined "lifetime excess cancer risk" and noncarcinogenic health effects assessed using the hazard index (HI) for humans, and the calculated HI for ecological receptors.

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privately owned. Highway 93, which runs north-south and connects the cities of Boulder and Golden, Colorado, is located approximately 1,500 feet (ft) west of the WAEU boundary.

1.1.2 Historic Activities and Potential Sources

The WAEU is located within the BZ OU, west of the IA that was used for RFETS operations (Figure 1.1). There are no known sources of groundwater or soil contamination within this EU based on the Historical Release Report (HRR) (DOE 1992a) or annual updates, which provide descriptions of known spills, releases or incidents involving hazardous substances occurring since the RFETS began operations. These releases are designated Individual Hazardous Substance Sites (IHSSs) or Potential Areas of Concern (PACs). The only potential nearby source area, located in the Interdrainage EU (Volume 4 of the CRA), is IHSS 168, the West Spray Field, which is located east of the WAEU. Excess water from the Solar Evaporation Ponds (SEP) (IHSS 101) was periodically sprayed within IHSS 168 between April 1982 and October 1985 (DOE 1992b).

A Colorado Department of Public Health and Environment (CDPHE) Risk-Based Conservative Screen was conducted for IHSS 168 by DOE (1995a). A no-further-action Corrective Action Decision/Record of Decision (CAD/ROD) was approved for IHSS 168 (also designated in the Interagency Agreement [IAG] of 1991 as OU 11) in October 1995 (Administrative Record reference OU11-A-000184). It is unlikely that IHSS 168, located outside the WAEU and hydraulically downgradient, is a source of contaminants for the WAEU.

1.1.3 Topography and Surface Water Hydrology

A recent aerial photograph of the WAEU shows that soil in the northern and southern portions of the EU has been disturbed by gravel mining unrelated to RFETS activities (Figure 1.2). The disturbed areas include a majority of the surface area of the WAEU, and consist of excavations, ponds, soil piles, and roads.

The WAEU is relatively level compared to the rest of RFETS, which is located on a broad, eastward-sloping pediment that is deeply transected by several stream valleys (eastern portion of RFETS). Although several ephemeral or intermittent creeks originate just west of and within the WAEU (Figure 1.2) and traverse the EU in a west to east-northeast direction, the channels are shallow. Named creeks in the WAEU include the Mahonia and Lindsay branches of the Rock Creek Drainage and portions of Church and McKay ditches (Figure 1.3). Groundwater in the EU originates upgradient of RFETS and is not affected by RFETS activities. A small natural pond is also located in the southern portion of the WAEU. The other water bodies visible in the aerial photograph are a result of mining activities.

1.1.4 Flora and Fauna

A vegetation map for the WAEU is shown on Figure 1.3. Areas that have not been disturbed by mining are characterized predominantly by xeric tallgrass prairie on the plains, and wetland and mesic mixed grassland in and adjacent to the drainages. Small areas of tall, upland shrubland and other shrubland also exist. The xeric tallgrass prairie is

distinguished at RFETS by such plant species as big bluestem (*Andropogon gerardii*), little bluestem (*Andropogon scoparius*), indian grass (*Sorghastrum nutans*), prairie dropseed (*Sporobolus heterolepis*), and switchgrass (*Panicum virgatum*); the same species that dominate the plant community on the eastern edge of the Great Plains.

Numerous animal species have been observed at RFETS and the more common ones are also expected to be present in the WAEU. Common large and medium-sized mammals likely to live at or frequent the WAEU include mule deer (*Odocoileus hemionus*), coyotes (*Canis latrans*), raccoons (*Procyon lotor*), desert cottontails (*Sylvilagus audubonii*), and white-tailed jackrabbit (*Lepus townsendii*). The most common reptile observed at RFETS is the western prairie rattlesnake (*Crotalis viridus*) and the most common birds include meadow larks (*Sturnella neglecta*) and vesper sparrows (*Pooecetes gramineus*). The most common small mammal species include deer mice (*Peromyscus maniculatus*), prairie voles (*Microtus ochrogaster*), meadow voles (*Microtus pennsylvanicus*), and different species of harvest mice (*Reithrodontomys sp.*).

The preferred habitat for the PMJM (*Zapus hudsonius preblei*) is the riparian corridors bordering RFETS streams, ponds, and wetlands. Small areas designated as PMJM habitat occur along three drainages in the WAEU as shown on Figure 1.4.

More information on the species that use the habitats at RFETS is provided in Section 2.0 of the RI/FS Report.

1.1.5 Data Description

WAEU Data are available for surface soil, subsurface soil, sediment, surface water and groundwater. The sampling locations for these media are shown in Figure 1.5 and data summaries for detected analytes in each medium are provided in Tables 1.1 through 1.6. Data on chemicals that were analyzed for but were not detected are presented in Appendix A. Detection limits are compared to preliminary remediation goals (PRGs) and ecological screening levels (ESLs) in Appendix A (Tables A.1 through A.6).

In accordance with the CRA Methodology, only data collected on or after June 28, 1991, and data for subsurface soil less than 8 ft in depth are used in the CRA. Subsurface soil data are limited to that less than 8 ft because it is not anticipated that the WRW or burrowing animals will dig to greater depths. Data collected prior to this date and data for subsurface soil greater than 8 ft are described in Appendix A.

A summary of the number of samples available for each medium in the WAEU is provided in Table 1.1, and the data are briefly described in the following sections.

Surface Soil

Ten surface soil samples from a depth of 0 to 0.5 ft were collected in the WAEU in March 2004 (Table 1.1). The surface soil sampling locations shown on Figure 1.5 were located on a 30-acre grid, as described in the CRA Sampling and Analysis Plan Addendum #04-01 (DOE 2004b). Five individual samples were collected from each 30-acre cell: one from each quadrant and one from the center. The five samples were then composited. One sample, from location AN33-000 (Figure 1.5), was a composite of only three individual samples. Samples were not collected at grid points located in an area of

disturbed soil. Some 30-acre grid cells in the WAEU were not sampled because of the extent of disturbed soil.

The data summary for detected analytes in WAEU surface soil is presented in Table 1.2. Detected analytes included several radionuclides and inorganics. Most inorganics were detected in all 10 surface soil samples. Several radionuclides were detected in all samples.[2]

Sediment

Ten sediment samples were collected at depths from 0 to 0.5 ft at two locations shown on Figure 1.5. Location SED004 was sampled six times and location SED023 was sampled four times, between August 1991 and March 1993. All sediment samples were analyzed for inorganics and organics; radionuclides were analyzed for in 8 of the 10 samples.

The data summary for sediment in the WAEU is presented in Table 1.3. Frequently detected analytes in sediment include several organics and radionuclides. All detections organics were "J" qualified, signifying that the reported result was below the method detection limit (MDL) and above the instrument detection limit. Most of the organics were detected in only one sample.

Subsurface Soil

Subsurface soil samples were collected from two locations (46192 and 50294) in the southeast portion of the WAEU (Figure 1.5). Subsurface soil samples to be used in the CRA are defined in the CRA Methodology as soil samples with a starting depth less than 8 ft and an ending depth below 0.5 ft. A total of 2 subsurface soil samples were collected at location 46192 and 5 samples were collected at location 50294 (Table 1.4). Additional samples collected from 5-ft depth intervals down to a depth of 80 ft are discussed in Appendix A (Section 2.0).

Surface Water

Surface water samples were collected from three sampling locations in the WAEU. The sampling locations are shown on Figure 1.5 and the data summary for surface water is presented in Table 1.5. A total of 51 surface water samples were collected in the WAEU between July 1991 and March 2004 and all data for these samples were used in the CRA (Table 1.1). All samples were analyzed for inorganics, 16 samples were analyzed for organics, and 15 samples were analyzed for radionuclides.

Groundwater

Groundwater samples were collected from 8 locations between July 1991 and July 1995 (Table 1.1). A total of 58 surface water samples were collected in the WAEU The locations are shown on Figure 1.5 and the data summary for groundwater is presented in Table 1.6.

[2] Radionuclide results are presented as the reported value. The reported value is always treated as a detection.

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1.2 Data Adequacy

Data adequacy assessment criteria are presented in the CRA Methodology (DOE 2004a). The data for the WAEU are considered adequate for the CRA, because the following criteria are met:

- Data for one metal and radionuclide surface soil sample is available per 30-acre grid cell in which surface soil exists (DOE 2004b). This data density is considered sufficient for areas outside of source areas.
- Data for sediment, surface water, and groundwater are considered representative for the WAEU, and are adequate for this assessment.

1.3 Data Quality Assessment

A data quality assessment (DQA) of the WAEU data was conducted to determine whether the data was of sufficient quality for risk assessment decisions. An evaluation of field quality control (QC) parameters for the WAEU is presented in Appendix B. An evaluation of laboratory QC parameters for the entire RFETS is presented in Volume 2 of the CRA. Laboratory QC is evaluated for the entire site because most of the RFETS sampling programs were conducted on sitewide, OU, or IHSS-Group basis. Consequently, the laboratory batches and laboratory QC parameters can only be associated on a sitewide basis.

The DQA includes an assessment of the precision, accuracy, representativeness, completeness, and comparability (PARCC) of the WAEU dataset. Method and detection limits were reviewed to determine if adequate sensitivities were achieved. Appendix B includes the field QC PARCC assessment for all sampled media in the WAEU. As demonstrated in Appendix B, data used in the WAEU risk assessment is adequate for CRA decisions.

Table 1.1 Number of Samples in Each Medium by Analyte Suite

Analyte Suite	Surface Soil 0-0.5 ft	Sediment	Subsurface Soil 0.5-8.0 ft	Surface Water	Groundwater
Inorganics	10	10	7	51	58
Organics	0	10	5	20	55
Radionuclides	10	8	7	15	56

Table 1.2 Summary of Detected Analytes in Surface Soil

Analyte	Range of Reported Detection Limits	Total Number of Results[c]	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Inorganics (mg/kg)							
Aluminum	5.2 - 5.8	10	100	8200	18000	13520	3168
Antimony	0.3 - 0.34	10	20	0.34	0.6	0.22	0.15
Arsenic	0.86 - 0.97	10	100	3.6	22	8.48	5.07
Barium	0.39 - 0.44	10	100	68	140	109	24.5
Beryllium	0.11 - 0.12	10	40	0.25	0.52	0.36	0.10
Boron	1.1 - 1.2	10	100	2.8	7.1	5.11	1.20
Calcium	7.4 - 8.4	10	100	880	4600	2308	943
Chromium	0.16 - 0.18	10	100	8.1	17	13.3	2.65
Cobalt	0.19 - 0.22	10	100	3.8	6.4	5.04	0.93
Copper	0.048 - 0.054	10	100	5.2	13	9.77	2.20
Iron	1.5 - 1.7	10	100	8900	16000	13190	2414
Lead	0.29 - 0.32	10	100	9.9	48	30.5	11.4
Lithium	0.52 - 0.58	10	100	5.7	12	9.28	1.74
Magnesium	8 - 9	10	100	1000	2500	1920	432
Manganese	0.18 - 0.21	10	100	150	320	260	55.8
Mercury	0.0073 - 0.0083	10	100	0.02	0.03	0.03	0.003
Molybdenum	0.31 - 0.35	10	100	0.32	0.91	0.61	0.20
Nickel	0.21 - 0.23	10	100	4.9	11	8.79	1.62
Potassium	38 - 43	10	100	1200	2800	2050	455
Silica	4.6 - 5.2	10	100	670	790	735	42.5

Table 1.2 Summary of Detected Analytes in Surface Soil

Analyte	Range of Reported Detection Limits	Total Number of Results[c]	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Silver	0.083 - 0.093	10	10	0.12	0.12	0.09	0.05
Sodium	140 - 150	10	20	140	200	91.5	43.8
Strontium	0.062 - 0.07	10	100	9.6	24	20.3	4.20
Thallium	0.96 - 1.1	10	10	1.3	1.3	0.57	0.26
Titanium	0.093 - 0.1	10	100	150	320	236	58.2
Vanadium	0.49 - 0.55	10	100	19	34	28	5
Zinc	0.48 - 0.54	10	100	21	50	37	9
Radionuclides[b] (pCi/g)							
Americium-241	0.131 - 0.296	10	100	-0.016	0.08	0.028	0.034
Plutonium-239/240	0.0582 - 0.275	10	100	-0.078	0.25	0.066	0.094
Uranium-233/234	0.136 - 0.423	10	100	0.71	1.27	0.888	0.203
Uranium-235	0.214 - 0.482	10	100	-0.011	0.189	0.084	0.084
Uranium-238	0.194 - 0.423	10	100	0.678	1.7	0.985	0.331

[a] For inorganics the mean is computed using one-half the reported value for non-detections.
[b] All reported radionuclide values are considered detections.
[c] Total of reported results.

Table 1.3 Summary of Detected Analytes in Sediment

Analyte	Range of Reported Detection Limits	Total Number of Results[d]	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Inorganics (mg/kg)							
Aluminum	4.8 - 40	10	100	2390	19400	9521	6050
Antimony	3 - 12	10	20	11.1	12.4	5.1	4.0
Arsenic	0.27 - 2	10	100	1.4	5.3	3.2	1.62
Barium	1.2 - 40	10	100	22.2	244	103	71
Beryllium	0.11 - 1	10	60	0.27	1.4	0.47	0.39

Table 1.3 Summary of Detected Analytes in Sediment

Analyte	Range of Reported Detection Limits	Total Number of Results[d]	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Cadmium	0.51 - 1.3	10	30	0.41	1.3	0.55	0.34
Chromium	0.56 - 2	10	100	2.1	24.8	10.5	6.9
Cobalt	0.6 - 10	10	100	2.6	10.1	6.4	2.5
Copper	0.45 - 5	10	90	4.3	25.9	13.9	8.6
Iron	3.6 - 20	10	100	4440	23400	13093	6153
Lead	0.6 - 2.5	10	100	2.8	25.5	14.0	7.8
Lithium	1.5 - 20	10	100	2.7	20.3	8.4	6.0
Magnesium	7.1-2000	10	100	662	4330	2189	1272
Manganese	0.28 - 3	10	100	101	470	238	1212
Molybdenum	1.2 - 40	10	30	0.79	2.4	1.25	0.7
Nickel	1.3 - 8	10	90	3.1	17.6	9.4	5.1
Nitrate/Nitrite	0.02 - 2.8	10	60	0.3	76	15.1	29.2
Potassium	144-2000	10	100	423	2890	1309	744
Silicon	5000-9800	2	100	187000	252000	219500	45962
Silver	0.62 - 2	9	11	2	2	0.6	0.6
Sodium	36.8-2000	10	100	75.2	559	260	139
Strontium	0.55 - 400	10	100	4.1	41.2	22.5	13
Thallium	0.41 - 2	10	10	0.4	0.4	0.3	0.1
Tin	2.2 - 40	10	30	3.6	17.5	7.3	7.2
Vanadium	0.49 - 10	10	100	8	51.9	26	13.4
Zinc	0.92 - 4	10	100	28.4	720	221	259
Organics (ug/kg)							
2-Butanone[b]	10 - 29	9	11	3	3	7.7	3.1
4-Methylphenol[b]	330 - 950	10	10	95	95	394	185
Benzoic acid[b]	1600 - 4800	10	30	380	480	1442	937
bis(2-Ethylhexyl)phthalate[b]	330 - 950	10	30	69	250	377	201
Di-n-butylphthalate[b]	330 - 950	10	40	52	150	288	186
Fluoranthene[b]	330 - 950	10	10	88	88	411	180

Table 1.3 Summary of Detected Analytes in Sediment

Analyte	Range of Reported Detection Limits	Total Number of Results[d]	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Pyrene[b]	330 - 950	10	10	61	61	409	186
Toluene[b]	5 - 14	10	10	2	2	4	1
Radionuclides[c] (pCi/g)							
Americium-241	0 - 0.015	8	100	-0.004	0.087	0.016	0.029
Cesium-134	0.079-0.087	2	100	0.079	0.087	0.083	0.005
Cesium-137	0.05 - 0.48	8	100	0.002	1.498	0.382	0.507
Gross Alpha	1.8 - 3.4	8	100	15.33	72	35	19.7
Gross Beta	2.4 - 5.2	8	100	35	59	43.3	7.41
Plutonium-239/240	0.002 - 0.014	8	100	0.002	0.04	0.016	0.011
Radium-226	0.19 - 1	4	100	0.39	1.8	1.06	0.693
Radium-228	0.33 - 1.76	4	100	0.94	4.1	2.41	1.39
Strontium-89/90	0.04 - 0.4	8	100	0.08	0.319	0.217	0.091
Tritium	211 - 420	8	100	-0.062	0.44	0.154	0.173
Uranium-233/234	0.014 - 0.044	8	100	0.63	3.079	1.78	0.891
Uranium-235	0 - 0.044	8	100	0.016	0.14	0.066	0.04
Uranium-238	0.008 - 0.062	8	100	0.65	2.81	1.68	0.893

[a] For inorganics the mean is computed using one-half the reported value for non-detections.
[b] All detections are "J" qualified, signifying that the reported result is an estimated value, that is, below the method detection limit, but above the instrument detection limit.
[c] All reported radionuclide values are considered detections
[d] Total number of reported results..

Table 1.4 Summary of Detected Analytes in Subsurface Soil

Analyte	Reported Detection Limit[b]	Total Number of Results[d]	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Inorganics (mg/kg)							
Aluminum	40 - 40	7	100	3130	15400	9153	4749
Arsenic	2 - 2	7	100	2.4	5.9	3.36	1.25
Barium	40 - 40	7	100	21.9	64	45.1	14.3
Beryllium	1 - 1	7	100	0.27	1.2	0.656	0.357
Calcium	1000 - 1000	7	100	347	3160	1237	995
Cesium	200 - 200	7	29	1.2	1.7	3.49	1.40
Chromium	2 - 2	7	100	13.1	22.8	15.7	3.60
Cobalt	10 - 10	7	100	3.5	13.7	7.17	3.29
Copper	5 - 5	7	100	4.8	12.5	8.63	2.93
Iron	20 - 20	7	100	6830	18100	10736	4093
Lead	0.6 - 1	7	100	2.8	13.9	6.91	3.97
Lithium	20 - 20	7	100	2	7.8	5.2	2.27
Magnesium	1000 - 1000	7	100	308	3160	1223	954
Manganese	3 - 3	7	100	90.5	295	151.4	67.5
Mercury	0.1 - 0.1	7	14	0.1	0.1	0.048	0.025
Nickel	8 - 8	7	86	5.7	12.6	7.89	2.81
Nitrate / Nitrite	0.1 - 0.1	5	100	0.1	1	0.380	0.356
Potassium	1000 - 1000	7	100	318	1010	780	249
Selenium	1 - 1	7	14	0.39	0.39	0.204	0.093
Sodium	1000 - 1000	7	100	30.3	559	152	202
Strontium	40 - 40	7	100	7.1	45	17.0	13.8
Tin	40 - 40	7	29	32.9	33.9	10.4	15.7
Vanadium	10 - 10	7	100	9.1	36.1	20.9	9.19
Zinc	4 - 4	7	57	14.3	26.9	12.5	9.23
Organic (ug/kg)							
Acetone[c]	10 - 10	1	100	2	2	2	-

Table 1.4 Summary of Detected Analytes in Subsurface Soil

Analyte	Reported Detection Limit[b]	Total Number of Results[d]	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
bis(2-Ethylhexyl)phthalate[c]	330 - 330	5	80	38	93	86.8	51.3
Diethylphthalate[c]	330 - 330	5	20	130	130	163	18.9
Di-n-butylphthalate	330 - 330	5	100	240	410	350	66.7
Fluoranthene	330 - 330	5	20	48	48	146	54.7
Toluene[c]	5 - 5	4	50	2	3	2.5	0.41
Radionuclides (pCi/g)							
Americium-241	0.008 - 0.02	5	100	0.002	0.013	0.006	0.004
Gross Alpha	2.2 - 2.2	2	100	13.9	21.1	17.5	5.09
Gross Beta	4.6 - 4.8	2	100	18.1	20.6	19.4	1.77
Plutonium-239/240	0.011 - 0.026	5	100	-0.002	0.032	0.007	0.014
Strontium-89/90	0.3 - 0.3	2	100	-0.03	0.133	0.052	0.115
Uranium-233/234	0.065 - 0.14	5	100	0.84	2.3	1.57	0.541
Uranium-235	0.046 - 0.12	5	100	0.033	0.1	0.063	0.026
Uranium-238	0.074 - 0.16	5	100	0.71	2.3	1.52	0.607

[a] For inorganics the mean is computed using one-half the reported value for non-detections.
[b] No detection limit reported.
[c] All detections are "J" qualified, signifying that the reported result is an estimated value that is below the method detection limit, but above the instrument detection limit.
[d] Total number of reported results.

Table 1.5 Summary of Detected Analytes in Surface Water

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/L)							
Aluminum	0.00025 - 0.2	71	89	0.0202	129	6.97	18.5
Antimony	0.00005 - 0.06	71	14	0.00041	0.029	0.007	0.007
Arsenic	0.00032 - 0.2	70	40	0.001	0.0167	0.004	0.01
Barium	0.00002 - 0.2	71	100	0.024	0.63	0.097	0.091
Beryllium	0 - 0.005	71	25	0.00004	0.0037	0.001	0.001
Cadmium	0.00003 - 0.005	70	9	0.00007	0.0038	0.001	0.001
Calcium	0.0016 - 5	71	100	4.68	39.2	21.3	8.14
Cesium	0.0001 - 1	36	17	0.00071	0.07	0.122	0.117
Chloride	0.1-5	25	100	2	67	16	13.7
Chromium	0.00005 - 0.01	71	49	0.00051	0.247	0.013	0.036
Cobalt	0.00001 - 0.05	71	41	0.00028	0.0193	0.002	0.003
Copper	0.00004 - 0.025	69	65	0.00115	0.0484	0.007	0.01
Cyanide	0.005 - 0.02	15	7	0.0024	0.0024	0.005	0.003
Fluoride	0.05 - 0.5	50	98	0.2	1	0.386	0.136
Iron	0.0025 - 0.1	71	99	0.01029	88.6	4.76	12.7
Lead	0.00003 - 0.15	68	66	0.00012	0.0508	0.006	0.011
Lithium	0.00002 - 0.1	66	56	0.00128	0.154	0.008	0.019
Magnesium	0.00008 - 5	71	100	1.25	18.2	5.38	2.39
Manganese	0.00001 - 0.015	71	99	0.00120	0.492	0.069	0.103
Mercury	0.00001 - 0.0002	63	13	0.00004	0.00477	0.0002	0.001
Molybdenum	0.00003 - 0.2	68	38	0.00095	0.0084	0.003	0.002
Nickel	0.00005 - 0.04	71	45	0.00141	0.12	0.01	0.019
Nitrate / Nitrite	0.02 - 1	18	61	0.06	2	0.443	0.588
Nitrite	0.02 - 0.05	13	8	0.058	0.058	0.018	0.014
Orthophosphate	0.05-0.05	10	10	0.58	0.58	0.081	0.18
Phosphate	0.01-0.05	6	83	0.02	0.06	0.04	0.017

Table 1.5 Summary of Detected Analytes in Surface Water

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]
Phosphorus	0.01-0.05	14	43	0.05	0.18	0.06	0.05
Potassium	0.00035 - 5	71	99	0.954	15.4	2.66	2.11
Selenium	0.0002 - 0.15	70	27	0.00065	0.019	0.002	0.004
Silicon	0.015-555.6	40	100	1.58	177000	13856	33582
Silver	0.00003 - 0.01	71	4	0.00006	0.0028	0.001	0.001
Sodium	0.00042 - 5	71	100	1.92	33.4	16.6	6.6
Strontium	0.00002 - 0.2	68	100	0.0279	0.238	0.132	0.046
Sulfate	0.1 - 10	50	100	4	48	28.8	11.3
Thallium	0.00005 - 0.35	70	11	0.00024	0.007	0.002	0.009
Tin	0.00016 - 0.2	66	9	0.00099	0.0042	0.005	0.006
Uranium	0.0027 - 0.028	9	22	0.0029	0.0038	0.003	0.004
Vanadium	0.00002 - 0.05	71	58	0.00041	0.132	0.014	0.028
Zinc	0.00008 - 0.02	70	74	0.002	0.103	0.02	0.025
Organics (ug/L)							
2-Butanone[b]	10	15	7	3	3	4.9	0.52
Acetone	10	15	7	28	28	7.6	6.05
Methylene chloride	5	16	6	16	16	4.3	4
Oil and grease	200 - 14500	15	33	600	17800	4667	5007
Radionuclides[c] (pCi/L)							
Americium-241	0 - 0.019	14	100	-0.001	0.024	0.005	0.008
Cesium, radio	0.55 - 0.814	4	100	0.39	0.74	0.510	0.156
Cesium-137	0.46 - 0.99	6	100	-0.558	0.45	0.07	0.35
Gross alpha	0.37 - 6	11	100	0.13	45	10.1	17.2
Gross beta	1 - 8	13	100	1.7	35	10.1	11.0
Plutonium-238	0.049 - 0.378	2	100	0.001	0.01343	0.007	0.009
Plutonium-239/240	0 - 0.257	15	100	0	0.043	0.006	0.01
Radium-226	0.16 - 0.5	3	100	-0.1	4.9	2.3	2.5
Strontium-90	0.21 - 0.835	8	100	0.14	2.172	1.2	0.74

Table 1.5 Summary of Detected Analytes in Surface Water

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]
Tritium	200 - 470	10	100	-32.9	751	166	231
Uranium-234	0.017 - 0.3	15	100	-0.056	5.1	0.92	1.45
Uranium-235	0 - 0.32	15	100	-0.00962	0.29	0.07	0.09
Uranium-238	0 - 0.26	15	100	0.059	4.9	0.9	1.4

[a] For inorganics the mean is computed using one-half the detection limit for non-detections.
[b] All detections are "J" qualified, signifying that the reported result is an estimated value, that is, below the method detection limit, but above the instrument detection limit.
[c] All reported radionuclide values are considered detections.
[d] Total number of reported results, includes filtered and unfiltered samples.

Table 1.6 Summary of Detected Analytes in Groundwater

Analyte	Range of Reported Detection Limits	Total Number of Results[d]	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Inorganics (mg/L)							
Aluminum	0.0086 - 0.2	82	50	0.0121	34.1	3.63	6.96
Ammonia	0.05 - 50	19	26	0.029	3.549	13.4	39.3
Antimony	0.00028 - 0.06	82	12	0.00031	0.0325	0.012	0.007
Arsenic	0.0007 - 0.01	82	24	0.0011	0.0083	0.001	0.001
Barium	0.00019 - 0.2	82	100	0.0115	0.462	0.092	0.079
Beryllium	0.00008 - 0.005	82	9	0.00055	0.002	0.001	0.0005
Cadmium	0.00004 - 0.005	82	5	0.00022	0.003	0.001	0.001
Calcium	0.0034 - 5	82	100	12.1	67	22.1	9.11
Cesium	0.008 - 1	77	6	0.024	0.04	0.047	0.071
Chloride	0.2 - 5	51	88	1	23	6	6
Chromium	0.00038 - 0.01	81	26	0.0021	0.0524	0.007	0.012
Cobalt	0.00006 - 0.05	82	23	0.003	0.0272	0.004	0.004
Copper	0.00069 - 0.025	82	29	0.001	0.0434	0.006	0.008
Cyanide	0.005 - 0.1	47	6	0.0014	0.00508	0.003	0.002
Fluoride	0.1 - 0.5	53	96	0.16	1.5	0.474	0.363
Iron	0.0018 - 0.1	81	54	0.0086	30.4	3.71	6.92
Lead	0.00005 - 0.003	82	38	0.00012	0.0204	0.003	0.005
Lithium	0.00007 - 0.1	82	51	0.0011	0.0259	0.006	0.005
Magnesium	0.00633 - 5	82	99	0.5	11.6	4.45	2.24
Manganese	0.0005 - 0.015	82	66	0.00069	1.93	0.134	0.303
Mercury	0 - 0.0002	82	5	0.00024	0.00045	0.0001	0.0001
Molybdenum	0.0002 - 0.2	82	26	0.002	0.0531	0.011	0.016
Nickel	0.00007 - 0.04	82	27	0.00121	0.0457	0.009	0.009
Nitrate / Nitrite	0.01 - 1	56	91	0.03	13	2.34	2.4
Potassium	0.0151 - 5	82	78	0.438	6.44	1.58	1.5
Selenium	0.00064 - 0.005	82	9	0.001	0.0042	0.001	0.001

Table 1.6 Summary of Detected Analytes in Groundwater

Analyte	Range of Reported Detection Limits	Total Number of Results[d]	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Silver	0.00004 - 0.01	82	2	0.0042	0.0054	0.001	0.001
Sodium	0.00968 - 5	82	100	7.35	33.5	14.8	7.21
Strontium	0.0002 - 0.2	82	100	0.0717	0.411	0.147	0.072
Sulfate	0.5 - 50	53	100	7	130	32	30
Thallium	0.00002 - 0.01	82	4	0.0037	0.0093	0.001	0.001
Tin	0.00082 - 0.2	82	11	0.0076	0.0678	0.013	0.011
Uranium	0.00002 - 0.00002	3	100	0.00027	0.00102	0.001	0.000
Vanadium	0.0014 - 0.05	82	45	0.002	4.1	0.062	0.452
Zinc	0.001 - 0.02	82	49	0.0015	0.201	0.024	0.033
Organics (ug/L)							
1,1,2,2-Tetrachloroethane[b]	0.2 - 5	55	2	1	1	1.26	1.15
1,1,2-Trichloroethane[b]	0.3 - 5	55	2	0.7	0.7	1.31	1.1
4-Methyl-2-pentanone[b]	10 - 10	26	4	3	3	4.92	0.392
bis(2-Ethylhexyl)phthalate	10 - 10	8	63	1	56	10.4	18.5
Bromoform[b]	0.2 - 5	54	2	0.6	0.6	1.28	1.14
Carbon disulfide[b]	5 - 5	27	7	0.2	2	2.40	0.449
Carbon tetrachloide[b]	0.1 - 5	55	2	5	5	1.34	1.25
Chloroform[b]	0.1 - 5	54	2	0.2	0.2	1.21	1.17
Diethylphthalate[b]	10 - 10	8	13	0.6	0.6	4.45	1.56
Di-n-butylphthalate[b]	10 - 10	8	25	1	2	4.13	1.64
Methylene chloride	0.1 - 5	55	13	0.2	3	1.33	1.13
Tetrachloroethene	0.1 - 5	55	2	0.4	0.4	1.28	1.17
Toluene[b]	0.1 - 5	55	2	0.3	0.3	1.24	1.17
Trichloroethene[b]	0.1 - 5	55	2	0.1	0.1	1.28	1.17
Radionuclides[c] (pCi/L)							
Americium-241	0 - 0.0398	57	100	-0.007	0.0906	0.005	0.012
Cesium, radio	0.48 - 0.998	31	100	-0.75	3.8	0.587	0.706

Table 1.6 Summary of Detected Analytes in Groundwater

Analyte	Range of Reported Detection Limits	Total Number of Results[d]	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration[a]	Standard Deviation[a]
Cesium-134	1.03 - 2.49	4	100	-0.104	0.6154	0.246	0.379
Cesium-137	0.55 - 2.54	20	100	-0.742	1.4	0.13	0.467
Gross Alpha	0.4 - 7.489	55	100	-0.51	32.2267	2.56	6.07
Gross Beta	0.95 - 15.048	61	100	-0.44	29.6649	3.16	5.42
Plutonium-238	0.0027 - 0.011	5	100	-0.0015	0.0025	0.001	0.001
Plutonium-239/240	0 - 0.038	57	100	-0.004	0.2346	0.005	0.031
Radium-226	0.049 - 0.347	10	100	0.13	3.3	1.02	1.05
Radium-228	1.21 - 1.84	4	100	-0.54	1	0.260	0.631
Strontium-89/90	0.2 - 1.1	53	100	-1.0894	0.9669	0.146	0.315
Tritium	189.1 - 640	55	100	-190	580	104	151
Uranium-233/234	0 - 0.887	61	100	-0.0296	3.3	0.507	0.581
Uranium-235	0 - 0.691	61	100	-0.027	0.3347	0.073	0.086
Uranium-238	0 - 0.72	61	100	-0.018	2.2	0.365	0.446

[a] For inorganics the mean is computed using one-half the detection limit for non-detections.
[b] All detections are "J" qualified, signifying that the reported result is an estimated value that is below the method detection limit, but above the instrument detection limit.
[c] All reported radionuclide values are considered detections.
[d] Total number of reported results.

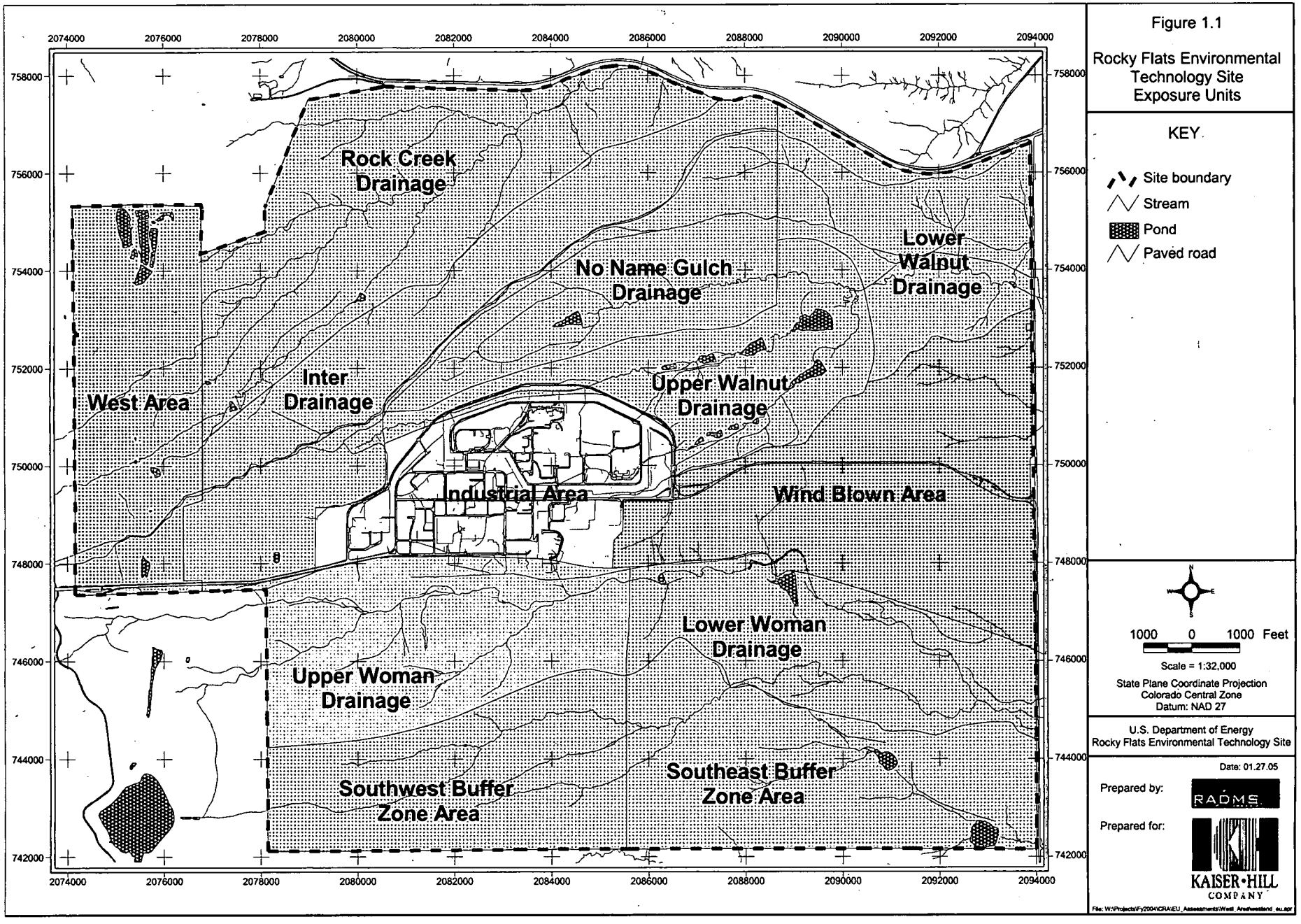

Figure 1.1

Rocky Flats Environmental Technology Site Exposure Units

KEY

- Site boundary
- Stream
- Pond
- Paved road

N

W E

S

1000 0 1000 Feet

Scale = 1:32,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

Date: 01.27.05

Prepared by: RADMS

Prepared for: KAISER•HILL COMPANY

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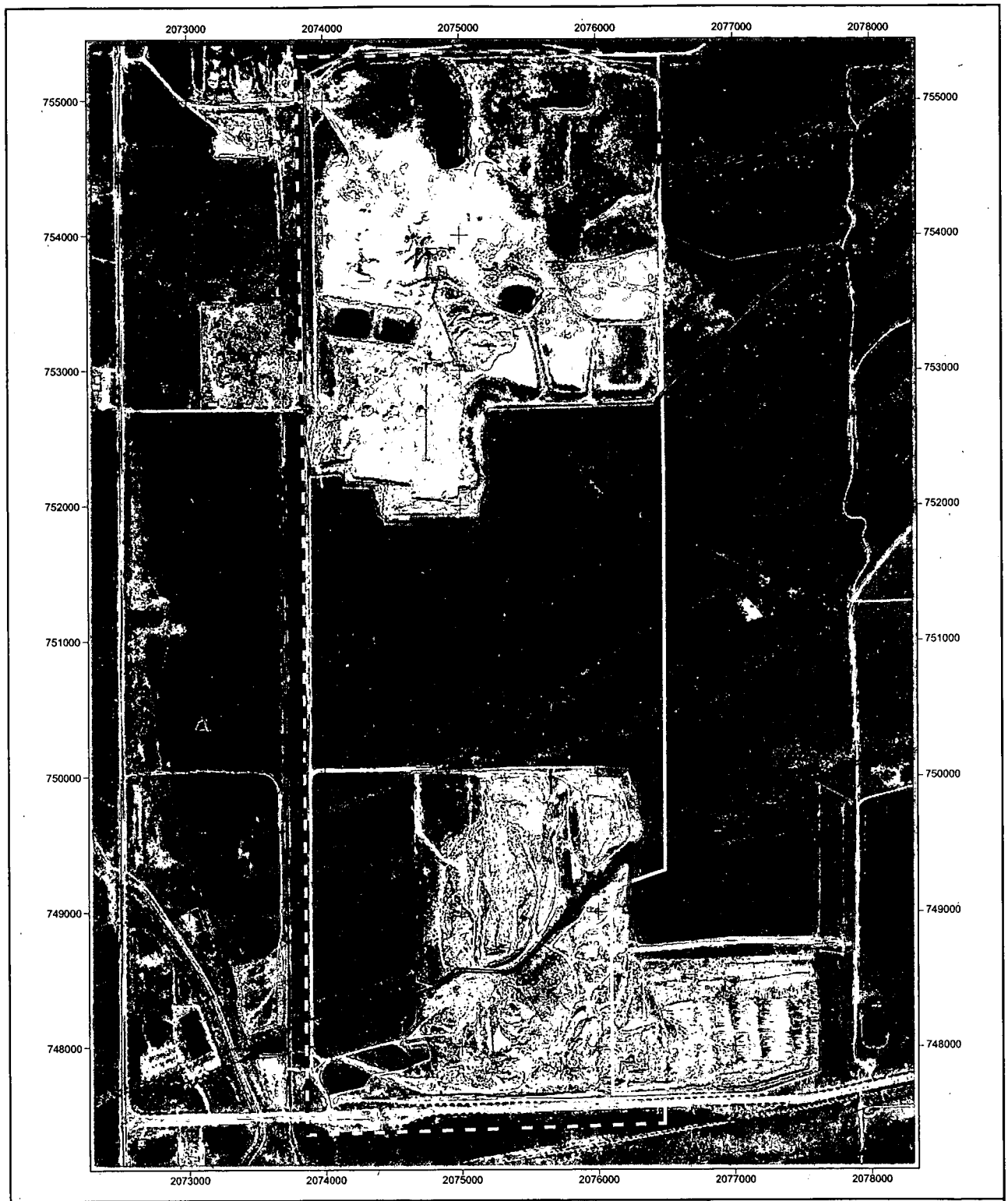

Figure 1.2

Aerial Photograph of West Area Exposure Unit October 2004

DRAFT

KEY

- West Area EU
- Exposure unit
- Soil Disturbance Area, October 2004
- Site boundary
- Stream
  - Ephemeral
  - Intermittent
  - Perennial

500 0 500 Feet

Scale 1:12,500

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

Date: 01.27.05

Prepared by: RADMS

Prepared for: KAISER•HILL COMPANY

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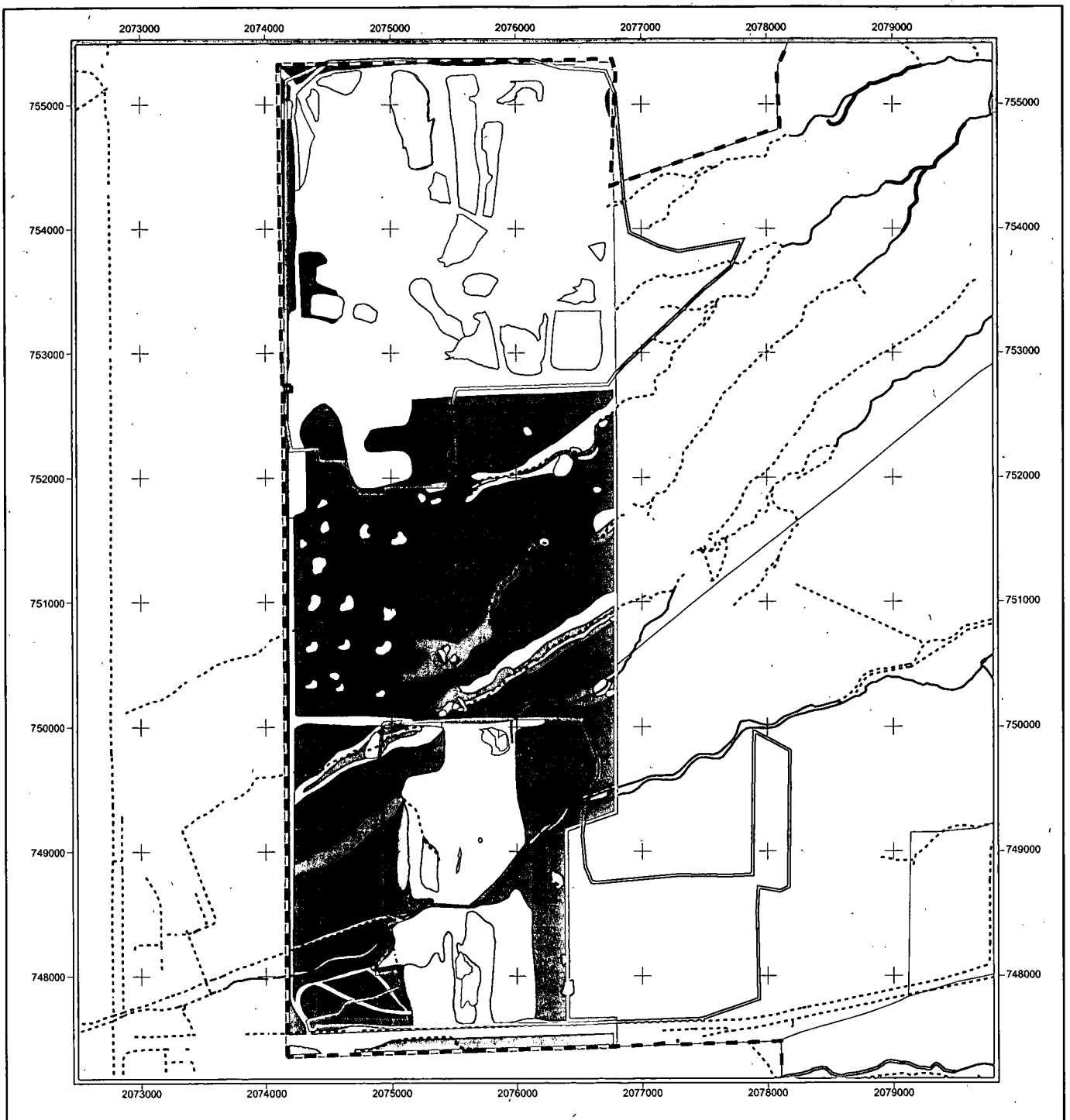

Figure 1.3

Vegetation in the West Area Exposure Unit

DRAFT

KEY

Vegetation, 1996

- Annual Grass/Forb Community
- Disturbed and Developed Areas
- Leadplant Riparian Shrubland
- Mesic Mixed Grassland
- Open Water
- Ponderosa Woodland
- Reclaimed Mixed Grassland
- Short Marsh
- Short Upland Shrubland
- Tall Marsh
- Tall Upland Shrubland
- Wet Meadow/Marsh Ecotone
- Xeric Tallgrass Prairie

- West Area EU
- Exposure unit
- Open water, October 2004
- Soil Disturbance Area, October 2004
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N W E S

500 0 500 Feet

Scale 1: 13,500

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

Date: 01.27.05

Prepared by: RADMS

Prepared for: KAISER•HILL COMPANY

File:W:\Projects\Fy2004\CRA\EU_Assessments\West_Area\westeu_veg.apr

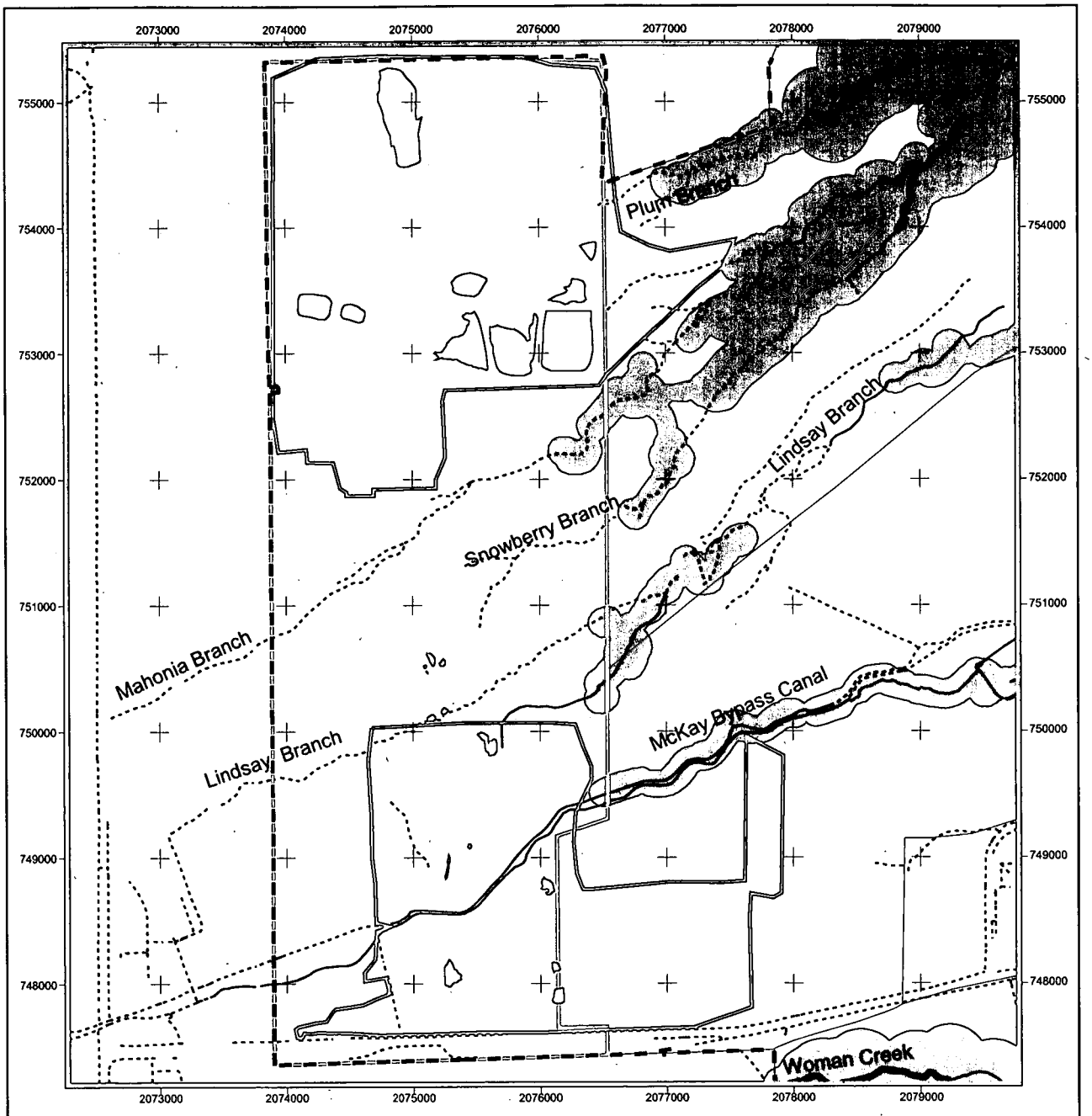

Figure 1.4

Preble's Meadow Jumping Mouse Habitat in the West Area Exposure Unit

DRAFT

KEY

- PMJM Habitat
- West Area EU
- Exposure unit
- Open water, October 2004
- Soil Disturbance Area, October 2004
- Site boundary

Stream

- Perennial
- Intermittent
- Ephemeral

N W E S

500 0 500 Feet

Scale 1:14,500

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

Date: 01.27.05

Prepared by: RADMS

Prepared for: KAISER•HILL COMPANY

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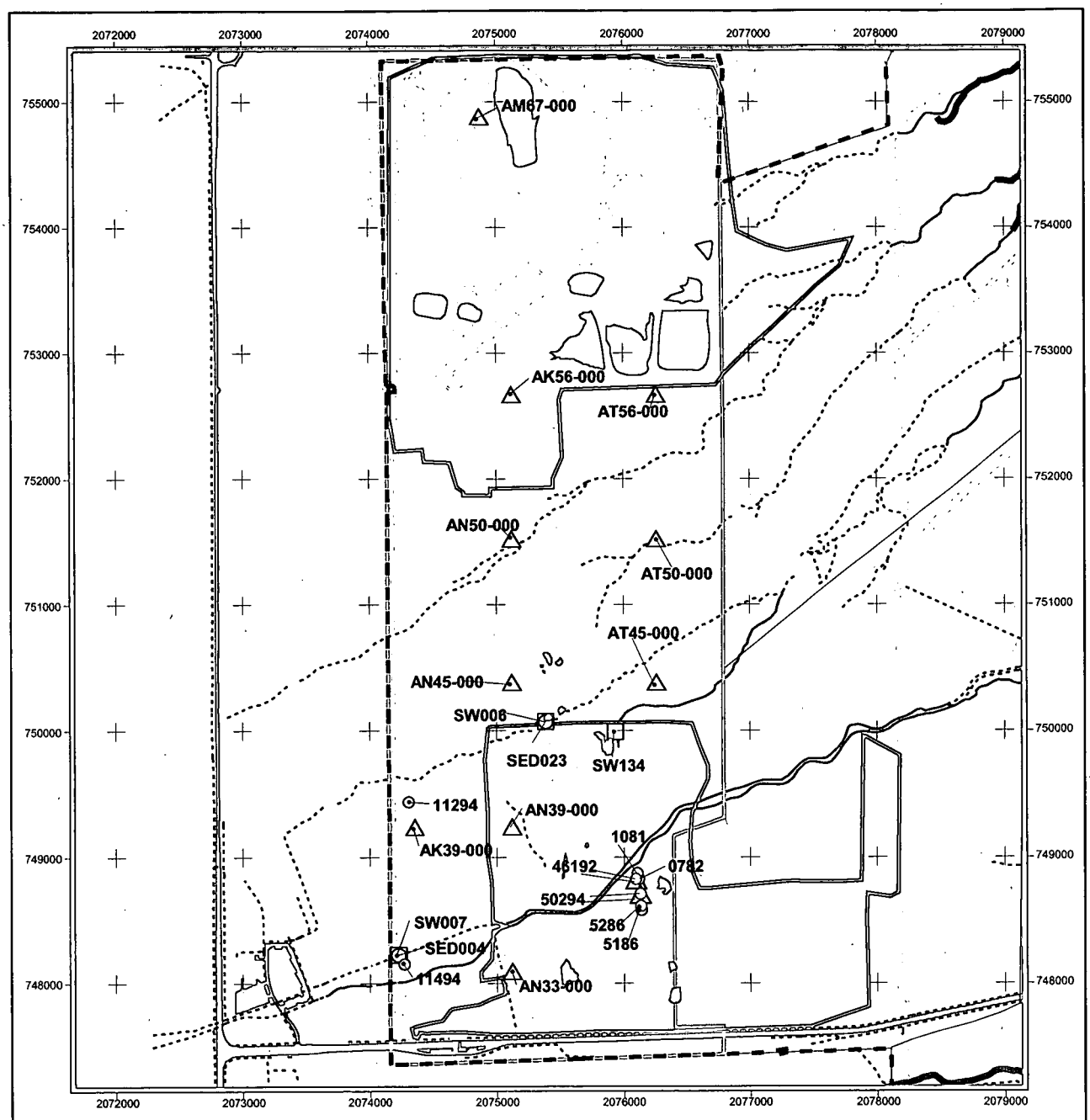

Figure 1.5

West Area Exposure Unit Sampling Locations

DRAFT

KEY

- Groundwater sampling location
- Sediment sampling location
- Surface water sampling location
- Subsurface soil sampling location
- Surface soil sampling location
- Soil Disturbance Area, October 2004
- West Area EU
- Exposure unit
- Open water, October 2004
- Site boundary

Stream

- Perennial
- Intermittent
- Ephemeral
- Dirt road
- Paved road

N W E S

500 0 500 Feet

Scale 1:14,500

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

Date: 01.27.05

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2.0 SELECTION OF HUMAN HEALTH CONTAMINANTS OF CONCERN

The human health contaminant of concern (COC) screening process is set forth in the CRA Methodology, Section 4.4 (DOE 2004a) and summarized in Volume 2 of the CRA..

Two potential future on-site human receptors are described in the CRA Methodology: the WRW and the WRV. The PRGs used in the COC selection process are based on the WRW exposure scenario and a risk of 1×10^{-6}. The PRGs based on the WRW are considered protective for the WRV. The derivation of the PRG values is documented in Appendix A of the CRA Methodology. The background data (DOE 1995b) used for the background screening step are discussed in Volume 2 of the CRA.

Only analytes detected at least once in a medium are included in the COC screen for that medium. Nondetected analytes are listed and the detection limits for these analytes are evaluated in Appendix A.

The human health COC selection process was conducted for the following media in the WAEU: surface soil, sediment, subsurface soil, and surface water. In addition, analytes in subsurface soil and groundwater were screened for their potential to be released into indoor air at levels that might cause significant human health effects. Groundwater was also screened if there are sources for contributions to surface water. Results of the COC selection process are summarized in Section 2.6.

2.1 Contaminant of Concern Selection for Surface Soil

Human health potential contaminants of concern (PCOCs) for surface soil were screened in accordance with the methodology presented in the CRA Methodology to identify the COCs.

2.1.1 Surface Soil Cation/Anion and Essential Nutrient Screen

The essential nutrient screen for analytes detected in surface soil is presented in Table 2.1. It includes analytes 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). These 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 are less than the DRIs. These PCOCs were not further evaluated as COCs for surface soil.

2.1.2 Surface Soil Preliminary Remediation Goals Screen

Table 2.2 presents the ratios of the MDCs to the WRW PRGs for each PCOC. If the MDC/PRG ratio for a PCOC is greater than 1, the PCOC is retained for further screening. Otherwise it is eliminated. Only arsenic has an MDC that exceeds its PRG for surface soil in the WAEU, and, accordingly, it was retained as a PCOC. Arsenic is further evaluated in the following sections.

2.1.3 Surface Soil Frequency of Detection Screen

Arsenic was the only analyte for which the MDC in surface soil exceeded the PRG. Arsenic was detected in all 10 surface soil samples, and, therefore, was retained for further evaluation in the screen.

2.1.4 Surface Soil Background Analysis

A statistical analysis was conducted to determine whether arsenic concentrations in WAEU surface soil are higher than those in background surface soil at the 0.1 level of significance as specified in the CRA Methodology (DOE 2004a). The background data are described in detail in Volume 2 of the CRA.

In accordance with the CRA Methodology, the background analysis used two statistical programs: ProUCL (Version 3.0) and S-Plus. The programs are described in detail in Appendix A of Volume 2. ProUCL was used to determine the distributions of the WAEU and background data sets. The distribution types determine the appropriate statistical test for the background comparison. S-Plus was then used to compare the two data sets. The results of the background analysis for arsenic in surface soil are described below and are summarized in Tables 2.3 and 2.4. Output summaries from the statistical programs are provided in Appendix C.

The analyses with ProUCL determined the WAEU surface soil and background surface soil data for arsenic have gamma and normal distributions, respectively. Therefore, the nonparametric Wilcoxon Rank Sum (WRS) test was used for the background comparison. The results in Table 2.4 indicated the WAEU median concentration for arsenic in the WAEU is greater than the background median at the 0.9 significance level. As such, arsenic is discussed further in the professional judgment section below.

2.1.5 Surface Soil Professional Judgment

Arsenic is the only PCOC in surface soil with concentrations that exceed the WRW PRG. The WRS test indicates the median of the WAEU arsenic data is greater than the median for background. Table 2.5 presents the range of data for the WAEU and background arsenic data sets and provides means, median, and the upper 95 percent upper confidence limits of the mean (UCLs). Arsenic concentrations in surface soil at the WAEU range from 3.6 to 22 mg/kg, and from 2.3 to 9.6 mg/kg in the background data. The second highest value in the WAEU data set is 9.3 mg/kg, below the maximum background value.

The box plots on Figure 2.2 show the medians (midpoints), the spread or variability of the two data sets, the skewness around the median (boxes and whiskers), and any "unusual" values. The box plots show that the WAEU data fall within the range of the background data and that the distributions of the data are very similar, with the exception of one 22 mg/kg value. Concentrations of arsenic similar in magnitude to the 22 mg/kg observation in the WAEU are seen in the Interdrainage EU (Figure 1.1, northwest portion of RFETS) and in the Southeast BZ EU (Figure 1.1, southeast portion of RFETS). There are no known contaminant release sites at any of these locations.

The WAEU is located topographically upgradient from IA, and is also predominantly upwind. Transport of arsenic to the WAEU by runoff is not possible, and by wind is

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remote. The nearest area to the WAEU that has been impacted by operations at RFETS is the West Spray Field. Arsenic is not associated with past spray activities in this area (DOE 1995c). The arsenic levels in surface soil in the spray field area were also slightly above background, but investigations clearly showed that there was no correlation of concentration levels with past disposal activities in the area, and arsenic was not evaluated as a COC for this area (DOE 1995c).

The single relatively higher arsenic concentration in the WAEU is likely due to spatial variations of naturally occurring arsenic in alluvial materials. The range for arsenic in surface soil of the western United States (U.S.) is 0.1 to 97 mg/kg with an arithmetic mean of 7 mg/kg (Shacklette and Boerngen 1984). The arsenic MDC of 22 mg/kg in the WAEU falls well within this range. The UCL of 11.9 mg/kg is less than the mean plus two standard deviations of arsenic concentrations (12 mg/kg) in rural Longmont surface soil (Conner and Shacklette 1975). Therefore, arsenic in surface soil in the WAEU is not considered a COC and was not further evaluated.

2.2 Contaminant of Concern Selection for Sediment

Human health PCOCs for sediment were screened in accordance with the methodology presented in the CRA Methodology to identify the COCs.

2.2.1 Sediment Cation/Anion and Essential Nutrient Screen

Data for cations, anions, and essential nutrients without toxicity criteria were not collected for sediment. Therefore, this screen was not performed. The affect of this on the conclusions of this risk assessment will be discussed in the uncertainty section.

2.2.2 Sediment Preliminary Remediation Goal Screen

The PRG screen for sediment is presented in Table 2.6. The surface soil PRG is used because soil and sediment data are combined for risk calculations as discussed in the CRA Methodology (DOE 2004a). PCOCs for which the MDC/PRG ratio exceeded 1 include two inorganic analytes (arsenic and manganese) and two radionuclides, cesium-137 and radium-228. These PCOCs are further evaluated below.

2.2.3 Sediment Frequency of Detection Screen

Arsenic, manganese, cesium-137 and radium-228 were detected at a frequency of 100 percent, therefore, these PCOCs were retained and are further evaluated in the following sections.

2.2.4 Sediment Background Analysis

The WAEU sediment data were compared to the background data set for the four PCOCs that passed the PRG screen. The background sediment samples were collected in the RFETS BZ (DOE 1993) and included some of the samples in the WAEU. Data for these samples were removed from the background data set prior to performing the background analysis. The background data and their use in statistical analysis are described in Volume 2 of the CRA.

Both the WAEU and background sediment data for arsenic have gamma distributions (Table 2.3). The UCLs are 4.73 mg/kg for the WAEU and 3.12 mg/kg for background.

The WRS test indicates the median of the WAEU arsenic data is higher than the background median at the significance level of 0.9 (Table 2.4). Arsenic is further evaluated in the professional judgment section.

The WAEU sediment data for manganese were determined to have a normal distribution; the background data have a gamma distribution (Table 2.3). The WAEU and background UCLs are 309 and 318 mg/kg, respectively. The maximum manganese concentration in the WAEU is 470 mg/kg, considerably lower than the background maximum of 1,280 mg/kg. The WRS test yielded a p-value of 0.7591, indicating the median concentration for the WAEU data is not greater than the median for background at the 0.1 level of significance. Manganese was not evaluated further.

The WAEU and background sediment data for cesium-137 have gamma and nonparametric distributions, respectively. The WAEU and background UCLs for cesium-137 are 1.2 and 0.55 picocuries per gram (pCi/g), respectively. The maximum concentrations for the WAEU and background are equal at 1.5 pCi/g. The WRS test indicates the WAEU data are of the same population as background at the 0.1 level of significance. Cesium-137 was not evaluated further.

Both the WAEU and background sediment data for radium-228 are normally distributed. The UCLs were 4 and 1.9 pCi/g for WAEU and background, respectively. The maximum Radium-228 concentration in the WAEU is 4.1 mg/kg, slightly higher than the background maximum of 3.5 mg/kg. The *t*-test indicates that the WAEU mean is greater than the background mean at the significance level of 0.1. Radium-228 is evaluated further in the professional judgment section.

2.2.5 Sediment Professional Judgment

The statistical tests for the WAEU arsenic median and radium-228 mean for stream sediment were slightly elevated over background stream sediment. However, both the quantile and slippage tests indicate the WAEU and background data sets for both arsenic and radium-228 are from the same population. As discussed in Section 2.1.5, the WAEU is located topographically and hydrologically upgradient from IA, and is also predominantly upwind. The nearest area to the WAEU that has been impacted by operations at RFETS is the West Spray Field. Arsenic and radium-228 are not associated with past spray activities and were not evaluated as COCs in this area (DOE 1995c).

The box plots for arsenic on Figure 2.3 also show that the background and WAEU data sets are very similar and that the WAEU data are well within the range of the background data. The MDC of arsenic in background sediment (17.3 mg/kg) is approximately three times higher than that in sediment at the WAEU (5.3 mg/kg) and is at the lower end of the range of concentrations for soils in the western U.S (Shacklette and Boerngen 1984). Therefore, arsenic is not considered a COC and was not evaluated further.

The box plot for radium-228 on Figure 2.4 shows that the background and WAEU data sets are very similar and are in the same range. The slightly higher median and maximum for the WAEU data are likely due to natural variation. The background data set was collected from several geographically distinct areas characterized by different lithologies

and soil types. The WAEU data are from only two sampling locations. Therefore radium-228 is not considered a COC and was not evaluated further.

2.3 Contaminant of Concern Selection for Subsurface Soil (Less than 8 ft Deep)

Human health PCOCs for subsurface soil were screened in accordance with the methodology presented in the CRA Methodology to identify the COCs.

2.3.1 Subsurface Soil Cation/Anion and Essential Nutrient Screen

Data for cations, anions, and essential nutrients without toxicity criteria are not available for subsurface soil. Therefore, this screen was not performed. The affect of this on the conclusions of this RA is discussed in the uncertainty section.

2.3.2 Subsurface Soil Preliminary Remediation Goal Screen

The PRG screen for detected analytes in soil less than 8 ft deep is presented in Table 2.7. The MDC/PRG ratio was less than 1 for all PCOCs. Therefore, no analytes detected in subsurface soil were retained beyond the PRG screen.

2.3.3 Subsurface Soil Frequency of Detection Screen

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

2.3.4 Subsurface Soil Background Analysis

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

2.3.5 Subsurface Soil Professional Judgment

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

2.4 Contaminant of Concern Selection for Surface Water

Human health PCOCs for surface water were screened in accordance with the methodology presented in the CRA Methodology to identify the COCs.

2.4.1 Surface Water Cation/Anion and Essential Nutrient Screen

Cations and anions that have been detected in surface water in the WAEU are listed in Table 2.8. Detected cation/anions include orthophosphate and sulfate. No toxicity values are available for these PCOCs; therefore, orthophosphate and sulfate were not further evaluated. The affect of this on the conclusions of this risk assessment is discussed in the uncertainty section.

Essential nutrients without toxicity values that have been detected in surface water in the WAEU are evaluated in Table 2.9. The essential nutrients and estimated intakes, based on the nutrient's maximum detected concentrations and a surface water ingestion rate of 30 milliliters per day (ml/day), were compared to allowable dietary intakes. The estimated daily intakes for calcium, magnesium, potassium, and sodium in surface water were

below the allowable dietary values for these PCOCs; therefore, they were not further evaluated.

2.4.2 Surface Water Preliminary Remediation Goal Screen

The PRG screen for detected PCOCs in surface water is presented in Table 2.10. None of the detected analytes had MDC/PRG ratios greater than 1. Four organics were detected at very low concentrations in surface water. There was a single "J" qualified result for 2-butanone, signifying an estimated value below the MDL. Acetone and methylene chloride, both common laboratory contaminants, were detected in one sample each. It is likely that all three detected analytes are laboratory artifacts.

There is no toxicity data for oil and grease and it was not retained as a PCOC. Further evaluation is provided in the uncertainty analysis in Section 6.

2.4.3 Surface Water Frequency of Detection Screen

The detection frequency screen was not performed for surface water because there are no PCOCs with concentrations greater than the PRGs.

2.4.4 Surface Water Background Analysis

The background analysis was not performed for surface water because there are no PCOCs with concentrations greater than the PRGs.

2.4.5 Surface Water Professional Judgment

The professional judgment step was not performed for surface water because there are no PCOCs with concentrations greater than the PRGs.

2.5 Pathway Significance Evaluations

As described in the CRA Methodology (DOE 2004a), the following pathways are evaluated for their potential significance in each EU:

- Groundwater-to-surface water pathway; and
- Subsurface soil/groundwater-to-air pathway.

The groundwater-to-surface water pathway does not need to be evaluated for the WAEU, because groundwater originating on RFETS does not flow to surface water in this area. There are a few intermittent groundwater seeps near the headwaters of the Lindsay Branch of Rock Creek, but the shallow streams in the WAEU are not fed by groundwater (DOE 1995b).

The second pathway, volatilization to indoor air is theoretically complete for the WAEU, because volatiles have been detected in groundwater. Most of the detections are "J" qualified, signifying estimated results, below the method detection limit (Table 1.6). Methylene chloride and bis(2-ethyhexyl)phthalate, common laboratory contaminants, were detected at low concentrations in a few samples. Tetrachloroethene was detected at the detection limit in one sample. Data were not collected for volatiles in subsurface soil and there are no known sources (DOE 1992a).

The volatile organic data collected for groundwater, was further evaluated using PRGs developed specifically for the CRA based on inhalation of indoor air by the WRW. The development methods and assumptions for these PRGs are presented in Appendix A of the CRA Methodology (DOE 2004a). The maximum detected concentrations for volatile organic compounds (VOCs) in groundwater are compared to the WRW indoor air PRGs in Table 2.11. The MDC/PRG ratios for all detected PCOCs in groundwater were less than 1, indicating the groundwater-to-indoor air pathway is not significant for the WAEU and does not need to be further evaluated.

2.6 Contaminant of Concern Selection Summary

A summary of the results of the COC screening process is presented in Table 2.12. No COCs were selected for any of the media at the WAEU.

Table 2.1 Essential Nutrient Screen for Surface Soil

Analyte	MDC (mg/kg)	Estimated Maximum Daily Intake[a] (mg/day)	RDA/RDI/AI[b] (mg/day)	UL[b] (mg/day)	Analyte Retained for PRG Screen?
Calcium	4600	0.46	500-1,200	2,500	No
Magnesium	2500	0.25	80-420	65-110	No
Potassium	2800	0.28	2,000-3,500	NA	No
Sodium	200	0.02	500-2,400	NA	No

[a] Based on the MDC and a 100 mg/day soil ingestion rate for a WRW.
[b] RDA/RDI/AI/UL taken from NAS 2000, 2002

Table 2.2 PRG Screen for Surface Soil

Analyte	MDC	PRG	Ratio MDC/PRG	Analyte Retained for Detection Frequency Screen?
Inorganics (mg/kg)				
Aluminum	18000	24774	0.7	No
Antimony	0.6	44.4	0.01	No
Arsenic	**22**	**2.4**	**9.1**	**Yes**
Barium	140	2872	0.05	No
Beryllium	0.52	100	0.005	No
Boron	7.1	9477	0.0007	No
Chromium[a]	17	166630	0.0001	No
Cobalt	6.4	122	0.05	No
Copper	13	4443	0.003	No
Iron	16000	33326	0.5	No
Lead	48	1000	0.048	No
Lithium	12	2222	0.005	No
Manganese	320	419	0.7	No
Mercury	0.03	33	0.0009	No
Molybdenum	0.91	555	0.002	No
Nickel	11	2222	0.005	No
Silver	0.12	555	0.0002	No
Strontium	24	66652	0.0004	No
Thallium	1.3	7.8	0.2	No
Titanium	320	169568	0.002	No
Vanadium	34	111	0.3	No
Zinc	50	33326	0.002	No
Radionuclides (pCi/g)				
Americium-241	0.0804	7.7	0.01	No
Plutonium-239/240	0.25	9.8	0.03	No
Uranium-234	1.27	25.3	0.05	No
Uranium-235	0.189	1.05	0.18	No
Uranium-238	1.7	29.3	0.06	No

[a] The PRG for chromium (III) is used because it is the predominant form of chromium in soil. The MDC is also below the PRG for chromium (VI), which is 28 mg/kg.

Table 2.3 Statistical Distributions for Human Health PCOCs in Surface Soil and Sediment

Medium	Analyte	Total No. of Samples		Statistical Distribution Testing Results					
				Background			WAEU		
		Back-ground	WAEU	Distribution/UCL Recommended by ProUCL[a]	UCL Value (mg/kg)	Detects (%)	Distribution/UCL Recommended by ProUCL[a]	UCL Value (mg/kg)	Detects (%)
Inorganics (mg/kg)									
Surface Soil	Arsenic	20	10	Normal/Student's t	6.89	100	Gamma/Gamma	11.6	100
Sediment	Arsenic	40	10	Gamma/Gamma	3.12	92	Gamma/Gamma	4.45	100
	Manganese	40	10	Gamma/Gamma	318	100	Normal/Student-t	309	100
Radionuclides (pCi/g)									
Sediment	Cesium-137	8	8	Non-Parametric/ Chebyshev	0.55	100	Gamma/Gamma	1.22	100
	Radium-228	13	4	Normal/Student- t	1.9	100	Normal/Student-t	4.04	100

[a] ProUCL is a statistical software package developed by EPA (EPA 2004)

Table 2.4 Statistical Background Comparisons for Human Health PCOCs in Surface Soil and Sediment

Medium	Analyte	Retain as PCOC?[a]	
		t-Test	WRS Test
Inorganics			
Surface Soil	Arsenic	NA	Yes
Sediment	Arsenic	NA	Yes
	Manganese	NA	No
Radionuclides			
Sediment	Cesium-137	NA	No
	Radium-228	Yes	NA

[a] Retained by t-Test and WRS Test if p = 0.9 or more.
t-Test = Test for comparison of means for two sample populations with normal distributions (EPA 2002).
WRS test = Wilcoxon rank sum test for comparison of medians for two sample populations with differing distributions (EPA 2002)
NA = Not applicable due to distribution of data.

Table 2.5 Arsenic Concentrations in WAEU and Background Surface Soil

WAEU Arsenic Concentration (mg/kg)		Background Arsenic Concentration (mg/kg)		PRG (mg/kg)
3.6		2.3	6	2.4
4.9		3.3	6.2	
5.9		3.9	6.3	
6.9		4.4	6.8	
7.5		4.8	7.4	
7.7		4.9	8.3	
7.8		5	8.4	
9.2		5.3	8.7	
9.3		5.8	9.2	
22		5.8	9.6	
Range	3.6 - 22	Range	2.3 – 9.6	
Mean	8.5	Mean	6.1	
Median	7.6	Median	5.9	
UCL	11.6	UCL	7	

Table 2.6 PRG Screen for Sediment

Analyte	MDC	PRG	Ratio MDC/PRG	Analyte Retained for Detection Frequency Screen?
Inorganics (mg/kg)				
Aluminum	19400	24774	0.8	No
Antimony	12.4	44.4	0.3	No
Arsenic	**5.3**	**2.4**	**2.20**	**Yes**
Barium	244	2872	0.09	No
Beryllium	1.4	100	0.014	No
Cadmium	1.3	91.4	0.01	No
Chromium	24.8	166630	0.00001	No
Cobalt	10.1	122	0.08	No
Copper	25.9	4443	0.006	No
Iron	23400	33326	0.70	No
Lead	25.5	1000	0.03	No
Lithium	20.3	2222	0.01	No
Manganese	**470**	**419**	**1.12**	**Yes**
Molybdenum	2.4	555	0.004	No
Nickel	17.6	22224	0.008	No
Nitrate/Nitrite	76	177739	0.0004	No
Silver	2	555	0.004	No
Strontium	41.2	66652	0.0006	No
Thallium	0.4	7.8	0.05	No
Tin	17.5	66652	0.0003	No
Vanadium	51.9	111	0.47	No
Zinc	720	33326	0.02	No
Organics (ug/kg)				
2-Butanone	3	46373332	0.0000001	No
4-Methylphenol	95	400718	0.0002	No
Benzoic acid	480	320574148	0.000001	No
bis(2-Ethylhexyl)phthalate	250	213750	0.001	No
Di-n-butylphthalate	150	8014354	0.00002	No
Fluoranthene	88	2958512	0.00003	No
Pyrene	61	2218884	0.00003	No

Table 2.6 PRG Screen for Sediment

Analyte	MDC	PRG	Ratio MDC/PRG	Analyte Retained for Detection Frequency Screen?
Toluene	2	3094217	0.000001	No
Radionuclides (pCi/g)				
Americium-241	0.087	7.7	0.011	No
Cesium-137	**1.498**	**0.22**	**6.78**	**Yes**
Plutonium-239/240	0.040	9.8	0.004	No
Radium-226	1.800	2.7	0.668	No
Radium-228	**4.1**	**0.11**	**36.9**	**Yes**
Strontium-90	0.319	13.2	0.024	No
Tritium	0.440	25082	.00002	No
Uranium-234	3.079	25.3	0.122	No
Uranium-235	0.14	1.05	0.133	No
Uranium-238	2.81	29.3	0.096	No

[a] The PRG for chromium (III) is used because chromium (III) is the predominant form of chromium in soils. The MDC is also below the PRG for chromium (VI), 28 mg/kg.

Table 2.7 PRG Screen for Subsurface Soil Less Than 8 Feet Deep

Analyte	MDC	PRG	Ratio MDC/PRG	Analyte Retained for Detection Frequency Screen?
Inorganics (mg/kg)				
Aluminum	15400	284902	0.05	No
Arsenic	5.9	28	0.2	No
Barium	64	33033	0.002	No
Beryllium	1.2	1151	0.001	No
Chromium	22.8	1916250	0.0000	No
Cobalt	13.7	1401	0.01	No
Copper	12.5	51100	0.0002	No
Iron	18100	383250	0.05	No
Lead	13.9	1000	0.01	No
Lithium	7.5	25550	0.0003	No
Manganese	295	4815	0.06	No
Mercury	0.1	379	0.0003	No
Nickel	12.6	25550	0.0005	No
Nitrate / Nitrite	1	2044000	0.0000	No
Selenium	0.39	6388	0.0001	No
Strontium	45	766500	0.0001	No
Tin	33.9	766500	0.0000	No
Vanadium	36.1	1278	0.028	No
Zinc	26.9	383250	0.0001	No
Organic (ug/kg)				
Acetone	2	1149750000	0.0000	No
bis(2-ethylhexyl)phthalate	93	2458128	0.0000	No
Diethylphthalate	130	737320540	0.0000	No
Di-n-butylphthalate	410	92165067	0.0000	No
Fluoranthene	48	34022891	0.0000	No
Toluene	3	35583491	0.0000	No
Radionuclides (pCi/g)				

Table 2.7 PRG Screen for Subsurface Soil Less Than 8 Feet Deep

Analyte	MDC	PRG	Ratio MDC/PRG	Analyte Retained for Detection Frequency Screen?
Americium-241	0.013	88	0.0002	No
Plutonium-239/240	0.032	112	0.0002	No
Strontium-89/90	0.133	152	0.001	No
Uranium-233/234	2.3	291	0.008	No
Uranium-235	0.1	12	0.008	No
Uranium-238	2.3	337	0.007	No

Table 2.8 Cation/Anion Screen for Surface Water

Analyte	Is Analyte an Cation/Anion?	Analyte Retained for Further Screening?
Orthophosphate	Yes	No
Sulfate	Yes	No

Table 2.9 Essential Nutrient Screen for Surface Water

Analyte	MDC (mg/L)	Maximum Daily Intake[a] (mg/day)	RDA/RDI/AI[b] (mg/day)	UL (mg/day)	Analyte Retained For PRG Screen?
Calcium	39.2	1.2	500 - 1,200	2,500	No
Magnesium	18.2	0.5	80 - 420	65 - 110	No
Potassium	15.4	0.5	2,000 - 3,500	NA	No
Sodium	33.4	1.0	500 - 2,400	NA	No

[a] Based on the MDC and a 30 ml/day surface water ingestion rate for a WRW.
[b] RDA/RDI/AI/UL taken from NAS 2000, 2002

Table 2.10 PRG Screen for Surface Water

Analyte	MDC	PRG	Ratio MDC/PRG	Analyte Retained for Detection Frequency Screen?
Inorganics (mg/L)				
Aluminum	129	2028	0.06	No
Antimony	0.029	0.8	0.04	No
Arsenic	0.0167	0.05	0.33	No
Barium	0.63	142	0.004	No
Beryllium	0.0037	4.1	0.0009	No
Cadmium	0.0038	1.0	0.004	No
Chromium	0.247	3042	0.00008	No
Cobalt	0.0193	40.6	0.0005	No
Copper	0.0484	81.1	0.0006	No
Cyanide	0.0024	40.6	0.00006	No
Fluoride	1	122	0.008	No
Iron	88.6	608	0.15	No
Lead	0.0508	7.02[a]	0.07	No
Lithium	0.154	40.6	0.004	No
Manganese	0.492	284	0.002	No
Mercury	0.00477	0.61	0.078	No
Molybdenum	0.0084	10.1	0.0008	No
Nickel	0.12	40.6	0.003	No
Nitrate/Nitrite	2	3244	0.0006	No
Nitrite	0.058	203	0.0003	No
Selenium	0.019	10.1	0.002	No
Silver	0.0028	10.1	0.0003	No
Strontium	0.238	1217	0.0002	No
Thallium	0.007	0.1	0.05	No
Tin	0.0042	1217	0.000003	No
Uranium	0.0038	6.1	0.0006	No
Vanadium	0.132	2.0	0.07	No
Zinc	0.103	608	0.0002	No

Table 2.10 PRG Screen for Surface Water

Analyte	MDC	PRG	Ratio MDC/PRG	Analyte Retained for Detection Frequency Screen?
Organics (µg/L)				
2-Butanone	3	1216667	0.0000	No
Acetone	28	1825000	0.0000	No
Methylene chloride	16	10121	0.001	No
Radionuclides (pCi/L)				
Americium-241	0.024	408	0.0000	No
Cesium-137	0.5	1396	0.0002	No
Plutonium-238	0.01343	324	0.0000	No
Plutonium-239/240	0.043	314	0.0004	No
Radium-226	4.9	110	0.045	No
Strontium-90	2.172	574.000	0.004	No
Tritium	751	837105	0.0009	No
Uranium-234	5.1	600	0.009	No
Uranium-235	0.29	610	0.0005	No
Uranium-238	4.9	663	0.007	No

[a] No PRG available. The site background mean for total lead + 2 standard deviations is used as a surrogate.

Table 2.11 Volatilization Screen for Groundwater

Analyte	MDC (µg/L)	Groundwater Volatilization PRG (µg/L)	Ratio MDC/ PRG	Retain as COC?
1,1,2,2-Tetrachloroethane[a]	1	907	0.001	No
1,1,2-Trichloroethane[a]	0.7	824	0.0008	No
4-Methyl-2-pentanone[a]	3	6420000	0.0000004	No
Bromoform[a]	0.6	25400	0.00002	No
Carbon disulfide[a]	2	18300	0.0001	No
Carbon tetrachloride[a]	5	62	0.08	No
Chloroform[a]	0.2	146	0.001	No
Methylene chloride	3	10000	0.0003	No
Tetrachloroethene	0.4	21400	0.00002	No
Toluene[a]	0.3	28200	0.00001	No
Trichloroethene[a]	0.1	1830	0.00006	No

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

Table 2.12 Summary of the COC Selection Process

Analyte	PRG Ratio	Detection Frequency (%)	Concentration > 30X the PRG?	Background Comparison	Professional Judgment	Retain as COC?
Surface Soil						
Arsenic	9.1	100	NA	Retain	Eliminate	No
Sediment						
Arsenic	2.2	92	NA	Retain	Eliminate	No
Manganese	1.1	100	NA	Retain	Eliminate	No
Cesium-137	6.8	100	NA	Retain	Eliminate	No
Radium-228	36.9	100	NA	Retain	Eliminate	No
Subsurface Soil						
None >PRG						
Surface Water						
None >PRG						
Groundwater						
None >PRG						

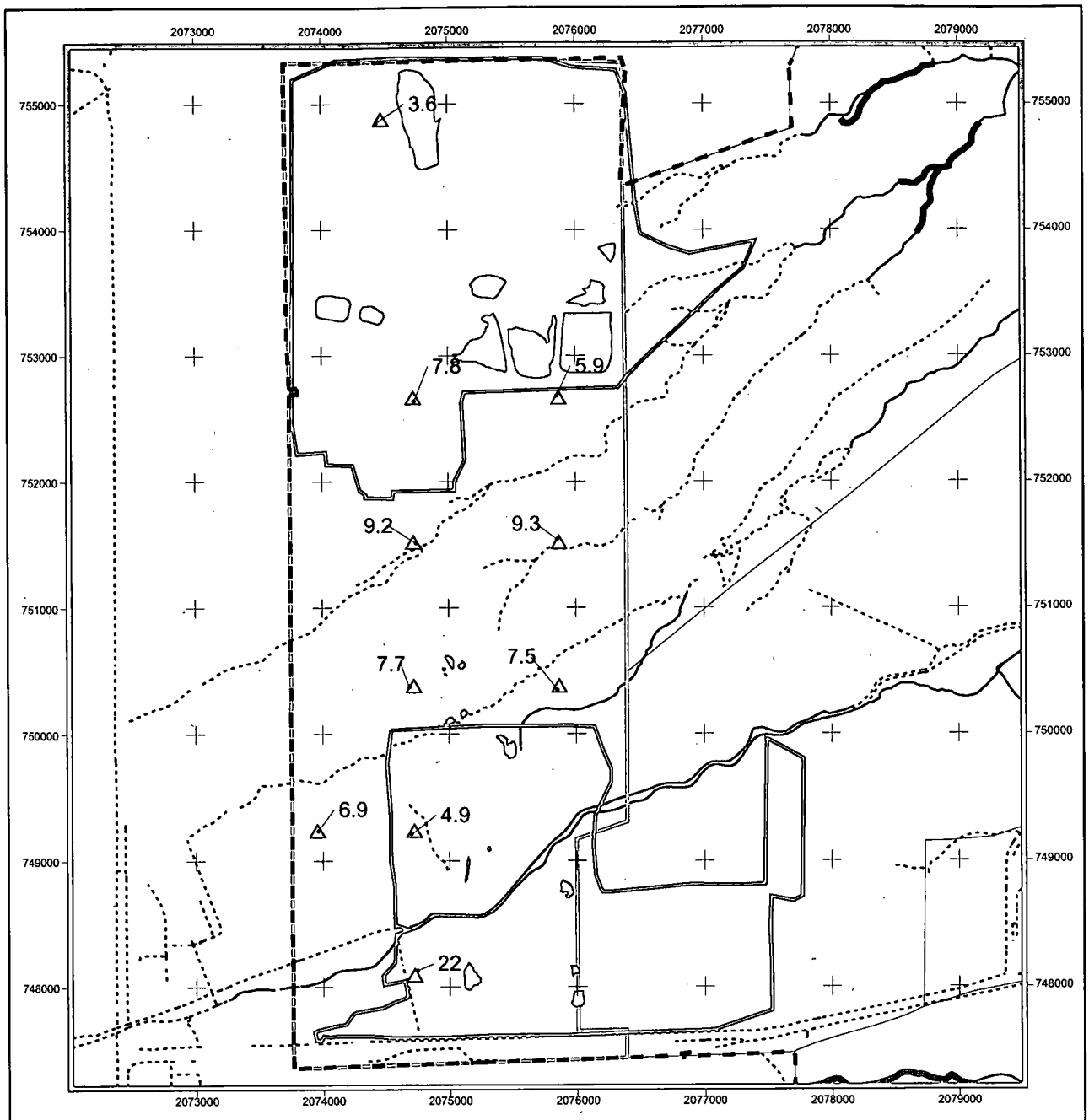


Figure 2.1

Arsenic Concentrations in the West Area Exposure Unit (mg/kg)

DRAFT

KEY

- △ Surface soil sampling station
- 3.6 Arsenic concentration, mg/kg (PRG=2.4 mg/kg)
- West Area Exposure Unit
- Exposure unit
- Open water, October 2004
- Soil Disturbance Area, October 2004
- Site boundary

Stream

- Perennial
- Intermittent
- Ephemeral

N W E S

500 0 500 Feet

Scale 1:14,500

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

Date: 01.27.05

Prepared by: RADMS

Prepared for: KAISER•HILL COMPANY

File: W:\Projects\Fy2004\CRA\EU_Assessments\West_Area\westend_eu.apr

Figure 2.2 Box Plot for Arsenic in Surface Soil

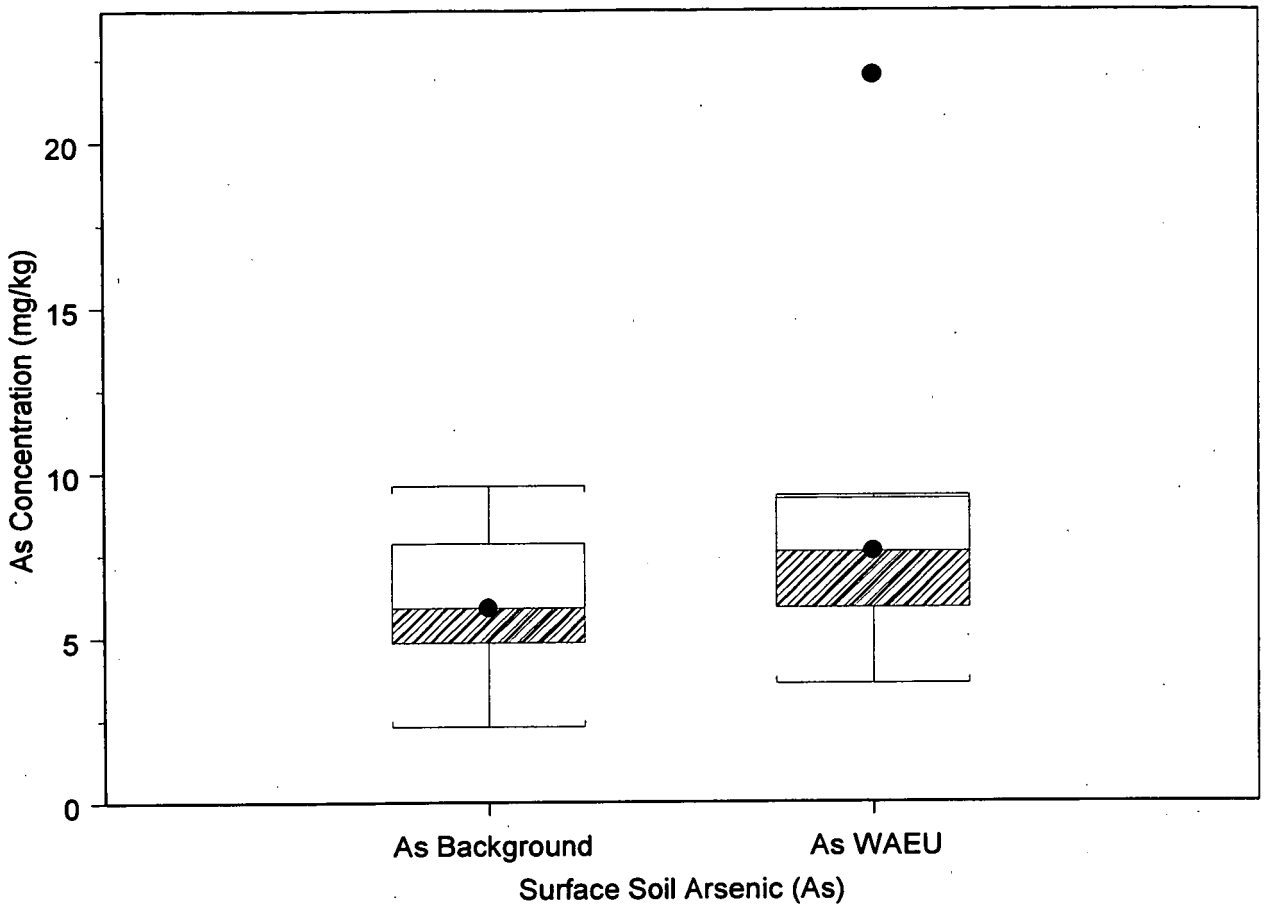


Figure 2.3 Box Plot for Arsenic in Sediment

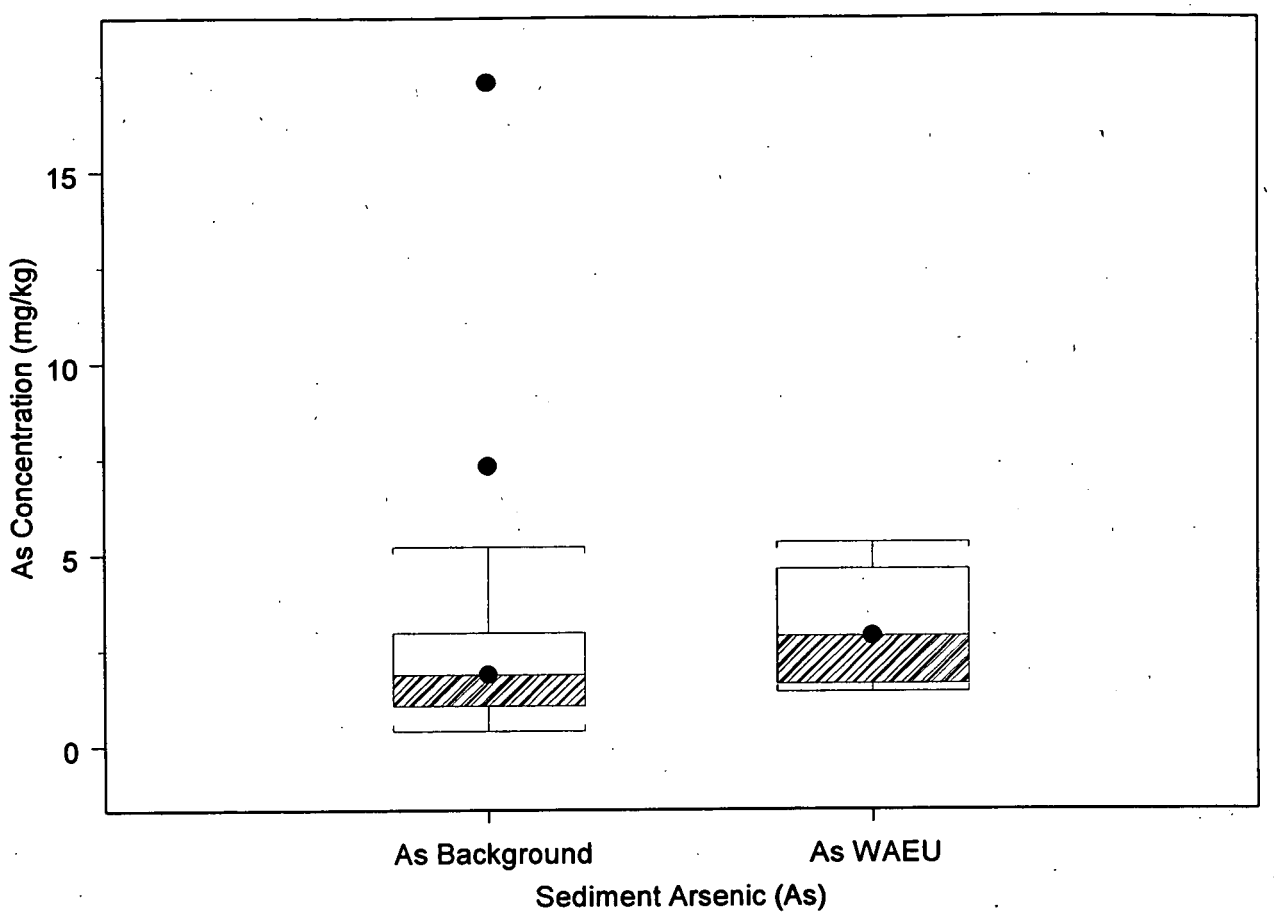
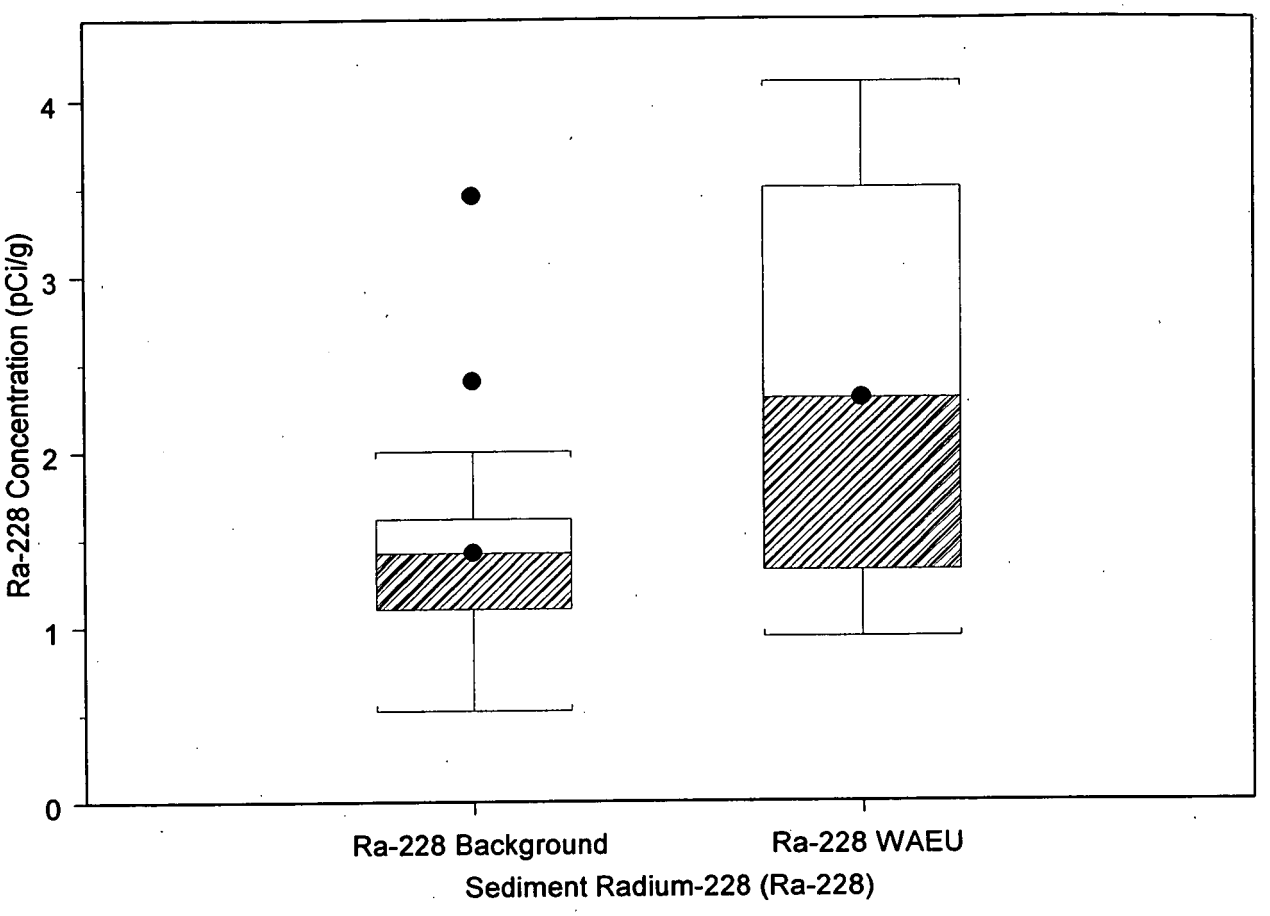


Figure 2.4 Box Plot for Radium-228 in Sediment



3.0 HUMAN HEALTH EXPOSURE ASSESSMENT

The purpose of the human health exposure assessment is to:

- Develop an EU-specific Site Conceptual Model (SCM);
- Calculate exposure point concentrations (EPCs) for each medium for which COCs have been selected; and
- Estimate chemical intakes for the WRW and WRV.

Methods and assumptions are presented in the CRA Methodology (DOE 2004a). All PCOCs were eliminated from further consideration as human health COCs based on comparisons of MDCs to PRGs, background comparisons, or professional judgment (see Section 2). A quantitative risk characterization is not necessary for the WAEU and therefore, an exposure assessment was not conducted.

4.0 HUMAN HEALTH TOXICITY ASSESSMENT

The purpose of the human health toxicity assessment is to:

- Identify toxicity criteria for each noncarcinogen, chemical carcinogen, and radionuclide;
- Characterize and describe the toxicity of each COC; and
- Identify dose conversion factors for each radionuclide COC.

Procedures and assumptions for the toxicity assessment are presented in the CRA Methodology (DOE 2004a). All PCOCs were eliminated from further consideration as human health COCs based on comparisons of MDCs to PRGs, background comparisons, or professional judgment (see Section 2). A quantitative risk characterization is not necessary for the WAEU and therefore, a toxicity assessment was not conducted.

5.0 HUMAN HEALTH RISK CHARACTERIZATION

In the risk characterization, health effects from exposure to carcinogens and noncarcinogens are estimated. The chemical-specific intakes for carcinogens are multiplied by the applicable chemical-specific dose response factors to estimate the cancer risk for an individual over a lifetime of exposure. The intakes are compared with reference doses (RfD)s to estimate health effects from exposure to noncarcinogens. Additional details regarding this approach are provided in the CRA Methodology (DOE 2004a).

All PCOCs were eliminated from further consideration as human health COCs based on comparisons of MDCs to PRGs, background comparisons, or professional judgment (see Section 2). Therefore, a quantitative risk characterization was not performed for the WAEU.

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6.0 UNCERTAINTIES ASSOCIATED WITH THE HUMAN HEALTH RISK ASSESSMENT

The following potential sources of uncertainty may impact the results of the HHRA:

- The adequacy and quality of the available data;
- Exposure and toxicity assumptions used in the development of PRGs;
- Methods and data used in the background comparison step; and
- Assumptions and information used in the professional judgment screening step.

6.1 Uncertainties Associated With the Data

The sampling and analyses conducted for surface soil, subsurface soil, sediment, surface water, and groundwater at the WAEU are considered adequate for the characterization of the EU. The density of surface soil samples collected in this area (that is, one five-sample composite per 30 acres) is in agreement with the sampling and analysis requirements for the BZ (DOE 2004a, 2004b). Samples were collected at several different times from two sediment sampling stations and three surface water locations. Samples from eight groundwater locations and two subsurface soil locations were analyzed. The sampling results are similar within each medium and do not indicate the presence of RFETS-related contamination. Organics were detected at very low concentrations in groundwater. Most of the detections were "J" qualified as estimated results below the detection limit. Others such as, Methylene chloride and bis(2-ethyhexyl)phthalate, both common laboratory contaminants, were detected at low concentrations in a few samples. Tetrachloroethene was detected at the detection limit in one sample. Subsurface sampling is sufficient because of the lack of contaminant sources and surface soil contamination in the WAEU. The sampling density and frequency for the WAEU is considered sufficient for the detection of any impacts from RFETS operations.

No data for anions/cations without toxicity information were collected for subsurface soil and sediments. This is not likely to affect the uncertainty associated with the results of this assessment because of the lack of contaminant sources in the WAEU.

Surface water, sediment, and subsurface soil samples available for the WAEU were collected from 1991 through 1995. Therefore the samples are representative of the area and sufficient for risk assessment.

Another source of uncertainty in the data is the relationship of detection limits to the PRGs. The detection limits were appropriate for the analytical methods used. This is examined in greater detail in Appendix A.

6.2 Uncertainties Associated With Screening Values

The COC screening analyses used 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 milligrams (mg) of soil/sediment 230 days a year for 18.7 years (DOE 2004a). In addition, a WRW is assumed to be dermally exposed and to inhale soil particles in the air. These assumptions are likely to overestimate actual exposures to surface soil for WRWs in the WAEU because a WRW

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will not spend 100 percent of their time in this area. Exposure to subsurface soil is assumed to occur 20 days per year. The WRW PRGs for subsurface soil are also expected to adequately estimate potential exposures because it is not likely that a WRW will excavate extensively in the WAEU.

There is also uncertainty associated with the PRG values, because of the toxicity criteria used in their development. The sources of the toxicity criteria are discussed in the CRA Methodology (DOE 2004a). Generally, a large source of uncertainty is inherent in the derivation of toxicity criteria (that is, RfDs and CSFs). The main sources of potential error in the derivation of toxicity criteria include extrapolation from animal data to humans and the assumption of linearity in carcinogenic dose response relationships. However, the safety factors incorporated into toxicity criteria are more likely to result in an overestimation rather than underestimation of potential cancer and noncancer risks. The PRGs are therefore expected to be protective of WRWs in the WAEU.

6.2.1 Potential Contaminants of Concern without Preliminary Remediation Goals

Detected PCOCs for which no PRGs are available occur only in surface water and include lead and oil/grease. The background mean plus two standard deviations for lead in surface water (0.007 milligrams per liter [mg/L]) is slightly higher than the average detected concentration of lead in surface water at the WAEU (0.006 mg/L). The EPA drinking water standard is 0.015 mg/L (EPA 2004). If the standard is recalculated based on the estimated WRW surface water incidental ingestion rate of 0.03 liters per day (L/day) rather than the drinking water ingestion rate of 2 L/day, the surface water standard would be 1 mg/L. This concentration is much higher than concentrations of lead observed in surface water at the WAEU.

Oil and grease were detected in only 5 of 15 surface water samples at concentrations ranging from 600 to 17,800 micrograms per liter (µg/L). The lack of a PRG and potential quantitative evaluation for oil and grease in surface water at the WAEU is not believed to have a significant impact on the results of the HHRA (no significant human health impacts expected) because other petroleum-related organics that are known to be toxic, such as benzene, toluene, ethylbenzene, xylene, or polyaromatic hydrocarbons were not detected in the surface water.

6.2.2 Eliminating Potential Contaminants of Concern Based on Professional Judgment

Arsenic in surface soil was eliminated as a PCOC, based on professional judgment. There is no identified source in the WAEU and the slightly elevated median value of the WAEU data is most likely due to natural variation. Arsenic concentrations in the WAEU are well within the background range for the area (Conner and Shacklette 1975) and the western U.S (Shacklette and Boerngen 1984).

6.2.3 Uncertainties Evaluation Summary

Uncertainties associated with the data and the COC screening process have been evaluated previously. This evaluation shows that there is reasonable confidence in the conclusion that the WAEU has not been affected by RFETS activities and there are no human health contaminants of concern for the WAEU.

7.0 IDENTIFICATION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN

The ecological contaminants of potential concern (ECOPCs) identification process streamlines the ecological risk characterization for each EU by focusing the assessment on contaminants of interest (ECOIs) that are present in the EU at concentrations of potential concern for the ecological receptors in the EU.

The ECOPC process consists of two separate evaluations, one for PMJM and one for non-PMJM receptors. The ECOPC identification process for the PMJM is more stringent than for other receptors because the PMJM is a federally listed threatened species under the Endangered Species Act (DOE 2004a). The ECOPC identification process for all receptors includes a screening step that compares MDCs to no observed adverse effect level (NOAEL) ESLs at which no effects to either individual receptors or populations of receptors are predicted. If an ECOI concentration exceeds the appropriate NOAEL ESL, a comparison to RFETS background is performed. If no ESL is available, the ECOI is identified as an ECOI of uncertain toxicity. At this point, those ECOIs that both exceed the PMJM ESL and are shown to be greater than background, are identified as ECOPCs for the PMJM. The ECOPC identification process for the non-PMJM receptors includes a frequency of detection evaluation, a professional judgment evaluation and a comparison of calculated EPCs to threshold ESLs (tESLs) or if a tESL cannot be calculated, to NOAEL ESLs.

A more detailed discussion of the ECOPC screening procedure and the assumptions inherent in this procedure is provided in Section 7.3 of the CRA Methodology (DOE 2004a). ESLs for each ECOI are also identified in this document.

7.1 Data Used in the Ecological Risk Assessment

A summary of the environmental data for the WAEU used in the ERA is provided in Tables 1.2 and 1.4. The following WAEU data are used in the ERA:

- Ten surface soil samples (analyzed for inorganics and radionuclides); and
- Two subsurface soil (less than 8 feet deep) samples (analyzed for inorganics).

Only subsurface soil down to 8 feet deep is considered in the ERA, because 8 feet is the assumed maximum depth to which burrowing receptors can dig (DOE 2004a). A data summary with the frequency of detection and minimum and maximum detections is provided in Table 1.2 for surface soil and Table 1.4 for subsurface soil less than 8 ft deep.

Sediment and surface water data for the WAEU were also collected (Section 1.1.4). These data are evaluated for the ERA in Volume 15 of the CRA.

7.2 Identification of Ecological Contaminants of Potential Concern for the Preble's Meadow Jumping Mouse in Surface Soil

ECOPCs for the PMJM were identified in accordance with the sequence presented in the CRA Methodology.

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7.2.1 Comparison to No Observed Adverse Effect Level Ecological Screening Levels

The PMJM habitat and surface soil sampling locations within the WAEU are shown on Figures 1.4 and 1.5, respectively. No surface soil samples were collected within PMJM habitat in the WAEU. However, it can be reasonably assumed that analyte concentrations in PMJM habitat are similar to those elsewhere in the WAEU, and analyte concentrations across the WAEU are generally similar.

The maximum detected concentrations of ECOIs in surface soil in the WAEU were compared to NOAEL ESLs for the PMJM (Table 7.1). The MDCs in surface soil exceed the NOAELs for the following analytes: arsenic, nickel, vanadium, and zinc. These chemicals were retained as ECOIs for a comparison to background concentrations.

NOAEL ESLs for the PMJM are not available for aluminum, iron, silver, and titanium (CRA Methodology [DOE 2004a] Appendix B, Table B-7). These analytes are discussed in the uncertainty section (Section 11.3) as ECOIs with uncertain toxicity.

7.2.2 Preble's Meadow Jumping Mouse Surface Soil Background Comparison

The background comparison is the final step in the ECOPC identification process for the PMJM receptor. The background evaluation for ECOIs consists of:

- Distribution tests for the EU and background data;
- Selection of a statistical test based on the data distributions; and
- Statistical comparison of the two data sets.

The results of these analyses for each remaining ECOI are presented in Tables 7.2 and 7.3. The *t*-test indicated the concentrations of nickel, vanadium, and zinc in surface soil at the WAEU are not statistically different from background surface soil concentrations (that is, p-value less than 0.9). These ECOIs were eliminated from further evaluation.

The WAEU arsenic surface soil concentrations were compared to background (Sections 2.1.4 and 2.1.5). The WAEU median concentration was shown to be statistically greater than the background median with the WRS test.

With the exception of one data point, the arsenic concentrations in all surface soil samples are less than the background maximum, ranging from 3.6 to 9.3 mg/kg with a concentration of 22 mg/kg in one sample (Table 2.5 and Figure 2.2). The single sampling location above the background maximum is not adjacent to PMJM habitat. Based these considerations, arsenic is not considered an ECOPC for the PMJM in the WAEU.

7.3 Identification of Ecological Contaminants of Potential Concern for Non-Preble's Meadow Jumping Mouse Receptors in Surface Soil

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

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7.3.1 Comparison with No Observed Adverse Effect Level Ecological Screening Levels

In the first step of the ECOPC identification process for non-PMJM receptors, the MDCs of ECOIs in surface soil were compared to receptor-specific NOAEL ESLs. NOAEL ESLs for surface soil were developed for three receptor groups: terrestrial vertebrates, terrestrial invertebrates, and terrestrial plants. The NOAEL ESLs are compared to MDCs in surface soil in Table 7.4.

The results of the NOAEL ESL screening analyses for all receptor types are presented in Table 7.5. Analytes in Table 7.5 that were further evaluated include aluminum, arsenic, boron, chromium, copper, lead, lithium, manganese, mercury, nickel, thallium, vanadium, and zinc.

NOAEL ESLs were not available for several ECOI/receptor pairs (Tables 7.4 and 7.5). Only iron and titanium lacked an ESL for all four of the non-PMJM receptors. For mammalian receptors, no ESLs were available for aluminum, iron, silver, or titanium. For avian receptors, no ESLs were available for aluminum, antimony, beryllium, iron, lithium, silver, strontium, thallium, or titanium. For terrestrial plants, no ESLs were available for iron, lithium, strontium, or thallium. Finally, for terrestrial invertebrates, no ESLs were available for aluminum, boron, cobalt, iron, lithium, manganese, molybdenum, silver, strontium, thallium, tin, titanium, or vanadium. These ECOI/receptor pairs are discussed as ECOIs with uncertain toxicity along with the potential impacts to the risk assessment in Section 11.3.

7.3.2 Non-Preble's Meadow Jumping Mouse 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, the ECOI is eliminated from further evaluation. The detection frequencies for chemicals in surface soil are presented in Table 1.2. None of the chemicals in surface soil at the WAEU that were retained after the NOAEL ESL screening step had a detection frequency of less than 5 percent. Therefore, frequency of detection was not further evaluated for surface soil in the WAEU.

7.3.3 Non-Preble's Meadow Jumping Mouse Surface Soil Background Comparisons

A background comparison for all ECOIs with background data available (Section 1.1.4) was performed and the results of these analyses for each remaining ECOI are presented in Tables 7.6 and 7.7. No background data are available for boron, and no comparison was done for thallium because of the high percentage of nondetections. The *t*-tests indicate the mean concentrations of lead, manganese, nickel, vanadium, and zinc in surface soil at the WAEU are not statistically different than the means for the background surface soil data set ($p < 0.9$). The WRS tests indicate the median concentrations of copper and mercury in surface soil at the WAEU are not statistically different than the means for the background surface soil data set ($p < 0.9$). These analytes were eliminated from further evaluation as ECOPCs.

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The *t*-test or WRS test did not eliminate aluminum, arsenic, chromium, lithium, (see discussion of arsenic in Sections 2.1.4). Therefore, these ECOIs were not assessed further.

No background data were available for boron and a statistical background comparison is not possible for thallium because of the high number of nondetections in the data set. Therefore, boron and thallium were retained for additional evaluation.

7.3.4 Non-Preble's Meadow Jumping Mouse Surface Soil Professional Judgment Evaluation

Professional judgment evaluation takes into account factors that could indicate it may be necessary to further evaluate ECOIs detected at concentrations greater than NOAEL ESLs and statistically greater than the range of background concentrations. The statistical comparisons discussed in Section 7.3.3 suggested that the population means for surface soil data at the WAEU exceeded those for the background soil data for aluminum, arsenic, chromium, and lithium. No background data are available for boron. Historical evidence indicates that there were no RFETS-related operations at the WAEU or in the vicinity of the WAEU that could be linked to the presence of these ECOIs (Section 1). Additional evaluations that discuss potential similarities between the WAEU and the background data set or present other arguments for not further evaluating aluminum, arsenic, chromium, lithium, boron and thallium are presented in the following paragraphs.

Figure 7.1 shows the box plot for aluminum. Although the WAEU median is above the median for the background data, the WAEU data are narrowly distributed around the median. Six background samples have higher concentrations than the WAEU maximum. Also, EPA EcoSSL guidance (EPA 2003) recommends that aluminum should not be considered an ECOPC for soils at sites where the pH of the soil exceeds 5.5 due to its limited bioavailability in non-acidic soils. Average pH values at RFETS are 8.2 for surface soil, 7.9 for subsurface soil, and 7.7 for sediment (Table 7.8). Therefore, aluminum is not considered to be a contaminant and was not assessed further.

The arsenic box plots in Figure 2.2 show that the WAEU concentrations are in the same ranges as the background data. A detailed discussion of arsenic in Section 2.1.5 concludes that no further assessment is necessary. Therefore, arsenic was not evaluated as an ECOPC.

The 95UCLs of the WAEU and background data sets for chromium are similar; 12.6 and 14.8 mg/kg, respectively. Both are lower than the arithmetic mean for chromium (56 mg/kg) in soils typical of the Western U.S (Shacklette and Boerngen 1984). The box plots for chromium in surface soil in Figure 7.2 indicate the confidence limits of both data sets are also very similar. In addition, there is no information suggesting any WAEU-related source for chromium in the WAEU. Therefore, chromium was not evaluated as an ECOPC.

The ranges of detected concentrations for WAEU and background surface soil data for lithium are 5.7 to 12 mg/kg and 4.8 to 11.6 mg/kg, respectively. The 95UCLs are 10.3 mg/kg for WAEU and 8.5 mg/kg for background surface soil. The box plots for lithium

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in WAEU and background surface soil on Figure 7.3 confirm the similarity of the two data sets. The observed range of lithium background concentrations in soil typical of the Western U.S. is from 5 to 30 mg/kg with an arithmetic mean equal to 25 mg/kg (Shacklette and Boerngen 1984). Lithium was not further evaluated as an ECOPC because the WAEU and background data for lithium are very similar; the MDC of lithium in WAEU surface soils is only slightly above the MDC for background and is less than the mean of background concentrations in the U.S; and no RFETS-related impacts to the WAEU have been identified.

The data for thallium are shown in Table 7.9. Thallium was detected once in WAEU surface soil and not at all in background surface soil. The detected concentration in the WAEU sample was 1.3 mg/kg. This concentration is at the bottom of the observed range for soil in the western U.S. (2.4 to 37 mg/kg) and well below the arithmetic mean of 9.8 mg/kg (Shacklette and Boerngen 1984). The single detection is not indicative of thallium contamination in the WAEU. Therefore, thallium was not evaluated as an ECOPC.

RFETS background data are not available for boron. The maximum detected concentration of boron in WAEU soil (7.1 mg/kg) is well below the range for soil typical of the western U.S (20 to 50 mg/kg) reported by Shacklette and Boerngen (1984). A background study of boron in soil of California (University of California 1996) reported boron concentrations ranging from 1 to 79 mg/kg with a geometric mean concentration of 14 mg/kg (University of California 1996). This is nearly twice the maximum detected concentration in WAEU surface soil. There is no evidence of impact from RFETS-related operations to WAEU surface soil. Therefore, boron was eliminated from further consideration based on this background assessment and historical evidence.

7.4 Identification of Ecological Contaminants of Potential Concern for Vertebrates in Subsurface Soil

Subsurface soil sampling locations for soil collected at a starting depth of 0 to 8 ft in the WAEU are identified on Figure 1.5. Soil in the area where the subsurface soil samples were collected has subsequently been impacted by mining activities and the data from the impacted soil are not representative of current conditions. For purposes of conservatism, the subsurface soil data are assessed as though no disturbance has occurred. A data summary for subsurface soil less than 8 ft deep is presented in Table 1.4.

7.4.1 Comparison to No Observed Adverse Effect Level Ecological Screening Levels

The CRA Methodology (DOE 2004a) indicates subsurface soil must be evaluated for those ECOIs that have greater concentrations in the subsurface (less than 8 ft deep) than in surface soil. Given the limited amount of subsurface soil data, a comparison of the two data sets provides minimal information that is useful to the ERA. However, because there are no known source areas in the WAEU and subsequently no clear exposure pathway, the data are adequate for screening.

The initial screening step for the WAEU was conducted using the MDCs of the ECOIs in subsurface soil, regardless of their relationship to surface soil. MDCs were compared to NOAEL ESLs for burrowing receptors (Table 7.10). Only manganese had a maximum

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subsurface soil concentration greater than the NOAEL ESL for the prairie dog. Therefore, manganese was further evaluated in the ECOPC identification process. NOAEL ESLs are not available for aluminum and iron, and both were considered ECOIs with uncertain toxicity and are discussed in the uncertainty analysis (Section 11.3).

7.4.2 Subsurface Soil Frequency of Detection Evaluation

No frequency-of-detection evaluation was conducted because only seven subsurface soil samples are available in the WAEU.

7.4.3 Subsurface Soil Background Comparison

Manganese was detected in all subsurface soil samples in the WAEU. The statistical comparison of the WAEU concentrations to background using the WRS test (Appendix C) shows that the medians are equal (p-value=0.434). Therefore manganese was not carried on as a ECOPC.

7.4.4 Subsurface Soil Professional Judgment

Manganese, the only ECOI above the ESL for the prairie dog, was determined to be at background concentrations in the WAEU as dicribed in Section 7.4.3.

7.5 Summary of Ecological Contaminants of Potential Concern

ECOIs in surface and subsurface soil in the WAEU were evaluated in the ECOPC identification process. None of these chemicals was retained past the professional judgment step of the ECOPC identification process. Therefore, no ECOPCs were identified for the WAEU.

Table 7.1 Comparison of MDCs in Surface Soil with NOAEL ESLs for the PMJM

Analyte	MDC (mg/kg)	PMJM NOAEL ESL (mg/kg)	MDC > ESL?	Retained for Background Analysis?
Aluminum	18000	NA	NA	UT
Antimony	0.6	1.00	No	No
Arsenic	**22**	**2.21**	**Yes**	**Yes**
Barium	140	743	No	No
Beryllium	0.52	8.16	No	No
Boron	7.1	52.7	No	No
Chromium	17	16079	No	No
Cobalt	6.4	340	No	No
Copper	13	95	No	No
Iron	16000	NA	NA	UT
Lead	48	220	No	No
Lithium	12	519	No	No
Manganese	320	388	No	No
Mercury	0.03	0.05	No	No
Molybdenum	0.91	1.84	No	No
Nickel	**11**	**0.51**	**Yes**	**Yes**
Silver	0.12	NA	NA	UT
Strontium	24	833	No	No
Thallium	1.3	8.64	No	No
Titanium	320	NA	NA	UT
Vanadium	**34**	**21.6**	**Yes**	**Yes**
Zinc	**50**	**6.41**	**Yes**	**Yes**

UT = Uncertain toxicity; no ESLs available. Will be discussed in Section 11, Uncertainties Associated With the Ecological Risk Assessment

NA indicates no ESL was available for that ECOI/receptor pair.

Table 7.2 Statistical Distributions for PMJM ECOIs in Surface Soil

Analyte	Total No. of Samples		Statistical Distribution Testing Results					
			Background			WAEU		
	Back-ground	WAEU	Distribution/UCL Recommended by ProUCL	UCL Value (mg/kg)	Detections (%)	Distribution/UCL Recommended by ProUCL	UCL Value (mg/kg)	Detections (%)
Arsenic	20	10	Normal/Student's *t*	6.89	100	Gamma/Gamma	11.6	100
Nickel	20	10	Normal/Student's *t*	10.7	100	Normal/Student's *t*	9.73	100
Vanadium	20	10	Normal/Student's *t*	31.2	100	Normal/Student's *t*	30.9	100
Zinc	20	10	Normal/Student's *t*	54.5	100	Normal/Student's *t*	42.2	100

Table 7.3 Statistical Comparison for PMJM ECOIs in Surface Soil

Medium	Analyte	Retain as ECOPC[a]	
		t-Test	WRS Test
Inorganics			
Surface Soil	Arsenic	NA	Yes
	Nickel	No	NA
	Vanadium	No	NA
	Zinc	No	NA

[a] Retained by t-test, WRS test if p = 0.9 or more.

t-Test = Test for comparison of means for two sample populations with normal distributions (EPA 2002).

WRS Test = Wilcoxon rank sum test for comparison of medians for two sample populations with differing distributions (EPA 2002)

Table 7.4 Comparison of MDCs in Surface Soil to NOAEL ESLs for Terrestrial Plants, Invertebrates and Vertebrates

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	18000	50	Yes	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	Plant	Yes
Antimony	0.6	5	No	78	No	NA	NA	NA	NA	NA	NA	9.89	No	0.90	No	18.72	No	57.62	No	137.93	No	13.18	No	3.85	No	NA	NA	Deer Mouse Insectivore	No
Arsenic	22	10	Yes	60	No	20	Yes	164	No	1028	No	2.57	Yes	51.36	No	9.35	Yes	12.99	Yes	709	No	341	No	293	No	NA	NA	Deer Mouse Herbivore	Yes
Barium	140	500	No	330	No	159	No	357	No	1317	No	930	No	4427	No	3224	No	4766	No	24896	No	19838	No	18369	No	NA	NA	Dove Herbivore	No
Beryllium	0.52	10	No	40	No	NA	NA	NA	NA	NA	NA	159.76	No	6.82	No	210.86	No	895.62	No	1071.87	No	102.77	No	29.19	No	NA	NA	Deer Mouse Insectivore	No
Boron	7.1	0.5	Yes	NA	NA	30.29	No	114.56	No	167.49	No	62.12	No	422.32	No	236.82	No	313.67	No	929.47	No	6070.46	No	1816	No	NA	NA	Plant	Yes
Chromium	17	1	Yes	0.4	Yes	24.56	No	1.34	Yes	13.96	Yes	237093	No	13233	No	586207	No	1231773	No	5735367	No	219264	No	57200	No	NA	NA	Invetebrates	Yes
Cobalt	6.4	13	No	NA	NA	278	No	87.03	No	440	No	1476	No	363	No	2461	No	7902	No	3785	No	2492	No	1519	No	NA	NA	Dove Insectivore	No
Copper	13	100	No	50	No	28.86	No	8.25	Yes	164.50	No	294.68	No	605.46	No	837.57	No	4118.52	No	5459.33	No	3000.41	No	4641	No	NA	NA	Dove Insectivore	Yes
Iron	16000	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	UT
Lead	48	110	No	1700	No	49.94	No	12.06	Yes	95.83	No	1344	No	242	No	1850	No	9798	No	8927	No	3065.78	No	1393	No	NA	NA	Dove Insectivore	Yes
Lithium	12	2	Yes	NA	NA	NA	NA	NA	NA	NA	NA	1882	No	610	No	3178	No	10173	No	18431	No	5607.76	No	2560	No	NA	NA	Plant	Yes
Manganese	320	500	No	NA	NA	1032	No	2631	No	9917	No	486	No	4080	No	221	Yes	2506	No	14051	No	10939.26	No	19115	No	NA	NA	Prairie Dog	Yes
Mercury	0.03	0.3	No	0.1	No	0.20	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	37.27	No	NA	NA	Dove Insectivore	Yes
Molybdenum	0.91	2	No	NA	NA	44.37	No	6.97	No	76.70	No	8.68	No	1.90	No	27.14	No	44.26	No	275.13	No	28.95	No	8.18	No	NA	NA	Deer Mouse Insectivore	No
Nickel	11	30	No	200	No	44.14	No	1.24	Yes	13.09	No	16.39	No	0.43	Yes	38.35	No	123.85	No	90.87	No	6.02	Yes	1.86	Yes	NA	NA	Deer Mouse Insectivore	Yes
Selenium	NA	NA	NA	NA	NA	1.61	No	1.00	No	8.48	No	0.87	No	0.75	No	2.80	No	3.82	No	32.49	No	12.21	No	5.39	No	NA	NA	Deer Mouse Insectivore	No
Silver	0.12	2	No	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	UT
Strontium	24	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	940	No	13578	No	3519	No	4702	No	584444	No	144904	No	57298	No	NA	NA	Deer Mouse Herbivore	No
Thallium	1.3	1	Yes	NA	NA	NA	NA	NA	NA	NA	NA	180.18	No	7.24	No	204.34	No	1038.96	No	211.92	No	81.58	No	30.82	No	NA	NA	Plant	Yes
Tin	NA	NA	NA	NA	NA	26.06	No	2.90	No	18.98	No	45.05	No	3.77	No	80.57	No	241.78	No	70.03	No	36.07	No	16.21	No	NA	NA	Dove Insectivore	No
Titanium	320	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	UT
Vanadium	34	2	Yes	NA	NA	503	No	274	No	1514	No	63.70	No	29.91	Yes	83.52	No	358	No	341	No	164	No	121	No	NA	NA	Plant	Yes
Zinc	50	50	No	200	No	108.73	No	0.65	Yes	113	No	171	No	5.29	Yes	1174	No	2772	No	16489	No	3887	No	431	No	NA	NA	Dove Insectivore	Yes
Radionuclides (pCi/g)																													
Americium-241	0.080	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	3890.00	No	NA	No
Plutonium-239/240	0.250	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	6110.00	No	NA	No
Uranium-234	1.270	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	4980.00	No	NA	No
Uranium-235	0.189	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2770.00	No	NA	No
Uranium-238	1.700	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1580.00	No	NA	No

NA indicates that no ESL was available for that ECOI/receptor pair.
UT = Uncertain toxicity; no ESL available. Assessed in Section 11, Uncertainties Associated With the Ecological Risk Assessment.

Table 7.5 Summary of NOAEL ESL Screening Results for Surface Soil in the WAEU

Analyte	Terrestrial Vertebrate Exceedance?	Terrestrial Invertebrate Exceedance?	Terrestrial Plant Exceedance?
Aluminum	UT	UT	**Yes**
Antimony	No	No	No
Arsenic	**Yes**	No	**Yes**
Barium	No	No	No
Beryllium	No	No	No
Boron	No	UT	**Yes**
Chromium	**Yes**	**Yes**	**Yes**
Cobalt	No	UT	No
Copper	**Yes**	No	No
Iron	UT	UT	UT
Lead	**Yes**	No	No
Lithium	No	UT	**Yes**
Manganese	**Yes**	UT	No
Mercury	**Yes**	No	No
Molybdenum	No	UT	No
Nickel	**Yes**	No	No
Silver	UT	UT	No
Strontium	No	UT	UT
Thallium	No	UT	**Yes**
Titanium	UT	UT	UT
Vanadium	**Yes**	UT	**Yes**
Zinc	**Yes**	No	No

UT = Uncertain toxicity; no ESL available. Assessed in Section 11, Uncertainties Associated With the Ecological Risk Assessment.

Table 7.6 Statistical Distributions for Non-PMJM ECOIs in Surface Soil

Analyte	Total No. of Samples		Statistical Distribution Testing Results					
			Background			WAEU		
	Back-ground	WAEU	Distribution/UCL Recommended by ProUCL	UCL Value (mg/kg)	Detections (%)	Distribution/UCL Recommended by ProUCL	UCL Value (mg/kg)	Detections (%)
Aluminum	20	10	Normal/Student's *t*	11,716	100	Normal/Student's *t*	15,357	100
Arsenic	20	10	Normal/Student's *t*	6.89	100	Gamma/Gamma	11.6	100
Boron	0	10	NA	NA	NA	Normal/Student's *t*	5.8	100
Chromium	20	10	Normal/Student's *t*	12.6	100	Normal/Student's *t*	14.8	100
Copper	20	10	Normal/Student's *t*	14	100	Normal/Student's *t*	11	100
Iron	20	10	Normal/Student's *t*	13,960	100	Normal/Student's *t*	14,589	100
Lead	20	10	Normal/Student's *t*	37.7	100	Normal/Student's *t*	37.1	100
Lithium	20	10	Normal/Student's *t*	8.54	100	Normal/Student's *t*	10.3	100
Manganese	20	10	Normal/Student's *t*	264	100	Normal/Student's *t*	292	100
Mercury	20	10	Normal/Student's *t*	0.084	40	Normal/Student's *t*	0.027	100
Nickel	20	10	Normal/Student's *t*	10.7	100	Normal/Student's *t*	9.73	100
Thallium	16	10	Normal/Student's *t*	0.421	0	Nonparametric/Student's *t*	0.72	10
Vanadium	20	10	Normal/Student's *t*	31.2	100	Normal/Student's *t*	30.9	100
Zinc	20	10	Normal/Student's *t*	54.5	100	Normal/Student's *t*	42.2	100

Table 7.7 Statistical Comparison for Non-PMJM ECOIs in Surface Soil

Medium	Analyte	Retain as ECOPC?	
		t-Test	WRS Test
Surface Soil	Aluminum	Yes	NA
	Arsenic	NA	Yes
	Boron	NA	NA
	Chromium	Yes	NA
	Copper	NA	No
	Iron	No	NA
	Lead	No	NA
	Lithium	Yes	NA
	Manganese	No	NA
	Mercury	NA	No
	Nickel	No	NA
	Thallium	NA	NA
	Vanadium	No	NA
	Zinc	No	NA

[a] Retained by t-test, WRS test if p = 0.9 or more.

t-Test = Test for comparison of means for two sample populations with normal distributions (EPA 2002)

WRS Test = Wilcoxon rank sum test for comparison of medians for two sample populations with differing distributions (EPA 2002)

Table 7.8 pH Values for Soil and Sediment at RFETS[a]

Media	Number of locations	Minimum Result	Maximum Result	Avgerage Result
Surface Soil	202	6.15	9.93	8.22
Sediment	157	5.48	9.56	7.68
Subsurface Soil	381	5.4	9.55	7.92

[a] Summary of sitewide data

Table 7.9 Comparison of Thallium Surface Soil Data for WAEU and Background

Thallium Concentrations			
WAEU (mg/kg)		Background (mg/kg)	
0.48		0.39	0.42
0.48		0.4	0.42
0.49		0.41	0.43
0.49		0.41	0.43
0.49		0.41	0.43
0.50		0.41	0.45
0.50		0.41	
0.5		0.41	
0.5		0.42	
1.3[a]		0.42	
Range	0.48 - 1.3	0.39 - 0.45	
Mean	0.57	0.41	
Median	0.49	0.42	
95th UCL	0.72	0.42	

[a] Only detection, all other values are nondetections at one-half the reported result.

Table 7.10 Comparison of MDCs in WAEU Subsurface Soil to NOAEL ESLs for the Burrowing Receptor

Analyte	MDC	Prairie Dog NOAEL ESL	MDC > ESL?
Inoganics (mg/kg)			
Aluminum	15400	NA	UT
Arsenic	5.9	9.35	No
Barium	64	3220	No
Beryllium	1.2	211	No
Cesium	1.7	NA	UT
Chromium	22.8	586000	No
Cobalt	13.7	2461	No
Copper	12.5	838	No
Iron	18100	NA	UT
Lead	13.9	1850	No
Lithium	7.8	3180	No
Manganese	**295**	**221**	**Yes**
Mercury	0.1	3	No
Nickel	12.6	38.3	No
Nitrate / Nitrite	1	16200.0	No
Selenium	0.39	2.8	No
Strontium	45	3519	No
Tin	33.9	80.6	No
Vanadium	36.1	83.5	No
Zinc	26.9	1170	No
Organics (ug/kg)			
Acetone[a]	2	248	No
bis(2-Ethylhexyl)phthalate[a]	93	2760	No
Diethylphthalate[a]	130	221000	No
Di-nbutylphthalate	410	40600	No
Toluene[a]	3	1220	No

UT = Uncertain toxicity; no ESLs available. Assessed in Section 11, Uncertainties Associated With the Ecological Risk Assessment.

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

Figure 7.1 Box Plot for Aluminum in Surface Soil

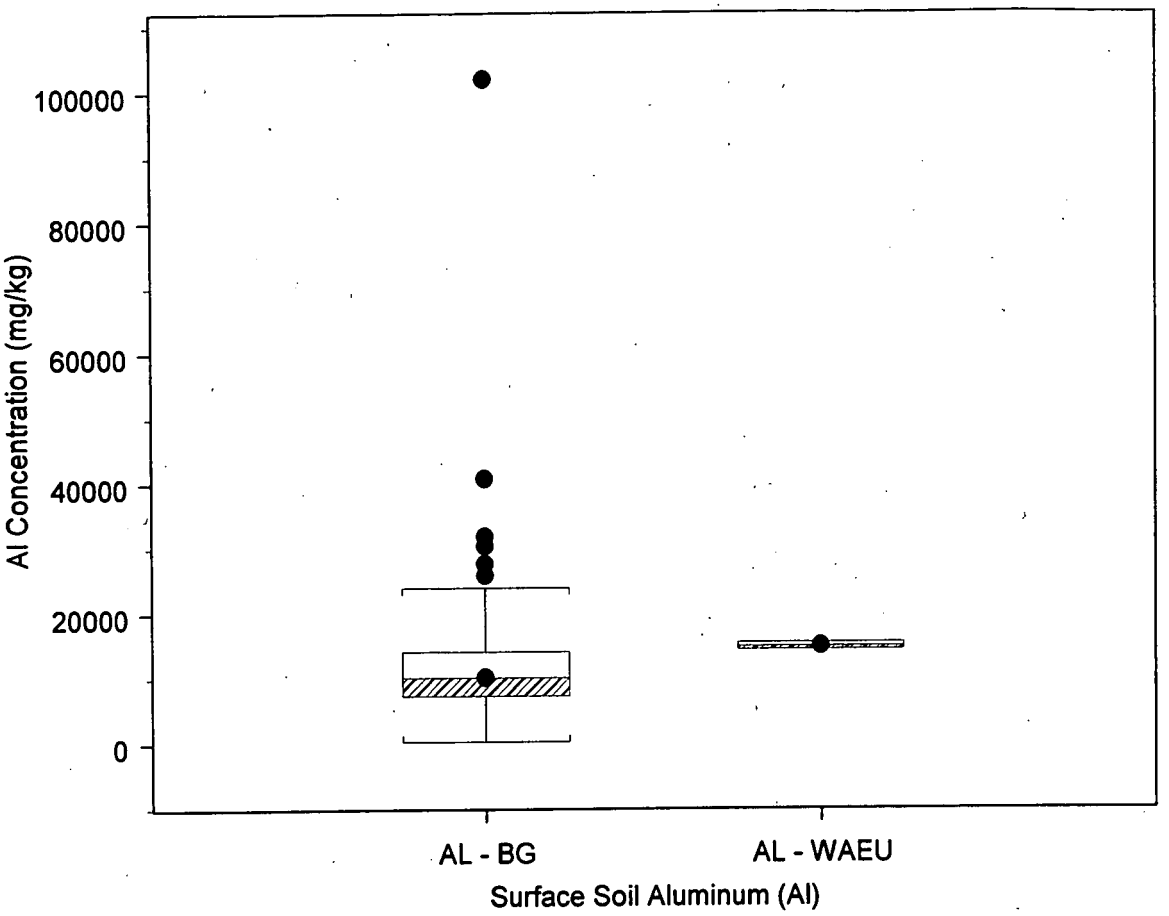


Figure 7.2 Box Plot for Chromium in Surface Soil

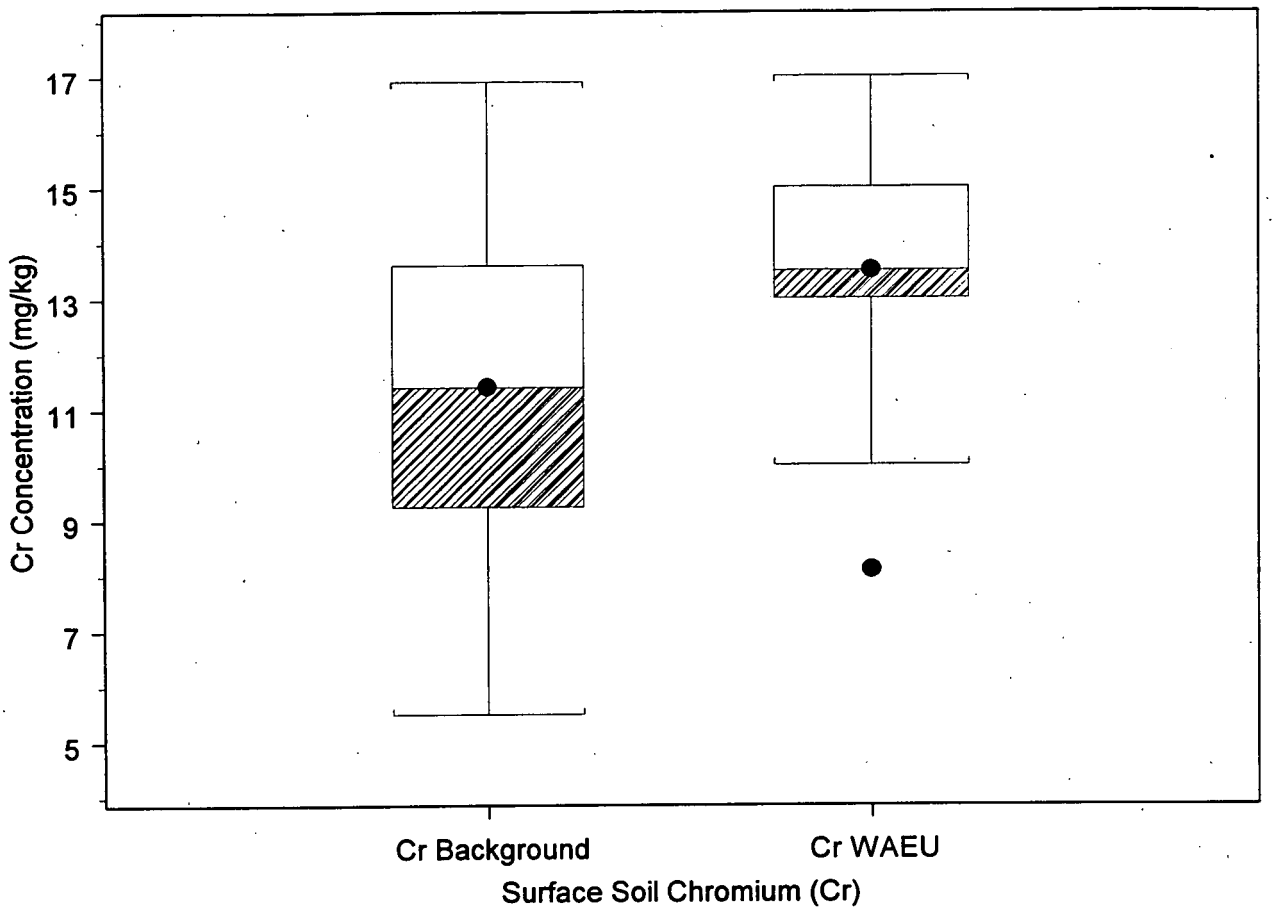


Figure 7.3 Box Plot for Lithium in Surface Soil

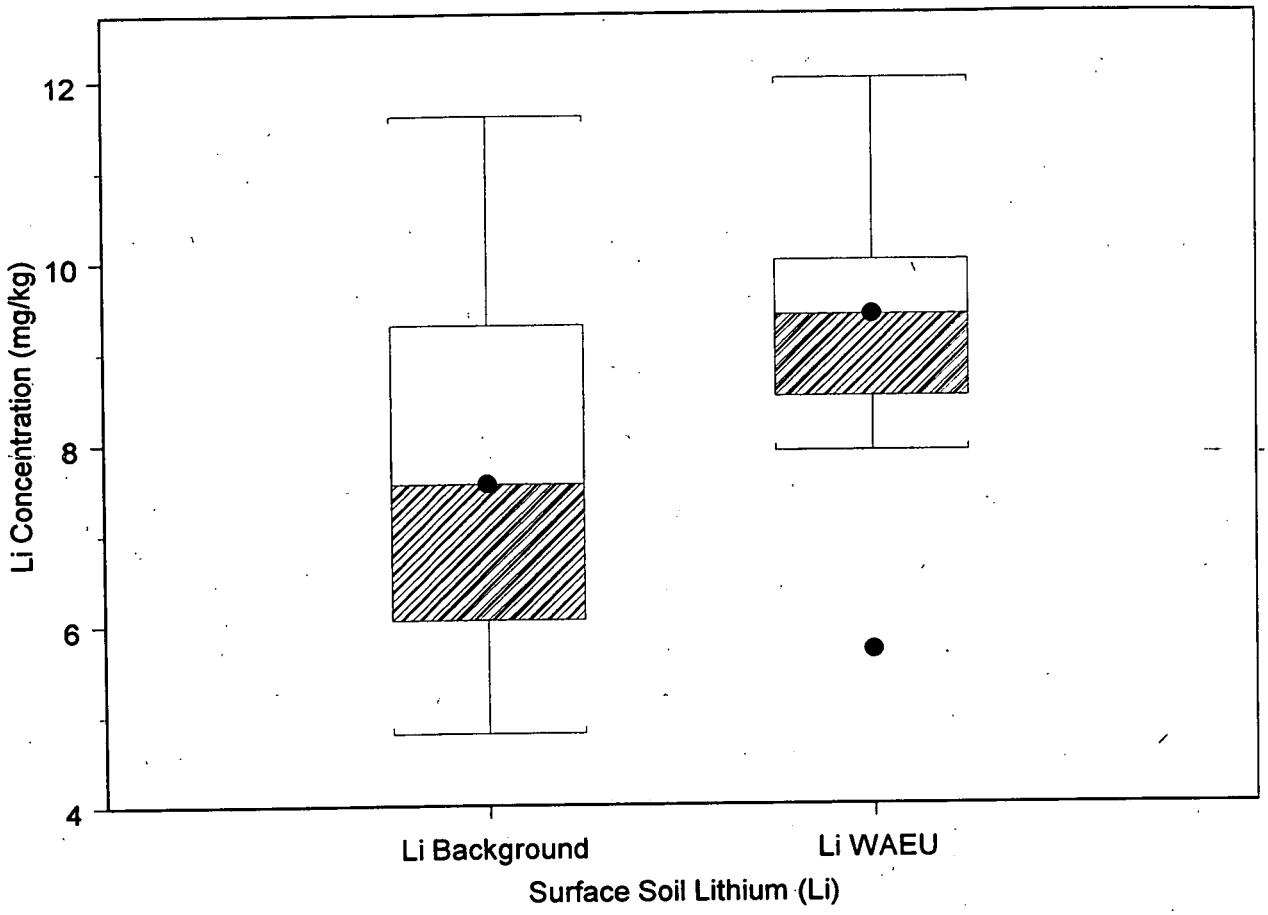
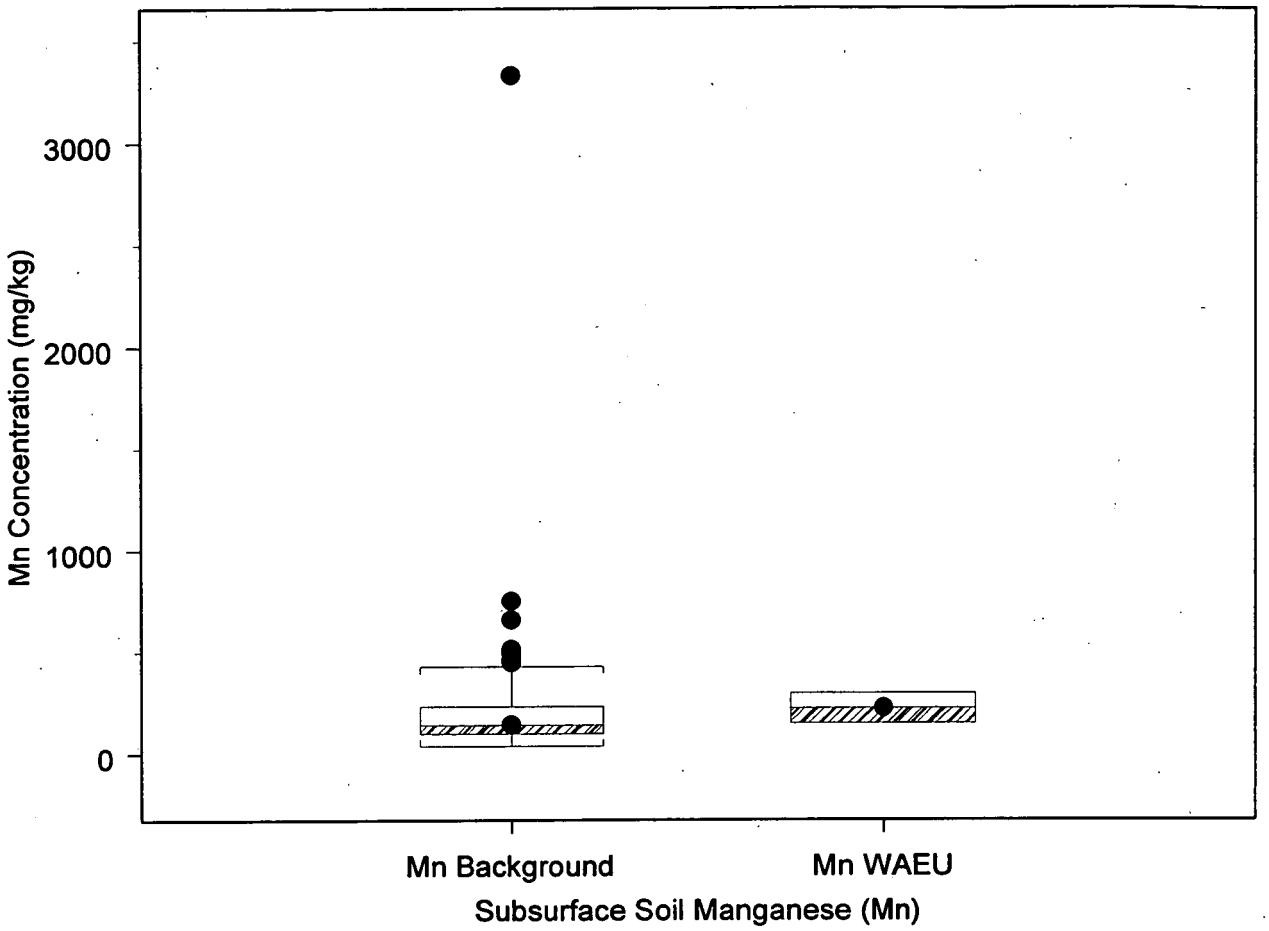


Figure 7.4 Box Plot for Manganese in Subsurface Soil



8.0 ECOLOGICAL EXPOSURE ASSESSMENT

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

9.0 ECOLOGICAL TOXICITY ASSESSMENT

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

10.0 ECOLOGICAL RISK CHARACTERIZATION

Characterization of risk focuses on the overall results for each assessment endpoint. This includes discussion of the potential for risk for each receptor group and level of biological organization (that is, individual or population level of protection), as appropriate for the assessment endpoints. As noted by EPA (1997), a well-balanced risk characterization should "...present risk conclusions and information regarding the strengths and limitations of the assessment for other risk assessors, EPA decision-makers, and the public."

Risk characterization typically has two main components: risk estimation and risk description. The risk estimation summarizes the results of the analysis, identifies the ECOPCs and associated receptors, presents a range of potential risks, and identifies the specific locations where risk may be present. The risk description provides the context for the analysis, including the proportions of habitats affected, and interpretation of overall results.

The following sections present the results of the ecological risk characterization for the WAEU grouped by receptor or assessment endpoint. The ECOPC identification process did not identify any ECOIs that require further risk characterization for discussion in the WAEU ERA (Section 7.0). Therefore, the risk characterization for the WAEU does not provide an additional evaluation of risk, but rather provides a summary of the ECOPC identification process for each receptor.

10.1 Preble's Meadow Jumping Mouse

PMJM habitat is present in a small area in the WAEU (Figure 1.4). No data are available from within the PMJM habitat (Section 7.2). Using a conservative approach, MDCs from all surface soil samples throughout the WAEU were used to identify ECOPCs for the PMJM regardless of the habitat associated with the sampling locations. Only maximum EU-wide detections of arsenic, nickel, vanadium, and zinc exceed the NOAEL ESL for the PMJM. All four of these ECOIs were shown to be within background concentrations and removed from further consideration as ECOPCs. Therefore, it is unlikely that PMJM receptors potentially inhabiting the WAEU are at risk from exposure to ECOIs.

10.2 Herbivorous Small Mammals

Only the MDC of arsenic exceeds the NOAEL ESL for the herbivorous deer mouse. Arsenic was eliminated from further consideration based on the background comparison. It is unlikely that populations of herbivorous small mammals in the WAEU are at risk.

10.3 Insectivorous Small Mammals

Chromium, nickel, vanadium, and zinc MDCs exceed NOAEL ESLs for the insectivorous deer mouse receptor. All of the ECOIs were eliminated from further consideration as ECOPCs based on comparisons to background concentrations. Therefore, no risks are predicted to the insectivorous small mammal feeding guild based on ECOIs at the WAEU.

10.4 Burrowing Small Mammals

Only arsenic and manganese MDCs in surface soil exceed the respective ESLs for the prairie dog receptor. Both analytes were subsequently removed from the list of ECOPCs because they were shown to be statistically within the range of background concentrations. No risks are predicted to the population of burrowing small mammals in the WAEU.

Only manganese was detected at concentrations in excess of the ESL in subsurface soil for the prairie dog receptor. Manganese was identified as being within the range of background subsurface soil concentrations and was eliminated from further consideration as an ECOPC. Therefore, no risks are predicted to burrowing small mammals from ECOIs at the WAEU.

10.5 Ruminant Mammals

Only arsenic was detected at a concentration that exceeds NOAEL ESLs in the WAEU surface soil for the mule deer receptor. Arsenic was removed from further consideration as an ECOPC based on a statistical comparison to background and professional judgment. Therefore, no ECOPCs were identified for the mule deer and no risk is predicted to ruminant mammals based on exposure to ECOIs in the WAEU.

10.6 Mammalian Predators

The MDC of nickel in the WAEU surface soil is greater than the NOAEL ESL for both the insectivore and generalist coyote feeding guilds. Nickel was eliminated from further consideration as an ECOPC based on a comparison with the background data for surface soil. The range of concentrations in the WAEU was shown to be not significantly different from the range of background concentrations. No risk to the mammalian predator, regardless of feeding guild, is predicted from ECOIs in the WAEU.

10.7 Herbivorous Small Birds

The MDC of arsenic slightly exceeds the NOAEL ESL for the herbivorous mourning dove receptor. Arsenic was subsequently eliminated from further consideration as an ECOPC based on a comparison to background values and professional judgment. Given that the MDC was essentially equal to the conservative ESL, no risk to the population of herbivorous small birds is predicted from exposure to arsenic in WAEU surface soil.

10.8 Insectivorous Small Birds

MDCs for chromium, copper, lead, mercury, nickel, and zinc exceed the respective NOAEL ESLs for the insectivorous mourning dove receptor. Comparison of the WAEU data sets to the background data set indicated all ECOIs are within the range of background concentrations. It is unlikely that any risks above what could reasonably be expected in areas outside of RFETS would occur to insectivorous small birds from exposures to ECOIs in the WAEU.

10.9 Avian Predators

Only the MDC of chromium exceeds the NOAEL ESL for the American kestrel receptor. Chromium was eliminated from further consideration as an ECOPC based on a comparison to background surface soil values. Therefore, no risks are predicted to avian predators frequenting the WAEU.

10.10 Terrestrial Plants

Aluminum, arsenic, boron, chromium, lithium, thallium, and vanadium were carried through the screening step for terrestrial plants. Aluminum, arsenic, chromium, lithium, thallium, and vanadium were shown to be within the range of background concentrations. Boron was eliminated from further consideration as an ECOPC based on professional judgment. None of the ECOIs is predicted to cause risk to the terrestrial plant communities in the WAEU.

10.11 Terrestrial Invertebrates

Only chromium was detected at a concentration that exceeds the ESL for terrestrial invertebrates. The range of chromium concentrations in the WAEU was found to be in the range of background concentrations. Therefore, no risk is predicted to terrestrial invertebrates from chromium in surface soil in the WAEU.

11.0 UNCERTAINTIES ASSOCIATED WITH THE ECOLOGICAL RISK ASSESSMENT

The approach presented in the CRA Methodology (DOE 2004a) is conservative. The conclusions reached in this report are also conservative and are adequately protective of potential ecological receptors in the WAEU. However, there are a number of uncertainties in the ERA process. This section focuses on uncertainties associated specifically with the data collected in the WAEU and the analyses performed for the WAEU. Uncertainties associated with the development of ESLs, although not specific to the WAEU, are also briefly discussed, because they are an important element of the ECOPC identification process.

11.1 Uncertainties Associated With Data Adequacy and Quality

Section 1.2 and Appendix B discuss the general data adequacy and data quality, respectively, for the WAEU. No soil data have been collected in the areas of the WAEU designated as PMJM habitat, as shown on Figure 1.4. As a result, no analyses specific to the PMJM habitat were conducted for the WAEU. This introduces uncertainty into the

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risk characterization process for the PMJM, but the uncertainty is minimal for the following reasons.

All of the ECOIs greater than PMJM NOAEL ESLs in all surface soil samples, regardless of habitat, were found to be statistically from the same population as background concentrations or were eliminated based on professional judgment because the concentrations of ECOIs in the WAEU were so similar to background. The professional judgment analysis also took into account the lack of suspected source areas in the WAEU and the lack of suspected contamination. Therefore, the assumption that no risks are predicted to the PMJM receptors that may inhabit the designated PMJM habitat areas in the WAEU is reasonable.

Subsurface soil data are also limited in number and extent. However, Section 1.2 indicates the data are adequate for the CRA because no RFETS-related activities have occurred in the WAEU.

11.2 Ecological Contaminants of Potential Concern Identification Process

The ECOPC identification process for surface and subsurface soil in the WAEU consisted of an initial comparison of MDCs to conservative NOAEL-based ESLs for different receptor groups and subsequent background source analyses and comparisons. The conservative assumptions associated with these steps minimized the potential for eliminating ECOIs of toxicological significance for the WAEU or those significantly above background concentrations.

11.2.1 Selection of Representative Receptors

ESLs were developed for several representative species that represent the various groups of species or feeding guilds potentially inhabiting RFETS. There are uncertainties associated with the selection of the representative receptors from the group of species identified at RFETS based on field observations. The receptors were selected based on several criteria, including their potential to be found in the various habitats present within the WAEU, their potential to come into contact with ECOIs, their potential sensitivities to ECOIs, and the amount of life history and behavioral information available. The use of these criteria decreases the uncertainty associated with receptor selection.

11.2.2 Development of No Observed Adverse Effect Level Ecological Screening Levels

ESLs are typically based on information gained from laboratory and other carefully controlled experimental exposures described in the literature. This information is then used to extrapolate conditions likely to exist in the natural environment. The laboratory information often does not provide adequate background for these extrapolations. Consequently, assessment factors are often used to compensate for the many uncertainties inherent in the extrapolation from laboratory effects data to effects in natural ecosystems (Warren-Hicks and Moore 1998). Uncertainties can arise when extrapolations are made from (Calabrese and Baldwin 1993):

- Acute to chronic endpoints;
- One life stage to an entire life cycle;

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- Individual effects to effects at the population level or higher;
- One species to many species;
- Laboratory to field conditions;
- One to all exposure routes;
- Direct to indirect effects;
- One ecosystem to all ecosystems; and/or
- One location or time to others.

The net effect of these uncertainties may result in either an overestimate or underestimate of risk, depending on RFETS-specific conditions, the types of receptors included in the evaluation, and the particular ECOIs.

The CRA Methodology (DOE 2004a) presents a strict set of rules for applying toxicity data to develop ESLs for the ECOIs and to minimize uncertainty related to the extrapolations listed above. No procedures for the identification of toxicity data and eventual development of ESLs can eliminate the uncertainty inherent in the overall development process for ESLs. However, a consistently conservative bias helps to ensure that risks are not underestimated.

11.3 Lack of Toxicity Data for Ecological Contaminant of Interest Detected at the Western Area Exposure Unit.

Several ECOIs detected in the WAEU do not have adequate toxicity data for the derivation of ESLs (Appendix B of the CRA Methodology). Those ECOIs are listed in Table 11.1.

The background analysis for the analytes listed in Table 11.1 indicated only aluminum and lithium may be present at concentrations greater than those found in background areas. However, subsequent data analyses suggest the WAEU and background data for these chemicals have similar confidence intervals, or UCLs or both, and means. In addition, no evidence for a RFETS-related origin for these ECOIs in the WAEU was identified. Therefore, aluminum and lithium were eliminated from further consideration as ECOPCs.

The potential for risk caused by these ECOIs is uncertain. However, given that they are in the same range as background concentrations, there are no sources of contamination to surface or subsurface soil in the WAEU, and the lack of risk from the ECOPCs with adequate toxicity data, no risk is expected from the previous list of ECOIs.

RFETS-specific background data are not available for boron and titanium. These analytes were not further evaluated because they are in the normal concentration range for western U.S. soil, and there is no evidence for an RFETS-related source.

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Table 11.1 Summary of Availability of Toxicity Data for ECOIs

Analyte	Has Toxicity Data?				
	PMJM	Terrestrial Invertebrates	Mammals	Birds	Terrestrial Plants
Aluminum	No	No	No	No	Yes
Antimony	Yes	Yes	Yes	No	Yes
Beryllium	Yes	Yes	Yes	No	Yes
Boron	Yes	No	Yes	Yes	Yes
Cobalt	Yes	No	Yes	Yes	Yes
Iron	No	No	No	No	No
Lithium	Yes	No	Yes	No	No
Manganese	Yes	No	Yes	Yes	Yes
Silver	No	No	No	No	Yes
Strontium	Yes	No	Yes	No	No
Thallium	Yes	No	Yes	No	Yes
Titanium	No	No	No	No	No
Vanadium	Yes	No	Yes	Yes	Yes

12.0 SUMMARY AND CONCLUSIONS

12.1 Human Health

The COC screening analyses compared maximum detected concentrations of analytes in WAEU media to PRGs for the WRW receptor. Analytes that passed the screen were compared to background concentrations and evidence for historic sources in or near the WAEU. No COCs were selected. There are no significant human health risks from RFETS-related operations at the WAEU, and health risks to the WRW and WRV are expected to be within the range of background risks.

12.2 Ecological Risk

No risk above what would be expected to be encountered in background areas in the vicinity of the WAEU are predicted for any of the receptors evaluated. All ECOIs were eliminated from further consideration as ECOPCs based on comparisons of MDCs to NOAEL ESLs, background comparisons, or professional judgment.

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DRAFT COMPREHENSIVE RISK ASSESSMENT

VOLUME 3: APPENDIX A

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ACRONYMS

COC	Chemical of Potential Concern
CRA	Comprehensive Risk Assessment
ERA	ecological risk assessment
ESL	ecological screening level
MaxDL	maximum detection limit
N/A	not available or not applicable
NOAEL	no observed adverse effect level
PAH	polyaromatic hydrocarbon
PARCC	precision, accuracy, representativeness, completeness and comparability
PRG	preliminary remediation goal
tESL	threshold ecological screening level
WAEU	West Area Exposure Unit
WRW	wildlife refuge worker

UNIT DESCRIPTIONS

µg/kg	micrograms per kilogram (may be found as ug/kg)
mg/kg	milligrams per kilogram
µg/L	micrograms per liter (may be found as ug/L)
pCi/g	picocuries per gram

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

Nondetections and the reported detection limits are listed in this appendix for each medium in the West Area Exposure Unit (WAEU) and compared to medium-specific human health preliminary remediation goals (PRGs) for the wildlife refuge worker (WRW) and ecological screening levels (ESLs) for a variety of ecological receptors. The detection limits are considered adequate if they are less than the respective PRGs and ESLs.

Nondetected analytes in surface soil, subsurface soil, sediment, surface water, and groundwater are compared to PRGs. A comparison with ESLs is only conducted for surface and subsurface soil because sediment and surface water will be evaluated in Volume 15 of the CRA. Groundwater is not a medium of concern for ecological receptors.

1.1 Comparison of Maximum Detection Limits for Nondetected Analytes to Preliminary Remediation Goals

Nondetected analytes in surface soil, subsurface soil, sediment, surface water, and groundwater are listed and maximum detection limits (MaxDLs) are compared to PRGs in Tables A.1 through A.5. The detection limits for nondetected analytes in surface soil, subsurface soil, surface water, and groundwater are below their respective PRGs. For sediment, three nondetected analytes, benzo(a)pyrene, dibenz(a,h)anthracene, and n-nitroso-di-n-propylamine, had detection limits above their PRGs. The range of detection limits for benzo(a)pyrene, dibenz(a,h)anthracene, and n-nitroso-di-n-propylamine were 390 to 1200 micrograms per kilogram (ug/kg). The PRGs for these analytes are 379, 379, and 429 ug/kg, respectively. The PRG values are below the upper range of the detection limits for these three analytes, but exceed the lowest detection limits for benzo(a)pyrene, dibenz(a,h)anthracene. The PRG for n-nitroso-di-n-propylamine is above the lowest detection limit in some, but not all of the 10 sediment samples collected in the WAEU.

Polyaromatic hydrocarbons (PAHs) were detected in sediment in the WAEU prior to 1991, but only post-June 1991 data are used in the Draft Comprehensive Risk Assessment (CRA) and PAHs were not detected in the post-June 1991 data.. Therefore, there is some uncertainty associated with the elevated detection limits for PAHs in some of the sediment samples. This adds a small amount of uncertainty to the chemicals of concern (COC) selection process.

PRGs were not available for several nondetected organic analytes in surface water and groundwater (Tables A.4 and A.5, respectively). However, the MaxDLs for other similar organic analytes were much lower than the respective PRGs (Tables A.4 and A.5). This, and the fact that there is no source for these analytes in groundwater or surface water at the WAEU, suggests there is little uncertainty associated with the lack of PRGs for the analytes.

1.2 Comparison of Maximum Detection Limits for Nondetected Analytes to Ecological Screening Levels

The MaxDLs for nondetections in surface and subsurface soil are compared to no observed adverse effects level (NOAEL)-based ESLs in Tables A.1 and A.3,

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respectively. All MaxDLs for nondetected analytes in surface and subsurface soil were less than the corresponding ESLs, except those for selenium in surface soil. The MaxDL for selenium was 1.1 mg/kg and the NOAEL ESL is 0.4 mg/kg. There is no threshold ESL (tESL) for selenium for the prairie dog that could be compared to detection limits. The slightly elevated detection limit for selenium will not substantially impact the conclusions of the ecological risk assessment (ERA).

2.0 DATA NOT USED IN THE COMPREHENSIVE RISK ASSESSMENT

Data collected since June 28, 1991 are used for the CRA; all data collected before this date are not used as set forth in the CRA Methodology (DOE 2004). Data collected prior to this date are included in the data set provided with this risk assessment.

Subsurface soil data with a starting depth greater than eight feet are also not considered in this risk assessment as set forth in the CRA Methodology. Subsurface soil greater than eight feet will only be evaluated if the data for soil less than 8 feet indicate a potential for indoor air impacts in the subsurface sol volatilization screen. This was not the case for the WAEU. Subsurface soil data with a starting depth greater than eight feet are included in the data set provided with this risk assessment.

3.0 REFERENCES

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Table A.1 Evaluation of Maximum Detection Limits for Nondetected Analytes in Surface Soil

Analyte	Range of Reported Detection Limits	Total Number of Results	WRW PRG for Soil	MaxDL > PRG?	Lowest ESL	MaxDL > ESL?
Inorganic (mg/kg)						
Cadmium	0.069 - 0.35	10	91.4	No	0.705	No
Selenium	0.85 - 1.1	10	555	No	0.421	Yes
Tin	0.89 - 2.2	10	66652	No	2.9	No
Uranium	1.5 - 1.7	10	333	No	333	No

N/A = Not available or not applicable

Table A.2 Evaluation of Maximum Detection Limits for Nondetected Analytes in Sediment

Analyte	Range of Reported Detection Limits	Total Number of Results	WRW PRG	MaxDL > PRG?
Inorganic (mg/kg)				
Mercury	0.06 - 0.21	10	32.9	No
Nitrite	0.3 - 0.4	2	11109	No
Selenium	0.24 - 0.69	10	555	No
Organic (ug/kg)				
1,1,1-Trichloroethane	6 - 14	10	9178628	No
1,1,2,2-Tetrachloroethane	6 - 14	10	10483	No
1,1,2-Trichloroethane	6 - 14	10	28022	No
1,1-Dichloroethane	6 - 14	10	2715777	No
1,1-Dichloroethene	6 - 14	10	17366	No
1,2,4-Trichlorobenzene	390 - 1200	10	151360	No
1,2-Dichlorobenzene	390 - 1200	10	2891221	No
1,2-Dichloroethane	6 - 14	10	13270	No
1,2-Dichloroethene	6 - 14	10	999783	No
1,2-Dichloropropane	6 - 14	10	38427	No
1,3-Dichlorobenzene	390 - 1200	10	3332609	No
1,4-Dichlorobenzene	390 - 1200	10	91315	No
2,4,5-Trichlorophenol	1900 - 5900	10	8014354	No
2,4,6-Trichlorophenol	390 - 1200	10	272055	No
2,4-Dichlorophenol	390 - 1200	10	240431	No
2,4-Dimethylphenol	390 - 1200	10	1602871	No
2,4-Dinitrophenol	1900 - 5900	10	160287	No
2,4-Dinitrotoluene	390 - 1200	10	160287	No
2,6-Dinitrotoluene	390 - 1200	10	80144	No
2-Chloronaphthalene	390 - 1200	10	6411483	No
2-Chlorophenol	390 - 1200	10	555435	No

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Table A.2 Evaluation of Maximum Detection Limits for Nondetected Analytes in Sediment

Analyte	Range of Reported Detection Limits	Total Number of Results	WRW PRG	MaxDL > PRG?
2-Methylnaphthalene	390 - 1200	10	320574	No
2-Methylphenol	390 - 1200	10	4007177	No
2-Nitroaniline	1900 - 5900	10	192137	No
3,3'-Dichlorobenzidine	780 - 2300	7	6667	No
4,4'-DDD	19 - 57	10	15528	No
4,4'-DDE	19 - 57	10	10961	No
4,4'-DDT	19 - 57	10	10927	No
4,6-Dinitro-2-methylphenol	1900 - 5900	10	8014	No
4-Chloroaniline	390 - 1200	10	320574	No
4-Methyl-2-pentanone	13 - 29	10	83210223	No
4-Nitroaniline	1900 - 5900	8	207917	No
4-Nitrophenol	1900 - 5600	9	641148	No
Acenaphthene	390 - 1200	10	4437768	No
Acenaphthylene	390 - 1200	10		N/A
Acetone	13 - 190	7	99978261	No
Aldrin	9.5 - 29	10	176	No
alpha-BHC	9.5 - 29	10	570	No
alpha-Chlordane	95 - 290	10	10261	No
Anthracene	390 - 1200	10	22188842	No
Benzene	6 - 14	10	23563	No
Benzo(a)anthracene	390 - 1200	10	3793	No
Benzo(a)pyrene	390 - 1200	10	379	Yes
Benzo(b)fluoranthene	390 - 1200	10	3793	No
Benzo(g,h,i)perylene	390 - 1200	9		N/A
Benzo(k)fluoranthene	390 - 1200	10	37927	No
Benzyl Alcohol	390 - 1200	10	24043061	No
beta-BHC	9.5 - 29	10	570	No
beta-Chlordane	95 - 280	4	10261	No
bis(2-Chloroethyl) ether	390 - 1200	10	3767	No
bis(2-Chloroisopropyl) ether	390 - 1200	10	59301	No
Bromodichloromethane	6 - 14	10	67070	No
Bromoform	6 - 14	10	419858	No
Bromomethane	13 - 29	9	20959	No
Butylbenzylphthalate	390 - 1200	9	16028707	No
Carbon Disulfide	6 - 14	10	1637032	No
Carbon Tetrachloride	6 - 14	10	8446	No
Chlorobenzene	6 - 14	10	666523	No
Chloroethane	13 - 29	9	1433909	No
Chloroform	6 - 14	10	7850	No
Chloromethane	13 - 29	10	115077	No
Chrysene	390 - 1200	10	379269	No

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Table A.2 Evaluation of Maximum Detection Limits for Nondetected Analytes in Sediment

Analyte	Range of Reported Detection Limits	Total Number of Results	WRW PRG	MaxDL > PRG?
cis-1,3-Dichloropropene	6 - 14	10	19432	No
delta-BHC	9.5 - 29	10	570	No
Dibenz(a,h)anthracene	390 - 1200	10	379	Yes
Dibenzofuran	390 - 1200	10	222174	No
Dibromochloromethane	6 - 14	10	49504	No
Dieldrin	19 - 57	10	187	No
Diethylphthalate	390 - 1200	10	64114830	No
Dimethylphthalate	390 - 1200	10	801435369	No
Di-n-octylphthalate	390 - 1200	10	3205741	No
Endosulfan I	9.5 - 29	10	480861	No
Endosulfan II	19 - 57	10	480861	No
Endosulfan sulfate	19 - 57	10	480861	No
Endrin	19 - 57	10	24043	No
Endrin ketone	19 - 57	10	24043	No
Ethylbenzene	6 - 14	10	5385973	No
Fluorene	390 - 1200	10	3205741	No
gamma-BHC (Lindane)	9.5 - 29	10	570	No
gamma-Chlordane	110 - 290	6	10261	No
Heptachlor	9.5 - 29	10	665	No
Heptachlor epoxide	9.5 - 29	10	329	No
Hexachlorobenzene	390 - 1200	10	1870	No
Hexachlorobutadiene	390 - 1200	10	22217	No
Hexachlorocyclopentadiene	390 - 1200	10	380452	No
Hexachloroethane	390 - 1200	10	111087	No
Indeno(1,2,3-cd)pyrene	390 - 1200	9	3793	No
Isophorone	390 - 1200	10	3157922	No
Methoxychlor	95 - 290	10	400718	No
Methylene Chloride	6 - 63	10	271792	No
Naphthalene	390 - 1200	10	1403301	No
Nitrobenzene	390 - 1200	10	43246	No
N-Nitroso-di-n-propylamine	390 - 1200	10	429	Yes
N-nitrosodiphenylamine	390 - 1200	10	612250	No
PCB-1016	95 - 290	10	1349	No
PCB-1221	95 - 290	10	1349	No
PCB-1232	95 - 290	10	1349	No
PCB-1242	95 - 290	10	1349	No
PCB-1248	95 - 290	10	1349	No
PCB-1254	190 - 570	10	1349	No
PCB-1260	190 - 570	10	1349	No
Pentachlorophenol	1900 - 5900	10	17633	No
Phenanthrene	390 - 1200	10		N/A

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Table A.2 Evaluation of Maximum Detection Limits for Nondetected Analytes in Sediment

Analyte	Range of Reported Detection Limits	Total Number of Results	WRW PRG	MaxDL > PRG?
Phenol	390 - 1200	10	24043061	No
Styrene	6 - 14	10	13789257	No
Tetrachloroethene	6 - 14	10	6705	No
Toxaphene	190 - 570	10	2720	No
trans-1,3-Dichloropropene	6 - 14	10	19432	No
Trichloroethene	6 - 14	10	1770	No
Vinyl acetate	13 - 29	10	2647023	No
Vinyl Chloride	13 - 29	10	2169	No
Xylene	6 - 14	10	1059049	No

N/A = Not available or not applicable

Table A.3 Evaluation of Maximum Detection Limits for Nondetected Analytes in Subsurface Soil Less Than 8 Feet Deep

Analyte	Range of Reported Detection Limits	Total Number of Results	WRW PRG For Subsurface Soil	MaxDL > PRG?	Lowest ESL	MaxDL > ESL?
Inorganic (mg/kg)						
Antimony	2.5 - 11.8	7	511	No	18.7	No
Cadmium	0.58 - 1	7	1051	No	198	No
Cyanide	2.5 - 2.7	5	25550	No	2200	No
Molybdenum	1.1 - 4.1	7	6388	No	27.1	No
Silver	0.39 - 0.95	7	6388	No		N/A
Thallium	0.2 - 0.24	7	89.4	No	204	No
Organic (ug/kg)						
1,1,1-Trichloroethane	5 - 5	4	105554221	No	48540627	No
1,1,2,2-Tetrachloroethane	5 - 5	4	120551	No	4699670	No
1,1,2-Trichloroethane	5 - 5	4	322253	No		N/A
1,1-Dichloroethane	5 - 5	4	31231437	No	215360	No
1,1-Dichloroethene	5 - 5	4	199706	No	1284203	No
1,2,4-Trichlorobenzene	330 - 350	5	1740638	No	94484	No
1,2-Dichlorobenzene	330 - 350	5	33249041	No		N/A
1,2-Dichloroethane	5 - 5	4	152603	No	2003899	No
1,2-Dichloroethene	5 - 5	4	11497500	No	1874411	No
1,2-Dichloropropane	5 - 5	4	441907	No	3923401	No
1,3-Dichlorobenzene	330 - 350	5	38325000	No		N/A
1,4-Dichlorobenzene	330 - 350	5	1050120	No	5932310	No
2,4,5-Trichlorophenol	1600 - 1800	5	92165067	No		N/A
2,4,6-Trichlorophenol	330 - 350	5	3128634	No	17263	No
2,4-Dichlorophenol	330 - 350	5	2764952	No	249324	No
2,4-Dimethylphenol	330 - 350	5	18433013	No		N/A
2,4-Dinitrophenol	1600 - 1800	5	1843301	No	4896746	No

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Table A.3 Evaluation of Maximum Detection Limits for Nondetected Analytes in Subsurface Soil Less Than 8 Feet Deep

Analyte	Range of Reported Detection Limits	Total Number of Results	WRW PRG For Subsurface Soil	MaxDL > PRG?	Lowest ESL	MaxDL > ESL?
2,4-Dinitrotoluene	330 - 350	5	1843301	No	24733	No
2,6-Dinitrotoluene	330 - 350	5	921651	No	477309	No
2-Butanone	10 - 11	4	533293318	No	49368606	No
2-Chloronaphthalene	330 - 350	5	73732054	No		N/A
2-Chlorophenol	330 - 350	5	6387500	No	21598	No
2-Methylnaphthalene	330 - 350	5	3686603	No	319121	No
2-Methylphenol	330 - 350	5	46082534	No	9256574	No
2-Nitroaniline	1600 - 1800	5	2209570	No	418475	No
3,3'-Dichlorobenzidine	660 - 710	5	76667	No		N/A
4,6-Dinitro-2-methylphenol	1600 - 1800	5	92165	No	44283	No
4-Chloroaniline	330 - 350	5	3686603	No	48856	No
4-Methylphenol	330 - 350	5	4608253	No		N/A
4-Nitroaniline	1600 - 1800	5	2391043	No	2620560	No
4-Nitrophenol	1600 - 1800	5	7373205	No	1020367	No
Acenaphthene	330 - 350	5	51034336	No		N/A
Anthracene	330 - 350	5	255171679	No		N/A
Benzene	5 - 5	4	270977	No	1095615	No
Benzo(a)anthracene	330 - 350	5	43616	No		N/A
Benzo(a)pyrene	330 - 350	5	4357	No	502521	No
Benzo(b)fluoranthene	330 - 350	5	43616	No		N/A
Benzo(k)fluoranthene	330 - 350	5	436159	No		N/A
Benzoic Acid	1600 - 1800	5	3686602698	No		N/A
Benzyl Alcohol	330 - 350	5	276495202	No	253015	No
bis(2-Chloroethyl) ether	330 - 350	5	43315	No		N/A
bis(2-Chloroisopropyl) ether	330 - 350	5	681967	No		N/A
Bromodichloromethane	5 - 5	4	771304	No	381135	No
Bromoform	5 - 5	4	4828368	No	198571	No
Bromomethane	10 - 11	4	241033	No		N/A
Butylbenzylphthalate	330 - 350	5	184330135	No	3372399	No
Carbon Disulfide	5 - 5	4	18825864	No	410941	No
Carbon Tetrachloride	5 - 5	4	97124	No	736154	No
Chlorobenzene	5 - 5	4	7665015	No	413812	No
Chloroethane	10 - 11	4	16489950	No		N/A
Chloroform	5 - 5	4	90270	No	560030	No
Chloromethane	10 - 11	4	1323388	No		N/A
Chrysene	330 - 350	5	4361590	No		N/A
cis-1,3-Dichloropropene	5 - 5	4	223462	No	222413	No
Dibenz(a,h)anthracene	330 - 350	5	4362	No		N/A
Dibenzofuran	330 - 350	5	2555000	No	2440000	No
Dibromochloromethane	5 - 5	4	569296	No	389064	No
Dimethylphthalate	330 - 350	5	9216506746	No	13493260	No
Di-n-octylphthalate	330 - 350	5	36866027	No	257827984	No

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Table A.3 Evaluation of Maximum Detection Limits for Nondetected Analytes in Subsurface Soil Less Than 8 Feet Deep

Analyte	Range of Reported Detection Limits	Total Number of Results	WRW PRG For Subsurface Soil	MaxDL > PRG?	Lowest ESL	MaxDL > ESL?
Ethylbenzene	5 - 5	4	61938689	No		N/A
Fluorene	330 - 350	5	36866027	No		N/A
Hexachlorobenzene	330 - 350	5	21508	No	190142	No
Hexachlorobutadiene	330 - 350	5	255500	No	150894	No
Hexachlorocyclopentadiene	330 - 350	5	4375200	No	799679	No
Hexachloroethane	330 - 350	5	1277500	No	45656	No
Indeno(1,2,3-cd)pyrene	330 - 350	5	43616	No		N/A
Isophorone	330 - 350	5	36316098	No		N/A
Methylene Chloride	5 - 5	4	3125604	No	209560	No
Naphthalene	330 - 350	5	16137963	No	16000000	No
Nitrobenzene	330 - 350	5	497333	No		N/A
N-Nitroso-di-n-propylamine	330 - 350	5	4929	No		N/A
N-nitrosodiphenylamine	330 - 350	5	7040876	No	2150592	No
Pentachlorophenol	1600 - 1800	5	202777	No	18373	No
Phenol	330 - 350	5	276495202	No	1489991	No
Pyrene	330 - 350	5	25517168	No		N/A
Styrene	5 - 5	4	158576458	No	1526152	No
Tetrachloroethene	5 - 5	4	77111	No	72494	No
trans-1,3-Dichloropropene	5 - 5	4	223462	No	222413	No
Trichloroethene	5 - 5	4	20354	No	32424	No
Vinyl acetate	10 - 11	4	30440762	No	730903	No
Vinyl Chloride	10 - 11	4	24948	No	6494	No
Xylene	5 - 5	4	12179060	No	111663	No

[a] No detection limit was reported. Therefore, the range of reported values was used.
N/A = Not available or not applicable

Table A.4 Evaluation of Maximum Detection Limits for Nondetected Analytes in Surface Water

Analyte	Range of Reported Detection Limits	Total Number of Samples	WRW PRG for Surface Water	MaxDL > PRG?
Inorganic (mg/L)				
Ammonia	0.1 - 0.1	1		N/A
Nitrate	0.05 - 0.05	1	3244	No
Sulfide	1 - 1	16		N/A
Organic (ug/L)				
1,1,1-Trichloroethane	5 - 5	16	567778	No
1,1,2,2-Tetrachloroethane	5 - 5	16	380	No
1,1,2-Trichloroethane	5 - 5	16	1332	No
1,1-Dichloroethane	5 - 5	16	202778	No

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Table A.4 Evaluation of Maximum Detection Limits for Nondetected Analytes in Surface Water

Analyte	Range of Reported Detection Limits	Total Number of Samples	WRW PRG for Surface Water	MaxDL > PRG?
1,1-Dichloroethene	5 - 5	16	101389	No
1,2,4-Trichlorobenzene	10 - 10	1	20278	No
1,2-Dichlorobenzene	10 - 10	1	182500	No
1,2-Dichloroethane	5 - 5	16	834	No
1,2-Dichloroethene	5 - 5	16	18250	No
1,2-Dichloropropane	5 - 5	16	1116	No
1,3-Dichlorobenzene	10 - 10	1	60833	No
1,4-Dichlorobenzene	10 - 10	1	3163	No
2,4,5-Trichlorophenol	51 - 51	1	202778	No
2,4,6-Trichlorophenol	10 - 10	1	6901	No
2,4-Dichlorophenol	10 - 10	1	6083	No
2,4-Dimethylphenol	10 - 10	1	40556	No
2,4-Dinitrophenol	51 - 51	1	4056	No
2,4-Dinitrotoluene	10 - 10	1	4056	No
2,6-Dinitrotoluene	10 - 10	1	2028	No
2-Chloronaphthalene	10 - 10	1	162222	No
2-Chlorophenol	10 - 10	1	10139	No
2-Methylnaphthalene	10 - 10	1	8111	No
2-Methylphenol	10 - 10	1	101389	No
2-Nitroaniline	51 - 51	1	6083	No
3,3'-Dichlorobenzidine	20 - 20	1	169	No
4,4'-DDD	0.1 - 0.1	1	316	No
4,4'-DDE	0.1 - 0.1	1	223	No
4,4'-DDT	0.1 - 0.1	1	223	No
4,6-Dinitro-2-methylphenol	51 - 51	1	203	No
4-Chloro-3-methylphenol	10 - 10	1		N/A
4-Chloroaniline	10 - 10	1	8111	No
4-Methyl-2-pentanone	10 - 10	15		N/A
4-Methylphenol	10 - 10	1	10139	No
4-Nitroaniline	51 - 51	1	3795	No
4-Nitrophenol	51 - 51	1	16222	No
Acenaphthene	10 - 10	1	121667	No
Acenaphthylene	10 - 10	1		N/A
Aldrin	0.052 - 0.052	1	4.5	No
alpha-BHC	0.052 - 0.052	1	12	No
alpha-Chlordane	0.52 - 0.52	1	217	No
Anthracene	10 - 10	1	608333	No
Benzene	5 - 5	16	1380	No
Benzo(a)anthracene	10 - 10	1	104	No
Benzo(a)pyrene	10 - 10	1	10.4	No

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Table A.4 Evaluation of Maximum Detection Limits for Nondetected Analytes in Surface Water

Analyte	Range of Reported Detection Limits	Total Number of Samples	WRW PRG for Surface Water	MaxDL > PRG?
Benzo(b)fluoranthene	10 - 10	1	104	No
Benzo(g,h,i)perylene	10 - 10	1		N/A
Benzo(k)fluoranthene	10 - 10	1	1040	No
Benzoic Acid	51 - 51	1	8111111	No
Benzyl Alcohol	10 - 10	1	608333	No
beta-BHC	0.052 - 0.052	1	12	No
bis(2-Chloroethyl) ether	10 - 10	1	69	No
bis(2-Chloroisopropyl) ether	10 - 10	1	1084	No
bis(2-ethylhexyl)phthalate	10 - 10	1	5422	No
Bromodichloromethane	5 - 5	16	1224	No
Bromoform	5 - 5	16	9608	No
Bromomethane	10 - 10	16	2839	No
Butylbenzylphthalate	10 - 10	1	405556	No
Carbon Disulfide	5 - 5	16	202778	No
Carbon Tetrachloride	5 - 5	16	584	No
Chlorobenzene	5 - 5	16	40556	No
Chloroethane	10 - 10	16	26175	No
Chloroform	5 - 5	16	20278	No
Chloromethane	10 - 10	16		N/A
Chrysene	10 - 10	1	10398	No
cis-1,3-Dichloropropene	5 - 5	16	759	No
delta-BHC	0.052 - 0.052	1	12	No
Dibenz(a,h)anthracene	10 - 10	1	10.4	No
Dibenzofuran	10 - 10	1	4056	No
Dibromochloromethane	5 - 5	16	904	No
Dieldrin	0.1 - 0.1	1	4.7	No
Diethylphthalate	10 - 10	1	1622222	No
Dimethylphthalate	10 - 10	1	20277778	No
Di-n-butylphthalate	10 - 10	1	202778	No
Di-n-octylphthalate	10 - 10	1	81111	No
Endosulfan I	0.052 - 0.052	1	12167	No
Endosulfan II	0.1 - 0.1	1	12167	No
Endosulfan sulfate	0.1 - 0.1	1	12167	No
Endrin	0.1 - 0.1	1	608	No
Endrin ketone	0.1 - 0.1	1	608	No
Ethylbenzene	5 - 5	16	202778	No
Fluoranthene	10 - 10	1	81111	No
Fluorene	10 - 10	1	81111	No
gamma-BHC (Lindane)	0.052 - 0.052	1	12	No
gamma-Chlordane	0.52 - 0.52	1	217	No

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Table A.4 Evaluation of Maximum Detection Limits for Nondetected Analytes in Surface Water

Analyte	Range of Reported Detection Limits	Total Number of Samples	WRW PRG for Surface Water	MaxDL > PRG?
Heptachlor	0.052 - 0.052	1	16.9	No
Heptachlor epoxide	0.052 - 0.052	1	8.3	No
Hexachlorobenzene	10 - 10	1	47.4	No
Hexachlorobutadiene	10 - 10	1	406	No
Hexachlorocyclopentadiene	10 - 10	1	12167	No
Hexachloroethane	10 - 10	1	2028	No
Indeno(1,2,3-cd)pyrene	10 - 10	1	104	No
Isophorone	10 - 10	1	79901	No
Methoxychlor	0.52 - 0.52	1	10139	No
Naphthalene	10 - 10	1	40556	No
Nitrobenzene	10 - 10	1	1014	No
N-Nitroso-di-n-propylamine	10 - 10	1	10.8	No
N-nitrosodiphenylamine	10 - 10	1	15491	No
PCB-1016	0.52 - 0.52	1	38	No
PCB-1221	0.52 - 0.52	1	38	No
PCB-1232	0.52 - 0.52	1	38	No
PCB-1242	0.52 - 0.52	1	38	No
PCB-1248	0.52 - 0.52	1	38	No
PCB-1254	1 - 1	1	38	No
PCB-1260	1 - 1	1	38	No
Pentachlorophenol	51 - 51	1	633	No
Phenanthrene	10 - 10	1		N/A
Phenol	10 - 10	1	608333	No
Pyrene	10 - 10	1	60833	No
Styrene	5 - 5	16	405556	No
Tetrachloroethene	5 - 5	16	141	No
Toluene	5 - 5	16	405556	No
Toxaphene	1 - 1	1	69	No
trans-1,3-Dichloropropene	5 - 5	16	759	No
Trichloroethene	5 - 5	16	190	No
Vinyl acetate	10 - 10	16	2027778	No
Vinyl Chloride	10 - 10	16	50.6	No
Xylene	5 - 5	16	405556	No

N/A = Not available or not applicable

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Table A.5 Evaluation of Maximum Detection Limits for Nondetected Volatile Analytes in Groundwater

Analyte	Range of Reported Detection Limits (ug/L)	Total Number of Samples	Groundwater Volatilization Screening-Level PRG (ug/L)	MaxDL > PRG?
1,1,1,2-Tetrachloroethane	0.2 - 1	28	907	No
1,1,1-Trichloroethane	0.1 - 5	54	88000	No
1,1-Dichloroethane	0.1 - 5	54	33800	No
1,1-Dichloroethene	0.1 - 5	54	139	No
1,2,3-Trichloropropane	0.4 - 1	24	56.2	No
1,2,4-Trichlorobenzene	0.2 - 10	29	1320	No
1,2-Dibromo-3-chloropropane	0.5 - 1	6	N/A	N/A
1,2-Dibromoethane	0.2 - 1	26	N/A	N/A
1,2-Dichlorobenzene	0.1 - 10	29	31400	No
1,2-Dichloroethane	0.2 - 5	54	419	No
1,2-Dichloroethene (total)	5 - 5	26	N/A	N/A
1,2-Dichloropropane	0.1 - 5	53	244	No
1,3-Dichloropropane	0.2 - 1	28	N/A	N/A
1,4-Dichlorobenzene	0.2 - 10	29	N/A	N/A
2,2-Dichloropropane	0.1 - 1	28	N/A	N/A
2-Butanone	10 - 10	15	22000000	No
2-Chlorotoluene	0.2 - 1	28	N/A	N/A
2-Hexanone	10 - 10	23	N/A	N/A
4-Isopropyltoluene	0.2 - 1	28	N/A	N/A
Acetone	10 - 10	26	2000000	No
Benzene	0.1 - 5	54	341	No
Benzene, 1,2,4-trimethyl	0.2 - 1	28	N/A	N/A
Benzene, 1,3,5-trimethyl-	0.1 - 1	28	N/A	N/A
Bromobenzene	0.1 - 1	28	N/A	N/A
Bromochloromethane	0.2 - 1	27	N/A	N/A
Bromodichloromethane	0.2 - 5	54	N/A	N/A
Bromomethane	0.1 - 10	53	271	No
Chlorobenzene	0.1 - 5	54	6640	No
Chloroethane	0.1 - 10	53	394000	No
Chloromethane	0.2 - 10	54	1970	No
cis-1,2-Dichloroethene	0.2 - 1	28	419	No
cis-1,3-Dichloropropene	0.1 - 5	52	374	No
Dibromochloromethane	0.2 - 5	54	641	No
Dibromomethane	0.2 - 1	28	N/A	N/A
Dichlorodifluoromethane	0.2 - 1	28	1760	No
Ethylbenzene	0.1 - 5	54	70900	No
Isopropylbenzene	0.2 - 1	28	1940	No
m+p Xylene	0.2 - 0.5	17	7000	No
m-Dichlorobenzene	0.1 - 10	29	N/A	N/A

Table A.5 Evaluation of Maximum Detection Limits for Nondetected Volatile Analytes in Groundwater

Analyte	Range of Reported Detection Limits (ug/L)	Total Number of Samples	Groundwater Volatilization Screening-Level PRG (ug/L)	MaxDL > PRG?
m-Xylene	0.2 - 0.2	1	7000	No
Naphthalene	0.2 - 10	29	2630	No
n-Butylbenzene	0.1 - 1	28	N/A	N/A
n-Propylbenzene	0.2 - 1	28	N/A	N/A
o-Xylene	0.2 - 0.5	18	7000	No
p-Chlorotoluene	0.2 - 1	28	N/A	N/A
p-Xylene	0.2 - 0.2	1	7000	No
sec-Butylbenzene	0.2 - 1	28	N/A	N/A
Styrene	0.1 - 5	54	150000	No
trans-1,2-Dichloroethene	0.1 - 1	28	N/A	N/A
trans-1,3-Dichloropropene	0.3 - 5	52	372	No
Trichlorofluoromethane	0.1 - 1	28	10700	No
Vinyl acetate	10 - 10	26	111000	No
Vinyl chloride	0.2 - 10	54	97.5	No
Xylene	0.5 - 5	36	7000	No

N/A = Not available or not applicable

DRAFT COMPREHENSIVE RISK ASSESSMENT

VOLUME 3: APPENDIX B
Data Quality Assessment

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ACRONYMS

BH	borehole
BP	borehole product
BZ	Buffer Zone
BZSAP	Buffer Zone Sampling and Analysis Plan
CLP	contract laboratory program
CRA	Comprehensive Risk Assessment
DER	duplicate error ratio
DOE	Department of Energy
DQA	data quality assessment
DQO	data quality objective
DSMETCLP	Dissolved CLP Metals
DWQPL	dissolved water quality parameters
EPA	Environmental Protection Agency
ERA	Ecological risk assessment
ESL	ecological screening level
FD	field duplicate
GW	groundwater
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LD	laboratory duplicate
LOE	level of effort
METADD	Total metals
MS	matrix spike
MSD	matrix spike duplicate
OU	operable unit
PARCC	precision, accuracy, representativeness, completeness, and comparability
PSA	Parameter specific analytical
PRG	Preliminary Remediation Goal
QA	Quality assurance
QC	Quality control
QA/QC	Quality Assurance/Quality Control
QAPP	quality assurance project plan
RCRA	Resource Conservation and Recovery Act
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RL	reporting limit
RPD	relative percent difference
SAP	sampling and analysis plan
SED	sediment
SMETCLP	Total CLP metals
SOW	statement of work

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ACRONYMS

SVOC	semivolatile organic compound
SW	surface water
TPU	total propagated uncertainty
TRAD	total radiological sample
VOC	volatile organic compound
V&V	verification and validation
WAEU	West Area Exposure Unit
WQPL	water quality parameter
WRW	wildlife refuge worker

UNIT DESCRIPTIONS

µg/kg	micrograms per kilogram
mg/kg	milligrams per kilogram
pCi/g	picocuries per gram
pCi/L	picocuries per liter
µg/L	micrograms per liter
mg/L	milligrams per liter

1.0 INTRODUCTION

This data quality assessment (DQA) was performed on data collected from the West Area Exposure Unit (WAEU) at the Rocky Flats Environmental Technology Site (RFETS) in Golden, Colorado. Samples were collected in accordance with the Buffer Zone (BZ) Sampling and Analysis Plan (SAP) (BZSAP) (DOE 2002) and the Final Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) Work Plan for Operable Unit (OU) 11 (West Spray Field) (DOE 1992). The influence of the field quality control (QC) data on precision, accuracy, representativeness, completeness, and comparability and sensitivity (PARCCS) are described in this document. Precision, accuracy, completeness, and sensitivity are evaluated for each sample matrix in separate sections of this document. Following these matrix-specific discussions, the representativeness and comparability of the data are discussed on an EU-wide basis. Only the field QC samples from the WAEU are evaluated in this DQA. The laboratory QC samples are discussed for RFETS as a whole in Volume 2 of the Comprehensive Risk Assessment (CRA).

This DQA describes the quality assurance (QA) and QC requirements for each sample matrix and discusses whether the requirements were met. Potential outliers relative to QA/QC criteria are noted and discussed. Results that do not meet the required criteria are further evaluated and discussed in terms of their impacts on the overall utility of the data set and the project decisions for the WAEU.

The QA/QC requirements that form the basis of this DQA are based on a review of the CRA Methodology (DOE 2004), laboratory contractor statements of work, and applicable SAPs and quality assurance project plans (QAPPs). In some cases specific QA/QC requirements have not been specified in the appropriate RFETS literature. In these cases, method- and matrix-specific QA/QC requirements from the U.S. Environmental Protection Agency's (EPA's) Contract Laboratory Program (CLP) are used as default values (EPA 2003, 2004a).

1.1 Evaluation of Precision

Precision is a measure of agreement between replicate measurements (real samples and duplicates). Replicate measurements evaluated in this DQA include field duplicates (FD) and matrix spike duplicates (MSD). The relative percent difference (RPD) for each of these sample types in the WAEU data set are assessed in this DQA. (For metals, laboratory matrix duplicates are generally used in place of MSDs to assess precision; however, laboratory duplicates will be assessed on an RFETS-wide basis along with other laboratory QC checks in Volume II of the CRA.) RPD values are calculated for field duplicates using the following equation:

$$RPD = \frac{|A - B|}{(A + B)/2} \times 100$$

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Where:

A = concentration in the initial sample; and

B = concentration in the duplicate.

For matrix spikes (MS)/MSDs the RPD calculations used the spike recoveries rather than the concentration values in accordance with the CLP Statement of Work (SOW)(EPA 2003). The RPD goals are a maximum of 20 percent for the groundwater and surface water samples and a maximum of 35 percent for surface soil, sediment, and subsurface soils (EPA 2004a). These RPD goals are applied for all organic and inorganic parameters.

Precision for radiological samples is assessed using the duplicate error ratio (DER), calculated using the following equation:

$$DER = \frac{A - B}{\sqrt{(aTPU^2 + bTPU^2)}}$$

Where:

A = concentration in the initial sample;
B = concentration in the duplicate;
$aTPU^2$ = square root of the total propagated uncertainty for sample A; and
$bTPU^2$ = square root of the total propagated uncertainty for sample B.

The counting error (2 sigma error) may be used in place of the total propagated uncertainty (TPU) value as a conservative measure.

Goals for the DER of radiological samples are less than 1.96, as defined in the Evaluation of Radiochemical Data Usability (Lockheed Martin 1997). TPU values were not provided in the database for the WAEU data set; therefore, the counting error was used in place of the TPU in the above DER equation.

RPD or DER exceedances were assessed only for duplicate results that were greater than five times the method reporting limits. This "five times" rule for evaluating precision data was implemented to comply with the requirements of the CRA Methodology (DOE 2004). The magnitude of the imprecision for analytes that exceeded RPD/DER criteria was also assessed through a secondary analysis of the highest detections of such analytes in the data set relative to applicable ecological screening levels (ESLs) and preliminary remediation goals (PRGs). This secondary analysis also referenced the evaluations performed during the CRA (screening relative to ESLs/PRGs and to background data sets) and applied additional statistical evaluations (outlier assessments) as necessary to clarify any affects of QC exceedances on the conclusions of the CRA.

1.2 Evaluation of Accuracy

Accuracy (bias) is the closeness of a measurement to the true value. Accuracy is measured by the percent recovery of target analytes or similar chemicals to the known value of a standard. The field quality control parameters used for accuracy are matrix spike (MS and MSD) recoveries. The percent recoveries are calculated using the following formula.

$$\%R = \frac{F}{T} \; x \; 100$$

Where:

F = analytical result;
T = true value of the spiked analyte.

The acceptable percent recovery range used for inorganics and radiochemistry parameters in this assessment are 75-125 percent as established in the CLP SOW for Inorganic Analysis (EPA 2004a). The acceptable percent recovery ranges for organic analytes are method- and analyte-specific and are documented in the CLP SOW for Organic Analysis (EPA 2003). These recovery ranges are summarized in Table B-1. The evaluations of percent recoveries as presented below focus on low recoveries that could indicate a potential low bias in results that are near the PRGs or ESLs.

1.3 Evaluation of Completeness

This DQA constitutes one component of the QA/QC process under which RFETS data are generated and used. Other data assessment activities (e.g., statistical data assessment) are performed as part of the CRA. Other aspects of QA/QC are covered under the RFETS data assessment process. As established in Kaiser-Hill Analytical Services Division Procedure ASD-001, "Performance Assurance Data Assessment Program", the data assessment process at RFETS includes programs of data verification and validation. Verification is an assessment process to ensure that data meet certain specified criteria. Verification is a graded process to assess both compliance of the data package with the contractual SOW and the acceptability of the data, using guidelines and Data Review Checklists established in the Parameter Specific Analytical (PSA) Modules. PSA modules are established for each analytical method used at RFETS. Verification ranges from a cursory check using the Data Review Checklist to a more thorough review of the data, up to and including the assignment of data qualifiers. Verification may indicate that the data package requires validation.

Validation is a more thorough assessment process than verification. Verification and validation criteria are generally based on government-published standards and guidelines, primarily EPA CLP and SW-846 method guidelines for organic and inorganic data evaluation and review. Validation involves the inspection of data package contents for both compliance with the SOW and validity of the data, using PSA Module verification

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and validation guidelines. Validation usually includes examination of raw data and calculations. The validation and verification of WAEU data is summarized in the completeness discussions, and the amount of data that were rejected as part of the validation and verification process, are summarized in the Completeness discussions for the different WAEU sample media below.

2.0 SURFACE SOIL SAMPLES

The precision, accuracy, sensitivity, and completeness of the surface soil data set from the WAEU are discussed below.

2.1 Precision

The evaluation of precision, including FDs and MSDs, is discussed below.

2.1.1 Field Duplicate Evaluation

Field duplicate results reflect sampling as well as laboratory precision, and thus provide an indication of the overall repeatability of the sampling process. The frequency of field duplicate collection should exceed 1 field duplicate per 20 real samples. Field duplicate frequency is presented in Table B-2 and RPD results are presented in Table B-3. Table B-3 presents only the field duplicate data for which the reported concentrations in the duplicates were greater than five times the applicable reporting limit. The overall field duplicate frequency for the WAEU was 10 percent, which exceeds the 5-percent goal.

The real-duplicate RPDs (Table B-3) indicate how much variation exists in the field duplicate analyses. Four analytes (calcium, cobalt, copper, and lead) out of 18 total analytes in surface soil, with concentrations five times the reporting limit, exceeded the RPD upper limit of 35 percent. To support further evaluation of the four analytes that exceeded the RPD limit, Table B-4 lists the maximum concentrations of the analytes that were detected in surface soil that have ESLs or PRGs. Calcium has no PRG or ESL, and is therefore, not shown. The maximum detection of cobalt is more than an order of magnitude less than its PRG and ESL. This observation indicates that risk-based decision making for these two metals was not compromised by the high RPDs. For copper and lead, the maximum detection is greater than the ESL, and these metals were retained for further evaluation in the CRA. Hence, the high RPDs did not affect risk-based decision-making for copper and lead.

2.1.2 Matrix Spike Duplicates

Precision is evaluated by calculating the RPD of the MS and MSD percent recoveries. EPA CLP guidelines (EPA 2003) specify that the RPD is calculated using the MS and MSD percent recoveries and not their actual measured concentrations. Table B-5 lists the maximum and average RPDs of MS/MSD pairs.

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A review of Table B-5 indicates that with the exception of iron, the RPDs for MS/MSD pairs for surface soil were less than the RPD goal of 35 percent and the data is usable. For iron, the maximum MS/MSD RPD was greater than 48 percent, but the maximum detection of iron was less than half of its PRG (Table B-4). Specifically, the highest result for iron was 16,000 mg/kg and the PRG is 33,326 mg/kg. Further review of the data indicated that the high RPD was because of a low MS recovery in an MS/MSD pair that was not within the same sample batch as the maximum detection. Rather, the low recovery was associated with a batch containing only one sample that was also used as the MS sample, with a concentration of 12,000 mg/kg. Because the recovery and RPD may have been impacted by the high native concentrations of iron in the sample, no impacts to the data set were assessed for the purposes of risk-based decision-making under the CRA.

2.2 Accuracy

The evaluation of field accuracy parameters for surface soil in the WAEU data set is discussed below.

2.2.1 Matrix Spikes

MS recoveries are presented in Table B-6. High and erratic recoveries relative to the QC criteria (75-125 percent) were observed for aluminum, iron, manganese, and titanium. Uniformly low recoveries were observed for antimony and silica. More nominal exceedances of QC criteria were observed for calcium and zinc. Of these metals, the maximum concentrations in the surface soil data set approach applicable ESLs and PRGs for aluminum, iron, manganese, and antimony.

Aluminum, iron, and manganese recoveries were affected by the high and variable concentrations of these analytes in the MS samples relative to the spike concentrations. For aluminum, recoveries were uniformly high indicating a high bias in the surface soil data set; however, the maximum surface soil result was still well below the PRG (Table B-4). For iron, manganese and antimony, the maximum concentrations at the WAEU were less than the PRGs and comparable to the UCLs of RFETS background data (14,000 mg/kg for iron, 264 mg/kg for manganese, and 0.36 mg/kg for antimony). These metals also had applicable ESLs with the exception of manganese, which was retained for further evaluation under the CRA. On this basis, the MS recoveries did not affect decision-making.

2.2.2 Field Blank Evaluation

Results from field-related blanks were included in the evaluation of accuracy. Detectable amounts of a given contaminant within the blanks, which could indicate possible cross-contamination of samples, are evaluated if the blank concentration is greater than one-tenth of the PRG or ESL, and are further evaluated only if the same contaminant is detected in the associated real samples. For surface soil, none of the associated field blank samples contained concentrations of target analytes that were greater than one-

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tenth the PRG or ESL. On this basis, field blank contamination did not affect project decisions for surface soil.

2.3 Sensitivity

Detection limits (DLs) in units of µg/kg for organics, mg/kg for inorganics, and pCi/g for radionuclides were compared with the ESLs and PRGs. DLs that exceeded the applicable ESL or PRG for surface soil are presented in Table B-7. As shown, the maximum DL for selenium exceeded the ESL but was below the PRG. The adequacy of method sensitivity focused on the PRGs because of the conservatism and uncertainty associated with the ESLs. Additionally, the ESLs were established well after most of the WAEU analytical methods were selected and samples were analyzed. The DLs for selenium, which ranged from 0.85 to 0.95 mg/kg, were only slightly above the ESL, and no detections were reported. Thus, the method sensitivity for surface soil was assessed to be adequate.

2.4 Completeness

Based on RFETS project data quality objectives (DQOs), a minimum of 25 percent of analytical and radiological results should be formally verified and validated. Of that percentage, not more than 10 percent of the results may be rejected. Table B-8 presents the number and percentage of validated records (codes without "1"), the number and percentage of verified records (codes with "1"), and the percentage of rejected records for each analytical method. For WAEU surface soil, 60 percent of all records were verified and 40 percent were validated. Out of a total 204 results, none were rejected.

3.0 SEDIMENT SAMPLES

The precision, accuracy, sensitivity, and completeness of the sediment data set from the WAEU, as assessed using the field QC data, are discussed below.

3.1 Precision

The evaluation of precision using the field duplicate and MS/MSD data available for sediment is discussed below.

3.1.1 Field Duplicate Evaluation

Field duplicate results reflect sampling precision or overall repeatability of the sampling process. The frequency of field duplicate collection should exceed 1 field duplicate per 20 real samples. Based on the data currently available in the WAEU database, however, field duplicates were not collected for sediment samples in the WAEU; therefore, the goal of 5 percent was not met for any methods.

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The calculated RPDs provide an indicator of the precision achieved in the field duplicate analyses. Because no field duplicates were obtained, RPDs were not calculated and this precision indicator could not be evaluated for sediment.

3.1.2 Matrix Spike Duplicates

Precision is also measured by calculating the RPD for each MS and its corresponding MSD. In accordance with EPA CLP guidelines (EPA 2003), the RPD is calculated using the percent recoveries of the spikes and not the actual spike concentrations. Table B-9 lists the maximum and average MS/MSD RPD values for sediment.

A review of Table B-9 indicates that MS/MSD results were reported only for organic analytes in sediment. In this respect, the sediment program followed the CLP SOW (EPA 2004a), in which laboratory precision evaluations of metals rely on laboratory matrix duplicates rather than MSDs. Laboratory duplicate data will be evaluated in Volume II of the CRA.) All RPDs for sediment MS/MSDs were within acceptable limits as established by the CLP SOW (EPA 2003). The RPD goal is 35 percent and the highest RPD values in this data set were less than 10 percent.

3.2 Accuracy

The evaluation of field accuracy parameters for WAEU sediment is discussed below.

3.2.1 Matrix Spikes

MS recoveries are presented in Table B-10 and maximum detections in the sediment data set relative to applicable ESLs and PRGs are presented in Table B-11. The lowest recoveries were noted for organic analytes; however, these recoveries were within CLP SOW control limits for soil (Table B-1). Three compounds, 1,2,3-trichlorobenzene, 1,4-dichlorobenzene, and 2,4,6-tribromophenol are not normally spiking compounds and do not have established recovery limits. However, the recoveries of these compounds are within the range of the other spiking compounds. Selenium, antimony, and nitrate/nitrite had minimum recoveries slightly below the lower QC limit of 75 percent. Selenium was not detected in any sediment samples, and DLs were less than the ESL and PRG. Despite the low recoveries, antimony had multiple detections at concentrations higher than the ESL, and has been retained for further evaluation in the ecological risk assessment (ERA)(Volume 15 of the CRA). Nitrate/nitrite does not have a PRG or ESL and no evaluation can be conducted. On this basis, project decisions were not affected by matrix spike recoveries.

3.2.2 Field Blank Evaluation

Results from field-related blanks were included in the evaluation of accuracy. Detectable amounts of a given contaminant within the blanks, which could indicate possible cross-contamination of samples, are evaluated if the blank concentration is greater than one-tenth of the PRG or ESL, and are further evaluated only if the same contaminant is detected in the associated real samples. For sediment, Table B-12 indicates that lead was

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detected in a rinse blank at a concentration that was significant relative to aqueous ESLs. Because lead in sediment is being retained for further evaluation as part of the ecological risk assessment (ERA), however, this did not affect the project decisions.

3.3 Sensitivity

DLs in units of µg/kg for organics, mg/kg for inorganics, and pCi/g for radionuclides were compared with ESLs and PRGs. Because no maximum DLs exceeded ESLs or PRGs, adequate method sensitivity was assessed for sediments.

3.4 Completeness

Based on RFETS project DQOs, a minimum of 25 percent of analytical and radiological results should be formally verified and validated. Of that percentage, not more than 10 percent of the results may be rejected. Table B-13 presents the number and percentage of validated records (codes without "1"), the number and percentage of verified records (codes with "1"), and the percentage of rejected records for each analytical method. No data were verified; however, at least 80 percent of the analytical records for each method were validated. The percentage of rejected data for the major classes of target analytes ranged from zero to 7 percent (radionuclides), and overall percent of rejected data for sediments was 1.4 percent, meeting project DQOs.

4.0 SUBSURFACE SOIL SAMPLES

The precision, accuracy, sensitivity, and completeness of the subsurface soil data set from the WAEU, as assessed using the field QC data, are discussed below.

4.1 Precision

The evaluation of precision using the field duplicate and MS/MSD data available for subsurface soil is discussed below.

4.1.1 Field Duplicate Evaluation

Field duplicate results reflect sampling precision or overall repeatability of the sampling process. The frequency of field duplicate collection should exceed 1 field duplicate per 20 real samples. For subsurface soil, no field duplicate samples were collected, and therefore, the variation in field duplicate samples, as measured by RPD results, cannot be evaluated.

4.1.2 Matrix Spike Duplicates

Additional precision data is generated by calculating the RPD for the MS and its corresponding MSD. In accordance with EPA CLP guidelines (EPA 2003), the RPD is calculated using the percent recoveries of the spikes and not the actual spike

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concentrations. MS/MSD pair RPDs were calculated for each method and are presented in Table B-14, which lists the maximum and average RPD values.

A review of Table B-14 indicates that MS/MSD results were reported only for organic analytes in subsurface soil. All RPDs were within acceptable limits as established by the CLP SOW (EPA 2003). The RPD goal is 35 percent and the highest RPD values (reported for semivolatile organics) in this data set were less than 10 percent.

4.2 Accuracy

The evaluation of field accuracy parameters for the WAEU subsurface soil data set is discussed below.

4.2.1 Matrix Spikes

MS recoveries are presented in Table B-15 and maximum detections in the subsurface soil data set relative to applicable ESLs and PRGs are presented in Table B-16. The lowest recoveries were noted for organic analytes; however, these recoveries were within CLP SOW control limits for soil (Table B-1). Three compounds, 1,2,3-trichlorobenzene, 1,4-dichlorobenzene, and 2,4,6-tribromophenol are not normally spiking compounds and do not have established recovery limits. However, the recoveries of these compounds are within the range of the other spiking compounds. Antimony had a minimum recovery below the lower QC limit of 75 percent. However, antimony was not detected in any subsurface soil samples used in the CRA, and DLs were below the ESL and PRG. On this basis, project decisions for subsurface soil were not affected by matrix spike recoveries.

4.2.2 Field Blank Evaluation

Results from field-related blanks were included in the evaluation of accuracy. Detectable amounts of a given contaminant within the blanks, which could indicate possible cross-contamination of samples, are evaluated if the blank concentration is greater than one-tenth of the PRG or ESL, and are further evaluated only if the same contaminant is detected in the associated real samples. For subsurface soil, Table B-17 indicates that lead was detected in a rinse blank at a concentration that was significant relative to aqueous ESLs. However, because the maximum lead concentration in the subsurface soil data set (13 mg/kg) was very low relative to the applicable Prairie Dog ESL (1850 mg/kg), this did not affect the project decisions. No PRGs have been identified for lead in subsurface soil.

4.3 Sensitivity

DLs in units of µg/kg for organics, mg/kg for inorganics, and pCi/g for radionuclides were compared with PRGs and ESLs. DLs that exceeded the ESL or PRG for subsurface soil are presented in Table B-18. As shown, the maximum DL for molybdenum slightly exceeded the ESL but was well below the PRG. The adequacy of method sensitivity focused on the PRGs because of the conservatism and uncertainty associated with the

ESLs, and because ESLs were established after most of the WAEU analytical methods were selected and samples were analyzed. Moreover, no detections of molybdenum were included in the CRA data set. Thus, the method sensitivity for subsurface soil was assessed to be adequate.

4.4 Completeness

Based on project DQOs, a minimum of 25 percent of analytical and radiological results should be formally verified and validated. Of that percentage, no more than 10 percent of the results may be rejected. Table B-19 presents the number and percentage of validated records (codes without "1"), the number and percentage of verified records (codes with "1"), and the percentage of rejected records for each analytical method. No data were verified for subsurface soil; however, the level of validation was 100 percent for most analytical parameters and was invariably more than 30 percent. The percentage of rejected data for the major classes of target analytes ranged from zero to 34 percent (radionuclides); however, and overall percent of rejected data for subsurface soil was 3.3 percent, meeting project DQOs. Despite the high rejection rates for radionuclides, the CRA found no critical data gaps that affected risk assessment evaluations or decisions in subsurface soil. The amount of valid data points was sufficient for risk assessment purposes.

5.0 SURFACE WATER SAMPLES

The precision, accuracy, sensitivity, and completeness of the surface water data set from the WAEU, as assessed using the field QC data, are discussed below.

5.1 Precision

The evaluation of precision using the field duplicate and MS/MSD data available for surface water is discussed below.

5.1.1 Field Duplicate Evaluation

Field duplicate RPDs can provide an indication of the overall precision of the sampling and analytical process. The frequency of field duplicate collection should exceed 1 field duplicate per 20 real samples. Field duplicate frequency is presented in Table B-20 and real duplicate RPD results are presented in Table B-21 (Table B-21 presents only the field duplicate data for which the reported concentrations in the duplicates were greater than five times the applicable reporting limit). Field duplicate frequency exceeded the goal of 5 percent for most surface water methods and major analyte classes (e.g., total metals). Only methods for which sampling was very limited (less than 10 samples collected) did not meet the frequency requirement.

Table B-21 indicates that only iron (total and dissolved) exceeded the RPD limit of 20 percent in the field duplicates for surface water. Assessment of the maximum iron

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concentrations measured in surface water relative to the ESL and PRG (Table B-22) indicates that the maxima are generally more than three orders of magnitude below the PRG and less than half the ESL. One iron result was greater than the ESL but less than the PRG and will be retained for further evaluation in the ERA (Volume 15 of the CRA). On this basis, the RPDs for the field duplicates did not affect data usability for surface water.

5.1.2 Matrix Spike Duplicates

Precision was further evaluated by calculating the RPD for the MS and its corresponding MSD. In accordance with EPA CLP guidelines (EPA 2003), the RPD is calculated using the percent recoveries of the spikes and not the actual spike concentrations. MS/MSD pair RPDs were calculated for each method and are presented in Table B-23, which presents the average and maximum RPD values.

Because the surface water data collection activities focused primarily on metals and inorganics, MS/MSD data were limited. (As established in the CLP SOW [EPA 2004a], laboratory precision evaluations of metals rely on laboratory matrix duplicates rather than MSDs.) However, a review of Table B-23 indicates that the RPDs for the available MS/MSD pairs for surface water were much less than the RPD goal of 20 percent.

5.2 Accuracy

The evaluation of field accuracy parameters for the WAEU surface water data set is discussed below.

5.2.1 Matrix Spikes

MS recoveries are presented in Table B-24. Aluminum, antimony, arsenic, iron, selenium, thallium, tin, and 1,1-dichloroethene were analytes with ESLs and PRGs that had minimum recoveries below the lower QC limit of 75 percent. Review of Table B-22 indicates that the maximum detections of all these analytes except for aluminum and selenium were well (generally an order of magnitude or more) below the applicable ESLs and PRGs. Despite the low recoveries, aluminum, iron, and selenium had multiple detections at concentrations greater than the ESLs, and will be retained for further evaluation in the ERA (Volume 15 of the CRA). There were no detections for 1,1-dichloroethene in this dataset. Calcium, chloride, magnesium, and sodium were analytes without PRGs or ESLs that had minimum recoveries less than the lower QC limit of 75 percent. No evaluation of these analytes can be conducted. On this basis, project decisions for surface water were not affected by MS recoveries.

5.2.2 Field Blank Evaluation

Results from field-related blanks were included in the evaluation of accuracy. Detectable amounts of a given contaminant within the blanks, which could indicate possible cross-contamination of samples, are evaluated if the blank concentration is greater than one-tenth of the PRG or ESL, and are further evaluated only if the same contaminant is

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detected in the associated real samples. For surface water, Table B-25 indicates that lead was detected in multiple rinse blanks at a concentration that was significant relative to aqueous ESLs. The VOC trichloroethene was also detected in a rinse blank at a concentration approximately 1/10th the PRG. However, neither lead nor trichloroethene was detected in any real samples.

Uranium-233/234 was detected in a rinse blank at a concentration well above the ESL. However, review of Table B-22 indicates that even with any high bias from cross-contamination, the maximum detection of uranium-233/234 in the real surface water samples was well below the ESL. Therefore, project decisions were not affected by field blank detections for surface water.

5.3 Sensitivity

DLs in units of µg/L for organics, mg/L for inorganics, and pCi/L for radionuclides were compared with PRGs and ESLs. DLs that exceeded the ESL or PRG for subsurface soil are presented in Table B-26. As shown, the maximum DLs exceeded the ESLs for a number of semivolatile organic and pesticide parameters, but remained below the PRGs. The adequacy of method sensitivity focused on the PRGs because of the conservatism and uncertainty associated with the ESLs, and because ESLs were established well after most of the WAEU analytical methods were selected and samples were analyzed. Moreover, no detections of these parameters were reported in the WAEU surface water data set. Thus, the method sensitivity for these parameters was assessed to be adequate.

Table B-26 also indicates that detection limits for arsenic and thallium ranged above the PRGs. These analytes will be retained for further evaluations (e.g., relative to backgrounds) in the ERA (Volume II of the CRA).

5.4 Completeness

Based on project DQOs, a minimum of 25 percent of analytical and radiological results should be formally verified and validated. Of that percentage, no more than 10 percent of the results may be rejected. Table B-27 presents the number and percentage of validated records (codes without "1"), the number and percentage of verified records (codes with "1"), and the percentage of rejected records for each analytical method. No data were verified for some surface water methods; however, the level of validation was between 50 and 100 percent for most analytical parameters and was invariably more than 29 percent. The percentage of rejected records for the major classes of target analytes were generally near zero, but ranged as high as 31 to 71 percent for radionuclides. Despite the high rejection rate for radionuclides, the overall percent of rejected data for surface water was 3.6 percent, meeting project DQOs. In addition, the CRA found that the high data rejection rates for radionuclides produced no critical data gaps that affected risk assessment evaluations or decisions for surface water. Sufficient valid surface water sample data remained in the WAEU data set for CRA purposes.

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6.0 GROUNDWATER SAMPLES

The precision, accuracy, sensitivity, and completeness of the groundwater data set from the WAEU, as assessed using the field QC data, are discussed below.

6.1 Precision

The evaluation of precision using the field duplicate and MS/MSD data available for groundwater is discussed below.

6.1.1 Field Duplicate Evaluation

Field duplicate RPDs can provide an indication of the overall precision of the sampling and analytical process. The frequency of field duplicate collection should exceed 1 field duplicate per 20 real samples. Field duplicate frequency for groundwater is presented in Table B-28 and real duplicate RPD results are presented in Table B-29 (Table B-29 presents only the field duplicate data for which the reported concentrations in the duplicates were greater than five times the applicable reporting limit). With the exception of total metals methods, field duplicate frequency for groundwater did not meet the minimum goal of 5 percent, providing only limited data for precision evaluations.

Table B-29 indicates that SMETCLP total iron, nickel, and uranium exceeded the RPD limit of 20 percent in the field duplicates for groundwater. Assessment of the maximum concentrations measured in groundwater relative to the PRGs (Table B-30) for these metals indicates that the maxima are more than an order of magnitude below the applicable PRGs (ESLs are not applicable for groundwater). On this basis, the RPDs for the field duplicates did not affect data usability for groundwater.

6.1.2 Matrix Spike Duplicates

Precision was further evaluated by calculating the RPD for the MS and its corresponding MSD. In accordance with EPA CLP guidelines (EPA 2003), the RPD is calculated using the percent recoveries of the spikes and not the actual spike concentrations. MS/MSD pair RPDs were calculated for each method and are presented in Table B-31, which presents the average and maximum RPD values for groundwater.

Like the field duplicate data, MS/MSD data were limited for groundwater. However, a review of Table B-31 indicates that the RPDs for the available MS/MSD pairs were much less than the RPD goal of 20 percent.

6.2 Accuracy

The evaluation of field accuracy parameters for WAEU groundwater is discussed below.

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6.2.1 Matrix Spikes

MS recoveries are presented in Table B-32. Acenaphthene, arsenic, cyanide, iron, magnesium, manganese, n-nitroso-di-methylamine, selenium, and thallium were analytes with PRGs that had minimum recoveries below the lower QC limits. Review of Table B-30 indicates that the maximum detections of all these analytes were generally an order of magnitude or more below the applicable PRGs. Magnesium does not have a PRG or ESL and could not be compared. On this basis, project decisions for groundwater were not affected by MS recoveries.

6.2.2 Field Blank Evaluation

Results from field-related blanks were included in the evaluation of accuracy. Detectable amounts of a given contaminant within the blanks, which could indicate possible cross-contamination of samples, are evaluated if the blank concentration is greater than one-tenth of the PRG or ESL, and are further evaluated only if the same contaminant is detected in the associated real samples. For groundwater, no target analytes were detected at concentrations within an order of magnitude of applicable PRGs.

6.3 Sensitivity

DLs in units of µg/L for organics, mg/L for inorganics, and pCi/L for radionuclides were compared with PRGs. No DLs exceeded the applicable PRGs for groundwater as shown in Table 33. Thus, method sensitivity for groundwater was assessed to be adequate.

6.4 Completeness

Based on RFETS project DQOs, a minimum of 25 percent of analytical and radiological results should be formally verified and validated. Of that percentage, no more than 10 percent of the results may be rejected. For groundwater, Table B-34 presents the number and percentage of validated records (codes without "1"), the number and percentage of verified records (codes with "1"), and the percentage of rejected records for each analytical method.

Table B-34 shows that more than 90 percent of the data were validated for all groundwater methods except those for total metals. For total metals, however, over 85 percent of the data were verified, and 7 percent were validated. The percent of rejected records is less than 3 percent for all methods and approximately 1 percent overall, meeting project DQOs.

7.0 REPRESENTATIVENESS

Representativeness is a measure of the degree to which data collected represent the extent of the contamination at the WAEU. In this data set, 270 samples were collected for analysis by various methods. The preceding discussions in this DQA noted only minor exceedances of control criteria in field QC samples that generally did not affect the data utility for the WAEU. These control criteria encompassed a range of field QC checks for

both precision and accuracy. Evaluations of QC blank samples also found no significant impacts to the data set from blank artifacts or cross contamination. In instances where a significant percentage of rejected data was noted from the verification and validation process (i.e., for radionuclides in subsurface soil and surface water), sufficient valid data remained for CRA purposes. On this basis, the WAEU data set is of sufficient representativeness to support the project decisions. Additional evaluations of data representativeness based on available laboratory QC data will be discussed on an RFETS-wide basis in Volume II of the CRA.

8.0 COMPARABILITY

Comparability is the measure of the ability of the different laboratories to report similar data. This ability is promoted by use of promulgated methods and standard laboratory practices. This data set was collected over a long time, and several laboratories were involved with various analytical and reporting requirements. However, the variations in data quality and usability appear to be minor because the methodologies remained fairly consistent. Overall, the analytical data collection approach conducted by RFETS over time has relied on standard, well-documented methods established by EPA under the CLP program, plus other proven techniques and promulgated methods from EPA (waste water, drinking water, and solid waste methods) and other sources. In the electronic data, comparability is indicated by consistency in reporting units, reporting limits, applied QC checks, QC criteria, and data format. Any minor differences in these data have been addressed by normalization protocols during data validation, verification, and reduction.

9.0 CONCLUSIONS

This DQA of the WAEU data set was conducted to determine whether the data was of sufficient quality for risk assessment decisions. The DQA focused on field QC samples that were collected along with the real samples of surface soil, sediment, subsurface soil, surface water, and groundwater collected at the WAEU. A further evaluation of data quality based on laboratory QC parameters for the entire RFETS will be presented in Volume 2 of the CRA. Laboratory QC is evaluated for the entire Site rather than for each EU because most of the RFETS sampling programs were conducted on sitewide, OU, or IHSS-Group basis. Consequently, the laboratory batches and QC parameters can only be associated on a sitewide basis.

Method and detection limits were also reviewed to determine if adequate sensitivities were achieved. Generally, the quality of the data meets RFETS QA/QC requirements and is sufficient for use in the CRA. There were low recoveries or high RPDs relative to specified QC limits for several metals and a few organic compounds. However, comparisons of the sample data to applicable PRGs, ESLs, and background levels indicated that the QC did not affect project decision-making.

Despite the overall sufficiency of the WAEU data, the DQA yielded a few items of concern:

- Field duplicate collection frequencies were very low for sediment, subsurface soil, and groundwater, allowing only limited evaluations of data set precision. A further evaluation of precision (i.e., using laboratory duplicates) will be included in Volume II of the CRA.

- Data rejection rates during the data validation and verification process were high (between 30 and 90 percent) for radiochemical parameters in subsurface soil and surface water. However, data users for the WAEU CRA found no critical data gaps when applying the radionuclide data for these media.

10.0 REFERENCES

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DRAFT COMPREHENSIVE RISK ASSESSMENT

VOLUME 3: APPENDIX B
Data Quality Assessment

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Table B-1
Matrix Spike/Matrix Spike Duplicate QC Limits CLP SOW

Analyte	Water Recovery	Water RPD	Soil Recovery	Soil RPD
Volatiles				
1,1-Dichloroethene	61-145	14	59-172	22
Trichloroethene	71-120	14	62-137	24
Benzene	76-127	11	66-142	21
Toluene	76-125	13	59-139	21
Chlorobenzene	75-130	13	60-133	21
Semivolatiles				
Phenol	12-110	42	26-90	35
2-Chlorophenol	27-123	40	25-102	50
n-Nitroso-di-n-proylamine	41-116	38	41-126	38
4-Chloro-3-methylphenol	23-97	42	26-103	33
Acenaphthene	46-118	31	31-137	19
4-Nitrophenol	10-80	50	11-114	50
2,4-Dinitrotoluene	24-96	38	28-89	47
Pentachlorophenol	9-103	50	17-109	47
Pyrene	26-127	31	35-142	36
Pesticides				
gamma-BHC	56-123	15	46-127	50
Heptachlor	40-131	20	35-130	31
Aldrin	40-120	22	34-132	43
Dieldrin	52-126	18	31-134	38
Endrin	56-121	21	42-139	45
4,4'-DDT	38-127	27	23-134	50

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Table B-2
Surface Soil Real Duplicate Frequency Summary

Analysis Group	Real Test Method	Real Samples	Duplicate Samples	Percent Frequency	Percent Frequency by Analysis
Total Metals	SW-846 6010	10	1	10.00%	10.00%
Total Radionuclides	ALPHA SPEC	10	1	10.00%	10.00%

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Table B-3
Surface Soil Real/Duplicate RPDs

Location Code	Collection Date	Test Method	Analyte	Duplicate Result	Real Result	Result Unit	RPD
AN50-000	04-Mar-04	SW-846 6010	Aluminum	13000	18000	mg/kg	32
AN50-000	04-Mar-04	SW-846 6010	Arsenic	7.1	9.2	mg/kg	26
AN50-000	04-Mar-04	SW-846 6010	Barium, non-isotopic	91	130	mg/kg	35
AN50-000	04-Mar-04	SW-846 6010	Calcium	1700	2600	mg/kg	42
AN50-000	04-Mar-04	SW-846 6010	Chromium	13	16	mg/kg	21
AN50-000	04-Mar-04	SW-846 6010	Cobalt, non-isotopic	4.1	6	mg/kg	38
AN50-000	04-Mar-04	SW-846 6010	Copper	8.7	13	mg/kg	40
AN50-000	04-Mar-04	SW-846 6010	Iron, non-isotopic	12000	15000	mg/kg	22
AN50-000	04-Mar-04	SW-846 6010	Lead, non-isotopic	30	44	mg/kg	38
AN50-000	04-Mar-04	SW-846 6010	Lithium	8.3	11	mg/kg	28
AN50-000	04-Mar-04	SW-846 6010	Magnesium	1600	2200	mg/kg	32
AN50-000	04-Mar-04	SW-846 6010	Manganese, non-isotopic	230	320	mg/kg	33
AN50-000	04-Mar-04	SW-846 6010	Nickel, non-isotopic	7.8	11	mg/kg	34
AN50-000	04-Mar-04	SW-846 6010	Potassium, non-isotopic	1800	2500	mg/kg	33
AN50-000	04-Mar-04	SW-846 6010	Strontium, non-isotopic	17	23	mg/kg	30
AN50-000	04-Mar-04	SW-846 6010	Titanium	230	290	mg/kg	23
AN50-000	04-Mar-04	SW-846 6010	Vanadium	26	34	mg/kg	27
AN50-000	04-Mar-04	SW-846 6010	Zinc	33	47	mg/kg	35

Table B-4
Surface Soil Detected Analytes With ESLs or PRGs

Analysis Group	Test Method	Analyte	Maximum Result	Result Units	WRW PRG 1E-06	ESL
Total Radionuclides	ALPHA SPEC	Plutonium-239/240	0.25	pCi/g	9.80	6110.00
	ALPHA SPEC	Uranium-233/234	1.27	pCi/g	25.31	4980.00
	ALPHA SPEC	Uranium-238	1.7	pCi/g	29.33	1580.00
Total metals	SW-846 6010	Aluminum	18000	mg/kg	24774.08	
	SW-846 6010	Antimony, non-isotopic	0.6	mg/kg	44.43	0.90
	SW-846 6010	Arsenic	22	mg/kg	2.41	2.21
	SW-846 6010	Barium, non-isotopic	140	mg/kg	2872.41	158.66
	SW-846 6010	Beryllium	0.52	mg/kg	100.11	6.82
	SW-846 6010	Boron	7.1	mg/kg	9476.52	30.29
	SW-846 6010	Chromium	17	mg/kg	166630.43	1.34
	SW-846 6010	Cobalt, non-isotopic	6.4	mg/kg	121.79	87.03
	SW-846 6010	Copper	13	mg/kg	4443.48	8.25
	SW-846 6010	Iron, non-isotopic	16000	mg/kg	33326.09	
	SW-846 6010	Lead, non-isotopic	48	mg/kg	1000.00	12.06
	SW-846 6010	Lithium	12	mg/kg	2221.74	518.71
	SW-846 6010	Manganese, non-isotopic	320	mg/kg	419.00	221.06
	SW-846 6010	Mercury, non-isotopic	0.03	mg/kg	32.92	0.00
	SW-846 6010	Molybdenum	0.91	mg/kg	555.43	1.84
	SW-846 6010	Nickel, non-isotopic	11	mg/kg	2221.74	0.43
	SW-846 6010	Silver	0.12	mg/kg	555.43	
	SW-846 6010	Strontium, non-isotopic	24	mg/kg	66652.17	832.92
	SW-846 6010	Thallium, non-isotopic	1.3	mg/kg	7.78	7.24
	SW-846 6010	Titanium	320	mg/kg	169568.30	
	SW-846 6010	Vanadium	34	mg/kg	111.09	21.60
	SW-846 6010	Zinc	50	mg/kg	33326.09	0.65

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Table B-5
Surface Soil MS/MSD RPD

Test Method	Analyte	Maximum RPD	Average RPD	Number of MS/MSD Pairs
SW-846 6010	Aluminum	20.0	9.0	3
SW-846 6010	Antimony, non-isotopic	2.4	1.3	3
SW-846 6010	Arsenic	0.3	0.1	3
SW-846 6010	Barium, non-isotopic	1.1	0.8	3
SW-846 6010	Beryllium	0.9	0.6	3
SW-846 6010	Boron	0.8	0.4	3
SW-846 6010	Cadmium, non-isotopic	0.6	0.6	3
SW-846 6010	Calcium	8.8	3.2	3
SW-846 6010	Chromium	2.4	1.3	3
SW-846 6010	Cobalt, non-isotopic	0.6	0.4	3
SW-846 6010	Copper	1.3	0.9	3
SW-846 6010	Iron, non-isotopic	48.6	48.6	1
SW-846 6010	Lead, non-isotopic	0.8	0.6	3
SW-846 6010	Lithium	1.3	0.7	3
SW-846 6010	Magnesium	1.6	0.9	3
SW-846 6010	Manganese, non-isotopic	23.9	17.1	2
SW-846 6010	Mercury, non-isotopic	0.6	0.2	3
SW-846 6010	Molybdenum	0.3	0.1	3
SW-846 6010	Nickel, non-isotopic	1.2	0.6	3
SW-846 6010	Potassium, non-isotopic	1.0	0.7	3
SW-846 6010	Selenium, non-isotopic	0.5	0.3	3
SW-846 6010	Silica (dissolved)	4.8	4.8	2
SW-846 6010	Silver	0.3	0.3	3
SW-846 6010	Sodium, non-isotopic	0.8	0.4	3
SW-846 6010	Strontium, non-isotopic	0.9	0.5	3
SW-846 6010	Thallium, non-isotopic	0.3	0.1	3
SW-846 6010	Tin, non-isotopic	0.3	0.1	3
SW-846 6010	Titanium	16.1	6.8	3
SW-846 6010	Uranium, total	0.0	0.0	3
SW-846 6010	Vanadium	2.2	1.6	3
SW-846 6010	Zinc	2.0	1.1	3

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Table B-6
Matrix Spike Recoveries

Analyte	Minimum Recovery	Maximum Recovery	Average Recovery	Number of MS and MSD Samples
Aluminum	1040	2670	2211.67	12
Antimony, non-isotopic	44	55	48.08	12
Arsenic	89	93	91.50	12
Barium, non-isotopic	91	108	101.33	12
Beryllium	85	95	87.92	12
Boron	84	94	86.25	12
Cadmium, non-isotopic	77	93	89.17	12
Calcium	86	144	98.17	12
Chromium	80	112	104.25	12
Cobalt, non-isotopic	84	96	92.42	12
Copper	76	101	92.25	12
Iron, non-isotopic	0	2460	762.83	12
Lead, non-isotopic	87	98	94.83	12
Lithium	85	101	91.25	12
Magnesium	89	98	94.58	12
Manganese, non-isotopic	0	348	145.20	12
Mercury, non-isotopic	87	97	94.80	10
Molybdenum	87	92	89.42	12
Nickel, non-isotopic	80	97	92.75	12
Potassium, non-isotopic	102	114	108.25	12
Selenium, non-isotopic	89	93	90.83	12
Silica (dissolved)	0	17	13.00	12
Silver	97	100	98.50	12
Sodium, non-isotopic	85	96	88.83	12
Strontium, non-isotopic	86	100	96.00	12
Thallium, non-isotopic	87	92	89.75	12
Tin, non-isotopic	82	86	83.92	12
Titanium	39	192	162.25	12
Uranium, total	90	95	92.83	12
Vanadium	86	112	102.50	12
Zinc	69	106	91.17	12

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Table B-7
Surface Soil Sensitivity Analysis

Analysis Group	Test Method	Analyte	Maximum Detection limit	ESL	WRW PRG 1E-06
Total Metals	SW-846 6010	Selenium, non-isotopic	0.95	0.42	555.43

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Table B-8
Surface Soil Verification and Validation Summary

Validation Qualifier Code	Total of Analytes	Total Radionuclides	Total Metals
J	28	0	28
J1	29	0	29
UJ	7	0	7
UJ1	11	0	11
V	105	20	85
V1	170	30	140
Total	350	50	300
Verified	210	30	180
Percent Verified	60.00%	60.00%	60.00%
Validated	140	20	120
Percent Validated	40.00%	40.00%	40.00%
Rejected	0	0	0
Percent Rejected	0.00%	0.00%	0.00%

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Table B-9
Sediment MS/MSD RPD

Analysis Group	Test Method	Analyte	Maximum RPD	Average RPD	Number of MS/MSD Pairs
Semivolatiles	BNACLP	1,2,4-Trichlorobenzene	4.14	1.71	5
	BNACLP	1,4-Dichlorobenzene	7.24	1.71	5
	BNACLP	2,4,6-Tribromophenol	1.88	0.96	3
	BNACLP	2,4-Dinitrotoluene	1.82	0.97	5
	BNACLP	2-Chlorophenol	6.60	1.94	5
	BNACLP	4-Chloro-3-methylphenol	2.90	1.48	5
	BNACLP	4-Nitrophenol	8.24	3.42	5
	BNACLP	Acenaphthene	2.59	0.80	5
	BNACLP	N-Nitroso-di-n-propylamine	5.32	2.24	5
	BNACLP	Pentachlorophenol	7.64	3.34	5
	BNACLP	Phenol	5.56	2.20	5
	BNACLP	Pyrene	2.17	0.98	5
Pesticides	PESTCLP	4,4'-DDT	3.26	1.57	6
	PESTCLP	Aldrin	2.81	1.19	6
	PESTCLP	Dieldrin	2.87	1.24	6
	PESTCLP	Endrin	3.27	1.40	6
	PESTCLP	gamma-BHC (Lindane)	2.25	1.35	6
	PESTCLP	Heptachlor	1.55	1.02	6
Volatiles	VOACLP	1,1-Dichloroethene	1.84	0.80	5
	VOACLP	Benzene	2.71	1.00	5
	VOACLP	Chlorobenzene	3.06	1.83	5
	VOACLP	Toluene	2.80	1.47	5
	VOACLP	Trichloroethene	1.63	0.66	5

Table B-10
Sediment Matrix Spike Recoveries

Analyte	Minimum Recovery	Maximum Recovery	Average Recovery	Number of MS and MSD Samples
1,1-Dichloroethene	93	161	121.40	10
1,2,4-Trichlorobenzene	46	86	67.20	10
1,4-Dichlorobenzene	44	87	67.30	10
2,4,6-Tribromophenol	57	77	66.33	6
2,4-Dinitrotoluene	46	95	70.40	10
2-Chlorophenol	51	90	68.90	10
4,4'-DDT	43	128	88.92	12
4-Chloro-3-methylphenol	52	82	65.20	10
4-Nitrophenol	38	90	64.50	10
Acenaphthene	49	84	67.80	10
Aldrin	42	112	81.67	12
Alkalinity	101	102	101.50	2
Antimony, non-isotopic	57.6	111.8	86.47	3
Arsenic	92	107	99.50	2
Barium, non-isotopic	98.7	103	100.85	2
Benzene	91	111	104.60	10
Beryllium	95.5	97	96.25	2
Cadmium, non-isotopic	93	94.5	93.75	2
Cesium, non-isotopic	92	132	112.00	2
Chlorobenzene	92	128	109.70	10
Chromium	96.5	98	97.25	2
Cobalt, non-isotopic	96.6	97	96.80	2
Copper	98	99.3	98.65	2
Dieldrin	41	102	81.33	12
Endrin	50	102	87.75	12
gamma-BHC (Lindane)	53	94	78.42	12
Heptachlor	46	100	79.83	12
Lead, non-isotopic	85	88.6	86.80	2
Lithium	91.5	103	97.25	2
Manganese, non-isotopic	86.4	127.6	104.67	3
Mercury, non-isotopic	98.9	104	101.45	2
Molybdenum	89.2	103	96.10	2
Nickel, non-isotopic	97	98.6	97.80	2
Nitrate / Nitrite	72	105	87.75	4
N-Nitroso-di-n-propylamine	42	88	62.80	10
Pentachlorophenol	50	83	69.00	10
Phenol	48	81	59.00	10
Pyrene	55	86	72.10	10
Selenium, non-isotopic	69	94	81.50	2
Silver	77.3	92	84.65	2

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Analyte	Minimum Recovery	Maximum Recovery	Average Recovery	Number of MS and MSD Samples
Strontium, non-isotopic	87.7	109	98.35	2
Thallium, non-isotopic	108.8	115	111.90	2
Tin, non-isotopic	79.8	111	95.40	2
Toluene	101	114	109.00	10
Trichloroethene	89	119	105.10	10
Vanadium	100	100.1	100.05	2
Zinc	86.6	98	92.30	2

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Table B-11
Sediment Detected Analytes With ESLs or PRGs

Analysis Group	Test Method	Analyte	Maximum Result	Result Units	WRW PRG 1E-06	ESL
Semivolatiles	BNACLP	4-Methylphenol	95	ug/kg	400717.68	12.30
	BNACLP	Benzoic Acid	480	ug/kg	320574147.67	
	BNACLP	bis(2-ethylhexyl)phthalate	250	ug/kg	213750.26	24900.00
	BNACLP	Di-n-butylphthalate	150	ug/kg	8014353.69	612.00
	BNACLP	Fluoranthene	88	ug/kg	2958512.22	423.00
	BNACLP	Pyrene	61	ug/kg	2218884.17	195.00
Total Metals	METADD	Lithium	7.6	mg/kg	2221.74	
	METADD	Molybdenum	2.4	mg/kg	555.43	
	METADD	Strontium, non-isotopic	21.9	mg/kg	66652.17	
	METADD	Tin, non-isotopic	3.6	mg/kg	66652.17	
	METCLP	Aluminum	19400	mg/kg	24774.08	15900.00
	METCLP	Arsenic	5.3	mg/kg	2.41	9.79
	METCLP	Barium, non-isotopic	169	mg/kg	2872.41	189.00
	METCLP	Beryllium	1.4	mg/kg	100.11	
	METCLP	Chromium	24.8	mg/kg	166630.43	43.40
	METCLP	Cobalt, non-isotopic	10.1	mg/kg	121.79	
	METCLP	Copper	21.3	mg/kg	4443.48	31.60
	METCLP	Iron, non-isotopic	23400	mg/kg	33326.09	20000.00
	METCLP	Lead, non-isotopic	25.5	mg/kg	1000.00	35.80
	METCLP	Lithium	20.3	mg/kg	2221.74	
	METCLP	Manganese, non-isotopic	326	mg/kg	419.00	630.00
	METCLP	Nickel, non-isotopic	17.6	mg/kg	2221.74	22.70
	METCLP	Silver	2	mg/kg	555.43	1.00
	METCLP	Strontium, non-isotopic	41.2	mg/kg	66652.17	
	METCLP	Thallium, non-isotopic	0.4	mg/kg	7.78	
	METCLP	Tin, non-isotopic	17.5	mg/kg	66652.17	
	METCLP	Vanadium	51.9	mg/kg	111.09	
	METCLP	Zinc	331	mg/kg	33326.09	121.00
	SMETCLP	Aluminum	12700	mg/kg	24774.08	15900.00
	SMETCLP	Antimony, non-isotopic	12.4	mg/kg	44.43	2.00
	SMETCLP	Arsenic	5.3	mg/kg	2.41	9.79
	SMETCLP	Barium, non-isotopic	244	mg/kg	2872.41	189.00
	SMETCLP	Beryllium	0.77	mg/kg	100.11	
	SMETCLP	Cadmium, non-isotopic	1.3	mg/kg	91.39	0.99
	SMETCLP	Chromium	12.8	mg/kg	166630.43	43.40
	SMETCLP	Cobalt, non-isotopic	8.3	mg/kg	121.79	
	SMETCLP	Copper	25.9	mg/kg	4443.48	31.60
	SMETCLP	Iron, non-isotopic	16900	mg/kg	33326.09	20000.00
	SMETCLP	Lead, non-isotopic	20.9	mg/kg	1000.00	35.80
	SMETCLP	Lithium	10.9	mg/kg	2221.74	
	SMETCLP	Manganese, non-isotopic	470	mg/kg	419.00	630.00
	SMETCLP	Molybdenum	1.4	mg/kg	555.43	

Analysis Group	Test Method	Analyte	Maximum Result	Result Units	WRW PRG 1E-06	ESL
	SMETCLP	Nickel, non-isotopic	14.5	mg/kg	2221.74	22.70
	SMETCLP	Strontium, non-isotopic	38.7	mg/kg	66652.17	
	SMETCLP	Vanadium	33.4	mg/kg	111.09	
	SMETCLP	Zinc	720	mg/kg	33326.09	121.00
Total Radionuclides	TRADS	Americium-241	0.08694	pCi/g	7.69	5150.00
	TRADS	Cesium-137	1.498	pCi/g	0.22	3120.00
	TRADS	Plutonium-239/240	0.04	pCi/g	9.80	5860.00
	TRADS	Radium-226	1.8	pCi/g	2.69	101.00
	TRADS	Radium-228	4.1	pCi/g	0.11	87.80
	TRADS	Strontium-89/90	0.319	pCi/g	13.19	582.00
	TRADS	Uranium-233/234	3.079	pCi/g	25.31	5280.00
	TRADS	Uranium-235	0.14	pCi/g	1.05	3730.00
	TRADS	Uranium-238	2.81	pCi/g	29.33	2490.00
Volatiles	VOACLP	2-Butanone	3	ug/kg	46373331.97	
	VOACLP	Toluene	2	ug/kg	3094216.64	1660.00
Wet Chemistry	WQPL	Nitrate / Nitrite	76	mg/kg	177739.13	

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Table B-12
Sediment Field Blank Summary

Field Blank	Test Method	Analyte	Maximum Result	Result Unit	ESL	WRW PRG 1E-06	Number of Blanks	Number of Detections
RNS	SMETCLP	Lead, non-isotopic	0.102	mg/L	0.0025		1	1

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Table B-13
Sediment Verification and Validation Summary

Validation Qualifier Code	Total of Analytes	Semivolatiles	Total Metals	Pesticides	Total Radionuclides	Volatiles	Wet Chemistry
	115	60	0	54	0	0	1
A	57	10	0	0	45	2	0
J	238	64	152	0	1	18	3
R	22	9	1	0	6	6	0
V	1146	457	127	216	34	304	8
Total	1578	600	280	270	86	330	12
Verified	0	0	0	0	0	0	0
Percent Verified	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Validated	1463	540	280	216	86	330	11
Percent Validated	92.71%	90.00%	100.00%	80.00%	100.00%	100.00%	91.67%
Rejected	22	9	1	0	6	6	0
Percent Rejected	1.39%	1.50%	0.36%	0.00%	6.98%	1.82%	0.00%

Notes: Total Metals consisted of METADD, METCLP, and SMETCLP

Table B-14
Subsurface Soil MS/MSD RPD

Analysis Group	Test Method	Analyte	Maximum RPD	Average RPD	Number MS/MSD Pairs
Semivolatiles	BNACLP	1,2,4-Trichlorobenzene	0.39	0.19	2
	BNACLP	1,4-Dichlorobenzene	1.69	1.05	2
	BNACLP	2,4,6-Tribromophenol	5.32	2.66	4
	BNACLP	2,4-Dinitrotoluene	2.99	1.68	4
	BNACLP	2-Chlorophenol	1.40	0.94	2
	BNACLP	4-Chloro-3-methylphenol	5.83	2.92	4
	BNACLP	4-Nitrophenol	7.05	3.53	4
	BNACLP	Acenaphthene	0.89	0.45	4
	BNACLP	N-Nitroso-di-n-propylamine	1.64	1.25	4
	BNACLP	Pentachlorophenol	5.17	2.59	4
	BNACLP	Phenol	3.76	2.37	4
	BNACLP	Pyrene	7.26	3.64	4
Volatiles	VOACLP	1,1-Dichloroethene	5.12	5.12	1
	VOACLP	4-Bromofluorobenzene	1.14	1.14	1
	VOACLP	Benzene	0.70	0.70	1
	VOACLP	Chlorobenzene	0.47	0.47	1
	VOACLP	Toluene	0.47	0.47	1
	VOACLP	Trichloroethene	0.48	0.48	1

Table B-15
Subsurface Soil MS Recoveries

Analyte	Minimum Recovery	Maximum Recovery	Average Recovery	Number of MS and MSD Samples
1,1-Dichloroethene	92	113	102.50	2
1,2,4-Trichlorobenzene	64	65	64.75	4
1,4-Dichlorobenzene	57	62	60.25	4
2,4,6-Tribromophenol	63	78	70.75	4
2,4-Dinitrotoluene	63	71	66.75	4
2-Chlorophenol	51	55	52.50	4
4-Chloro-3-methylphenol	53	67	59.75	4
4-Nitrophenol	64	85	73.50	4
Acenaphthene	55	57	56.00	4
Antimony, non-isotopic	30.1	98	64.05	2
Arsenic	84	123	103.50	2
Barium, non-isotopic	100	101	100.50	2
Benzene	105	108	106.50	2
Beryllium	96	96.7	96.35	2
Cadmium, non-isotopic	101	101.7	101.35	2
Cesium, non-isotopic	97.5	133	115.25	2
Chlorobenzene	106	108	107.00	2
Chromium	107	108.4	107.70	2
Cobalt, non-isotopic	98.6	100	99.30	2
Copper	102	103.9	102.95	2
Cyanide	75	75	75.00	1
Lead, non-isotopic	78	153	115.50	2
Lithium	101.3	110	105.65	2
Manganese, non-isotopic	106.8	166	136.40	2
Mercury, non-isotopic	89	134.1	111.55	2
Molybdenum	95.6	98	96.80	2
Nickel, non-isotopic	97	100.1	98.55	2
Nitrate / Nitrite	98	98	98.00	1
N-Nitroso-di-n-propylamine	57	63	59.75	4
Pentachlorophenol	65	80	71.00	4
Phenol	43	52	47.75	4
Pyrene	53	71	62.50	4
Selenium, non-isotopic	88	89	88.50	2
Silver	84.2	103	93.60	2
Strontium, non-isotopic	101.1	113	107.05	2
Thallium, non-isotopic	99.2	113	106.10	2
Tin, non-isotopic	95.9	104	99.95	2
Toluene	106	108	107.00	2
Trichloroethene	104	106	105.00	2
Vanadium	105	105.4	105.20	2
Zinc	98	104.1	101.05	2

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Table B-16
Subsurface Soil Detected Analytes With ESLs or PRGs

Analysis Group	Test Method	Analyte	Maximum Result	Result Units	WRW PRG 1E-06	ESL
Semivolatiles	BNACLP	bis(2-ethylhexyl)phthalate	93	ug/kg	2458128.04	2759554.97
	BNACLP	Diethylphthalate	130	ug/kg	737320539.64	221016203.94
	BNACLP	Di-n-butylphthalate	410	ug/kg	92165067.46	40554535.65
	BNACLP	Fluoranthene	48	ug/kg	34022890.55	
Total Metals	METADD	Lithium	7.8	mg/kg	25550.00	3177.82
	METADD	Strontium, non-isotopic	13.7	mg/kg	766500.00	3519.20
	METCLP	Aluminum	15400	mg/kg	284901.87	
	METCLP	Arsenic	3.6	mg/kg	27.70	9.35
	METCLP	Barium, non-isotopic	64	mg/kg	33032.77	3224.20
	METCLP	Beryllium	1.2	mg/kg	1151.21	210.86
	METCLP	Chromium	13.6	mg/kg	1916250.00	586206.90
	METCLP	Cobalt, non-isotopic	7.9	mg/kg	1400.60	2461.42
	METCLP	Copper	11	mg/kg	51100.00	837.57
	METCLP	Iron, non-isotopic	18100	mg/kg	383250.00	
	METCLP	Lithium	7.5	mg/kg	25550.00	3177.82
	METCLP	Magnesium	3160	mg/kg	4815.00	
	METCLP	Manganese, non-isotopic	295	mg/kg	4815.00	221.06
	METCLP	Nickel, non-isotopic	12.6	mg/kg	25550.00	38.35
	METCLP	Strontium, non-isotopic	45	mg/kg	766500.00	3519.20
	METCLP	Tin, non-isotopic	33.9	mg/kg	766500.00	80.57
	METCLP	Vanadium	36.1	mg/kg	1277.50	83.52
	METCLP	Zinc	26.9	mg/kg	383250.00	1174.07
	SMETCLP	Aluminum	12200	mg/kg	284901.87	
	SMETCLP	Arsenic	5.9	mg/kg	27.70	9.35
	SMETCLP	Barium, non-isotopic	55	mg/kg	33032.77	3224.20
	SMETCLP	Beryllium	0.65	mg/kg	1151.21	210.86
	SMETCLP	Chromium	22.8	mg/kg	1916250.00	586206.90
	SMETCLP	Cobalt, non-isotopic	13.7	mg/kg	1400.60	2461.42
	SMETCLP	Copper	12.5	mg/kg	51100.00	837.57
	SMETCLP	Iron, non-isotopic	10700	mg/kg	383250.00	
	SMETCLP	Magnesium	1040	mg/kg	4815.00	
	SMETCLP	Manganese, non-isotopic	163	mg/kg	4815.00	221.06
	SMETCLP	Mercury, non-isotopic	0.1	mg/kg	378.63	3.15
	SMETCLP	Nickel, non-isotopic	9.4	mg/kg	25550.00	38.35
	SMETCLP	Selenium, non-isotopic	0.39	mg/kg	6387.50	2.80
	SMETCLP	Vanadium	25	mg/kg	1277.50	83.52
	SMETCLP	Zinc	14.6	mg/kg	383250.00	1174.07
Total	TRADS	Americium-241	0.013	pCi/g	88.44	3890.00

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Analysis Group	Test Method	Analyte	Maximum Result	Result Units	WRW PRG 1E-06	ESL
Radionuclides						
	TRADS	Plutonium-239/240	0.032	pCi/g	112.42	6110.00
	TRADS	Strontium-89/90	0.133	pCi/g	151.71	22.50
	TRADS	Uranium-233/234	2.3	pCi/g	291.09	4980.00
	TRADS	Uranium-235	0.1	pCi/g	12.08	2770.00
	TRADS	Uranium-238	2.3	pCi/g	337.28	1580.00
Volatiles	VOACLP	Acetone	2	ug/kg	1149750000	247687.43
	VOACLP	Toluene	3	ug/kg	35583491.39	1223383.21
Wet Chemistry	WQPL	Nitrate / Nitrite	1	mg/kg	2044000.00	16232.83

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Table B-17
Subsurface Soil Field Blank Summary

Field Blank	Test Method	Analyte	Maximum Result	Result Unit	ESL	WRW PRG 1E-06	Number of Blanks	Number of Detections
RNS	METCLP	Lead, non-isotopic	0.0015	mg/L	0.0025		1	1

Table B-18
Subsurface Soil Sensitivity Analysis

Analysis Group	Test Method	Analyte	Maximum Detection Limit	ESL	WRW PRG 1E-06
Total Metals	METADD	Molybdenum	40	27.14	6387.5
	METCLP	Molybdenum	40	27.14	6387.5

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Table B-19
Subsurface Soil Verification and Validation Summary

Validation Qualifier Code	Total of Analytes	Semivolatiles	Total Metals	Total Radionuclides	Volatiles	Wet Chemistry
A	8	1	0	4	3	0
J	69	0	64	0	0	5
R	23	0	0	16	7	0
V	384	98	132	27	122	5
Z	201	201	0	0	0	0
Total	685	300	196	47	132	10
Verified	0	0	0	0	0	0
Percent Verified	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Validated	484	99	196	47	132	10
Percent Validated	70.66%	33.00%	100.00%	100.00%	100.00%	100.00%
Rejected	23	0	0	16	7	0
Percent Rejected	3.36%	0.00%	0.00%	34.04%	5.30%	0.00%

Note: Total Metals consists of METADD, METCLP,and SMETCLP

Table B-20
Surface Water Real Duplicate Frequency Summary

Analysis Group	Real Test Method	Real Samples	Duplicate Samples	Percent Frequency	Percent Frequency by Analysis
Total Metals	CLP-SOW	2	0	0.00%	11.29%
	CLP-SOW-TOTAL	18	2	11.11%	
	EPA 600	9	0	0.00%	
	HSLMET	1	0	0.00%	
	METADD	11	1	9.09%	
	METCLP	8	2	25.00%	
	SMETCLP	13	2	15.38%	
Dissolved Metals	DHSLMET	1	0	0.00%	12.90%
	DMETADD	11	1	9.09%	
	DMETCLP	7	2	28.57%	
	DSMETCLP	12	1	8.33%	
Total Radionuclides	TRADS	15	3	20.00%	20.00%
Dissolved Radionuclides	DRADS	2	0	0.00%	0.00%
Pesticides	PESTCLP	1	0	0.00%	0.00%

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Table B-21
Surface Water Real/Duplicate RPDs

Location Code	Collection Date	Test Method	Analyte	Duplicate Result	Real Result	Result Unit	RPD
SW006	02-Dec-92	DMETADD	Strontium, soluble	0.12	0.108	mg/L	11
SW006	30-Jun-92	DMETCLP	Sodium, non-isotopic	30	30.8	mg/L	3
SW006	02-Dec-92	DSMETCLP	Barium, soluble	0.0409	0.0404	mg/L	1
SW006	02-Dec-92	DSMETCLP	Calcium, soluble	17.1	16.6	mg/L	3
SW006	02-Dec-92	DSMETCLP	Iron, soluble	0.118	0.167	mg/L	34
SW006	02-Dec-92	DSMETCLP	Magnesium, soluble	5.08	4.9	mg/L	4
SW006	02-Dec-92	DSMETCLP	Manganese, soluble	0.0333	0.0331	mg/L	1
SW006	02-Dec-92	DSMETCLP	Sodium, soluble	24	23.2	mg/L	3
SW134	05-Mar-01	CLP-SOW-TOTAL	Aluminum	4.37	3.97	mg/L	10
SW134	05-Mar-01	CLP-SOW-TOTAL	Barium, non-isotopic	0.0824	0.0858	mg/L	4
SW134	05-Mar-01	CLP-SOW-TOTAL	Beryllium	0.00028	0.00028	mg/L	0
SW134	05-Mar-01	CLP-SOW-TOTAL	Calcium	23.1	24.4	mg/L	5
SW134	05-Mar-01	CLP-SOW-TOTAL	Chromium	0.0127	0.0124	mg/L	2
SW134	05-Mar-01	CLP-SOW-TOTAL	Cobalt, non-isotopic	0.0013	0.0014	mg/L	7
SW134	05-Mar-01	CLP-SOW-TOTAL	Copper	0.0044	0.0047	mg/L	7
SW134	05-Mar-01	CLP-SOW-TOTAL	Iron, non-isotopic	2.71	2.81	mg/L	4
SW134	05-Mar-01	CLP-SOW-TOTAL	Lithium	0.0058	0.0058	mg/L	0
SW134	05-Mar-01	CLP-SOW-TOTAL	Magnesium	5.15	5.41	mg/L	5
SW134	05-Mar-01	CLP-SOW-TOTAL	Manganese, non-isotopic	0.0446	0.0516	mg/L	15
SW134	05-Mar-01	CLP-SOW-TOTAL	Nickel, non-isotopic	0.0077	0.0079	mg/L	3
SW134	05-Mar-01	CLP-SOW-TOTAL	Potassium, non-isotopic	1.51	1.52	mg/L	1
SW134	05-Mar-01	CLP-SOW-TOTAL	Sodium, non-isotopic	11.3	11.9	mg/L	5
SW134	05-Mar-01	CLP-SOW-TOTAL	Strontium, non-isotopic	0.135	0.142	mg/L	5
SW134	05-Mar-01	CLP-SOW-TOTAL	Vanadium	0.0099	0.0098	mg/L	1
SW134	05-Mar-01	CLP-SOW-TOTAL	Zinc	0.0121	0.0126	mg/L	4
SW006	02-Dec-92	SMETCLP	Barium, non-isotopic	0.0423	0.0428	mg/L	1
SW006	02-Dec-92	SMETCLP	Calcium	17.5	17.1	mg/L	2
SW134	24-May-97	SMETCLP	Calcium	29.1	28.8	mg/L	1
SW006	02-Dec-92	SMETCLP	Iron, non-isotopic	0.327	0.405	mg/L	21
SW134	24-May-97	SMETCLP	Iron, non-isotopic	0.656	0.689	mg/L	5
SW006	02-Dec-92	SMETCLP	Magnesium	5.14	4.98	mg/L	3
SW006	02-Dec-92	SMETCLP	Manganese, non-isotopic	0.0352	0.0383	mg/L	8
SW006	02-Dec-92	SMETCLP	Sodium, non-isotopic	24.3	23	mg/L	5
SW006	02-Dec-92	METADD	Strontium, non-isotopic	0.121	0.12	mg/L	1
SW134	05-Mar-01	EPA 300.0	Fluoride	0.4	0.4	mg/L	0

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Table B-22
Surface Water Detected Analytes With ESLs or PRGs

Analysis Group	Test Method	Analyte	Maximum Result	Result Units	WRW PRG 1E-06	ESL
Dissolved Metals	DHSLMET	Aluminum	0.28601	mg/L	2027.78	0.087
	DHSLMET	Barium, non-isotopic	0.03853	mg/L	141.94	0.438
	DHSLMET	Copper	0.00587	mg/L	81.11	0.009
	DHSLMET	Iron, non-isotopic	0.20459	mg/L	608.33	1
	DHSLMET	Magnesium	3.46	mg/L	94.60	
	DHSLMET	Manganese, non-isotopic	0.00686	mg/L	94.60	1.65
	DHSLMET	Strontium, non-isotopic	0.08247	mg/L	1216.67	8.3
	DHSLMET	Zinc	0.00304	mg/L	608.33	0.118
	DMETADD	Lithium	0.0041	mg/L	40.56	0.096
	DMETADD	Molybdenum	0.00252	mg/L	10.14	0.8
	DMETADD	Strontium, non-isotopic	0.16504	mg/L	1216.67	8.3
	DMETADD	Strontium, soluble	0.121	mg/L	1216.67	8.3
	DMETCLP	Aluminum	0.0869	mg/L	2027.78	0.087
	DMETCLP	Aluminum, soluble	0.598	mg/L	2027.78	0.087
	DMETCLP	Arsenic, soluble	0.0016	mg/L	0.05	0.15
	DMETCLP	Barium, non-isotopic	0.0577	mg/L	141.94	0.438
	DMETCLP	Barium, soluble	0.0774	mg/L	141.94	0.438
	DMETCLP	Cadmium, soluble	0.0032	mg/L	1.01	0.00025
	DMETCLP	Chromium, soluble	0.0021	mg/L	3041.67	0.074
	DMETCLP	Cobalt, soluble	0.0031	mg/L	40.56	0.1
	DMETCLP	Copper	0.0046	mg/L	81.11	0.009
	DMETCLP	Copper, soluble	0.008	mg/L	81.11	0.009
	DMETCLP	Iron, non-isotopic	0.194	mg/L	608.33	1
	DMETCLP	Iron, soluble	0.415	mg/L	608.33	1
	DMETCLP	Magnesium	7.42	mg/L	94.60	
	DMETCLP	Magnesium, soluble	6.2	mg/L	94.60	
	DMETCLP	Manganese, non-isotopic	0.028	mg/L	94.60	1.65
	DMETCLP	Manganese, soluble	0.0266	mg/L	94.60	1.65
	DMETCLP	Molybdenum, soluble	0.0046	mg/L	10.14	0.8
	DMETCLP	Selenium, non-isotopic	0.0039	mg/L	10.14	0.0046
	DMETCLP	Selenium, soluble	0.0016	mg/L	10.14	0.0046
	DMETCLP	Strontium, non-isotopic	0.165	mg/L	1216.67	8.3
	DMETCLP	Strontium, soluble	0.194	mg/L	1216.67	8.3
	DMETCLP	Zinc, soluble	0.0172	mg/L	608.33	0.118
	DSMETCLP	Aluminum	0.166	mg/L	2027.78	0.087
	DSMETCLP	Aluminum, soluble	0.0769	mg/L	2027.78	0.087
	DSMETCLP	Antimony, non-isotopic	0.029	mg/L	0.81	0.24
	DSMETCLP	Arsenic	0.0018	mg/L	0.05	0.15
	DSMETCLP	Barium, non-isotopic	0.132	mg/L	141.94	0.438
	DSMETCLP	Barium, soluble	0.0627	mg/L	141.94	0.438
	DSMETCLP	Cadmium, non-isotopic	0.0022	mg/L	1.01	0.00025
	DSMETCLP	Chromium	0.0154	mg/L	3041.67	0.074
	DSMETCLP	Cobalt, non-isotopic	0.000327	mg/L	40.56	0.1

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Analysis Group	Test Method	Analyte	Maximum Result	Result Units	WRW PRG 1E-06	ESL
	DSMETCLP	Copper	0.00119	mg/L	81.11	0.009
	DSMETCLP	Copper, soluble	0.0063	mg/L	81.11	0.009
	DSMETCLP	Iron, non-isotopic	3.19	mg/L	608.33	1
	DSMETCLP	Iron, soluble	0.316	mg/L	608.33	1
	DSMETCLP	Lithium	0.0038	mg/L	40.56	0.096
	DSMETCLP	Magnesium	6.90866	mg/L	94.60	
	DSMETCLP	Magnesium, soluble	4.94	mg/L	94.60	
	DSMETCLP	Manganese, non-isotopic	0.486	mg/L	94.60	1.65
	DSMETCLP	Manganese, soluble	0.0331	mg/L	94.60	1.65
	DSMETCLP	Mercury, non-isotopic	0.00477	mg/L	0.61	0.00077
	DSMETCLP	Nickel, non-isotopic	0.0073	mg/L	40.56	0.052
	DSMETCLP	Strontium, non-isotopic	0.16	mg/L	1216.67	8.3
	DSMETCLP	Thallium, non-isotopic	0.00043	mg/L	0.14	0.015
	DSMETCLP	Vanadium	0.0277	mg/L	2.03	0.012
	DSMETCLP	Zinc	0.015	mg/L	608.33	0.118
	DSMETCLP	Zinc, soluble	0.0038	mg/L	608.33	0.118
Total Metals	CLP-SOW	Aluminum	1.17	mg/L	2027.78	0.087
	CLP-SOW	Barium, non-isotopic	0.0791	mg/L	141.94	0.438
	CLP-SOW	Beryllium	0.00005	mg/L	4.06	0.0024
	CLP-SOW	Chromium	0.0065	mg/L	3041.67	0.074
	CLP-SOW	Cobalt, non-isotopic	0.00029	mg/L	40.56	0.1
	CLP-SOW	Copper	0.0026	mg/L	81.11	0.009
	CLP-SOW	Iron, non-isotopic	0.729	mg/L	608.33	1
	CLP-SOW	Lithium	0.0056	mg/L	40.56	0.096
	CLP-SOW	Magnesium	6.78	mg/L	94.60	
	CLP-SOW	Manganese, non-isotopic	0.0151	mg/L	94.60	1.65
	CLP-SOW	Mercury, non-isotopic	0.0001	mg/L	0.61	0.00077
	CLP-SOW	Molybdenum	0.0014	mg/L	10.14	0.8
	CLP-SOW	Nickel, non-isotopic	0.0055	mg/L	40.56	0.052
	CLP-SOW	Strontium, non-isotopic	0.176	mg/L	1216.67	8.3
	CLP-SOW	Thallium, non-isotopic	0.0021	mg/L	0.14	0.015
	CLP-SOW	Vanadium	0.0035	mg/L	2.03	0.012
	CLP-SOW	Zinc	0.0065	mg/L	608.33	0.118
	CLP-SOW-TOTAL	Aluminum	26.8	mg/L	2027.78	0.087
	CLP-SOW-TOTAL	Antimony, non-isotopic	0.00093	mg/L	0.81	0.24
	CLP-SOW-TOTAL	Arsenic	0.0093	mg/L	0.05	0.15
	CLP-SOW-TOTAL	Barium, non-isotopic	0.265	mg/L	141.94	0.438
	CLP-SOW-TOTAL	Beryllium	0.0021	mg/L	4.06	0.0024
	CLP-SOW-TOTAL	Cadmium, non-isotopic	0.00044	mg/L	1.01	0.00025
	CLP-SOW-TOTAL	Chromium	0.162	mg/L	3041.67	0.074
	CLP-SOW-	Cobalt, non-isotopic	0.0066	mg/L	40.56	0.1

Analysis Group	Test Method	Analyte	Maximum Result	Result Units	WRW PRG 1E-06	ESL
	TOTAL					
	CLP-SOW-TOTAL	Copper	0.0279	mg/L	81.11	0.009
	CLP-SOW-TOTAL	Iron, non-isotopic	16.2	mg/L	608.33	1
	CLP-SOW-TOTAL	Lithium	0.0182	mg/L	40.56	0.096
	CLP-SOW-TOTAL	Magnesium	8.53	mg/L	94.60	
	CLP-SOW-TOTAL	Manganese, non-isotopic	0.181	mg/L	94.60	1.65
	CLP-SOW-TOTAL	Mercury, non-isotopic	0.00012	mg/L	0.61	0.00077
	CLP-SOW-TOTAL	Molybdenum	0.0051	mg/L	10.14	0.8
	CLP-SOW-TOTAL	Nickel, non-isotopic	0.0939	mg/L	40.56	0.052
	CLP-SOW-TOTAL	Selenium, non-isotopic	0.0017	mg/L	10.14	0.0046
	CLP-SOW-TOTAL	Silver	0.00006	mg/L	10.14	0.00032
	CLP-SOW-TOTAL	Strontium, non-isotopic	0.218	mg/L	1216.67	8.3
	CLP-SOW-TOTAL	Thallium, non-isotopic	0.0011	mg/L	0.14	0.015
	CLP-SOW-TOTAL	Tin, non-isotopic	0.003	mg/L	1216.67	0.073
	CLP-SOW-TOTAL	Vanadium	0.0771	mg/L	2.03	0.012
	CLP-SOW-TOTAL	Zinc	0.0527	mg/L	608.33	0.118
	EPA 600	Aluminum	50.8	mg/L	2027.78	0.087
	EPA 600	Antimony, non-isotopic	0.00092	mg/L	0.81	0.24
	EPA 600	Arsenic	0.0148	mg/L	0.05	0.15
	EPA 600	Barium, non-isotopic	0.336	mg/L	141.94	0.438
	EPA 600	Beryllium	0.0037	mg/L	4.06	0.0024
	EPA 600	Chromium	0.247	mg/L	3041.67	0.074
	EPA 600	Cobalt, non-isotopic	0.0121	mg/L	40.56	0.1
	EPA 600	Copper	0.0484	mg/L	81.11	0.009
	EPA 600	Iron, non-isotopic	33	mg/L	608.33	1
	EPA 600	Lithium	0.0324	mg/L	40.56	0.096
	EPA 600	Magnesium	8.32	mg/L	94.60	
	EPA 600	Manganese, non-isotopic	0.237	mg/L	94.60	1.65
	EPA 600	Mercury, non-isotopic	0.00048	mg/L	0.61	0.00077
	EPA 600	Molybdenum	0.0084	mg/L	10.14	0.8
	EPA 600	Nickel, non-isotopic	0.12	mg/L	40.56	0.052
	EPA 600	Selenium, non-isotopic	0.019	mg/L	10.14	0.0046
	EPA 600	Silver	0.00024	mg/L	10.14	0.00032
	EPA 600	Strontium, non-isotopic	0.238	mg/L	1216.67	8.3
	EPA 600	Tin, non-isotopic	0.0018	mg/L	1216.67	0.073

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Analysis Group	Test Method	Analyte	Maximum Result	Result Units	WRW PRG 1E-06	ESL
	EPA 600	Uranium, total	0.0038	mg/L	6.08	0.0026
	EPA 600	Vanadium	0.132	mg/L	2.03	0.012
	EPA 600	Zinc	0.103	mg/L	608.33	0.118
	HSLMET	Aluminum	9.18	mg/L	2027.78	0.087
	HSLMET	Barium, non-isotopic	0.11135	mg/L	141.94	0.438
	HSLMET	Chromium	0.00828	mg/L	3041.67	0.074
	HSLMET	Copper	0.01306	mg/L	81.11	0.009
	HSLMET	Iron, non-isotopic	7.79	mg/L	608.33	1
	HSLMET	Lithium	0.00851	mg/L	40.56	0.096
	HSLMET	Magnesium	4.76	mg/L	94.60	
	HSLMET	Manganese, non-isotopic	0.12518	mg/L	94.60	1.65
	HSLMET	Nickel, non-isotopic	0.01113	mg/L	40.56	0.052
	HSLMET	Strontium, non-isotopic	0.09817	mg/L	1216.67	8.3
	HSLMET	Vanadium	0.01643	mg/L	2.03	0.012
	HSLMET	Zinc	0.02965	mg/L	608.33	0.118
	METADD	Lithium	0.154	mg/L	40.56	0.096
	METADD	Molybdenum	0.006	mg/L	10.14	0.8
	METADD	Strontium, non-isotopic	0.17	mg/L	1216.67	8.3
	METADD	Tin, non-isotopic	0.0042	mg/L	1216.67	0.073
	METCLP	Aluminum	6.56	mg/L	2027.78	0.087
	METCLP	Arsenic	0.0025	mg/L	0.05	0.15
	METCLP	Barium, non-isotopic	0.11	mg/L	141.94	0.438
	METCLP	Cadmium, non-isotopic	0.0038	mg/L	1.01	0.00025
	METCLP	Chromium	0.0061	mg/L	3041.67	0.074
	METCLP	Cobalt, non-isotopic	0.0038	mg/L	40.56	0.1
	METCLP	Copper	0.0088	mg/L	81.11	0.009
	METCLP	Iron, non-isotopic	5.07	mg/L	608.33	1
	METCLP	Lithium	0.0049	mg/L	40.56	0.096
	METCLP	Magnesium	7.52	mg/L	94.60	
	METCLP	Manganese, non-isotopic	0.22	mg/L	94.60	1.65
	METCLP	Selenium, non-isotopic	0.0008	mg/L	10.14	0.0046
	METCLP	Silver	0.0028	mg/L	10.14	0.00032
	METCLP	Strontium, non-isotopic	0.2	mg/L	1216.67	8.3
	METCLP	Vanadium	0.0119	mg/L	2.03	0.012
	METCLP	Zinc	0.034	mg/L	608.33	0.118
	SMETCLP	Aluminum	129	mg/L	2027.78	0.087
	SMETCLP	Antimony, non-isotopic	0.0063	mg/L	0.81	0.24
	SMETCLP	Arsenic	0.0167	mg/L	0.05	0.15
	SMETCLP	Barium, non-isotopic	0.63	mg/L	141.94	0.438
	SMETCLP	Cadmium, non-isotopic	0.00046	mg/L	1.01	0.00025
	SMETCLP	Chromium	0.0552	mg/L	3041.67	0.074
	SMETCLP	Cobalt, non-isotopic	0.0193	mg/L	40.56	0.1
	SMETCLP	Copper	0.0443	mg/L	81.11	0.009
	SMETCLP	Iron, non-isotopic	88.6	mg/L	608.33	1
	SMETCLP	Lithium	0.0027	mg/L	40.56	0.096
	SMETCLP	Magnesium	18.2	mg/L	94.60	

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Analysis Group	Test Method	Analyte	Maximum Result	Result Units	WRW PRG 1E-06	ESL
	SMETCLP	Manganese, non-isotopic	0.492	mg/L	94.60	1.65
	SMETCLP	Nickel, non-isotopic	0.0431	mg/L	40.56	0.052
	SMETCLP	Selenium, non-isotopic	0.0015	mg/L	10.14	0.0046
	SMETCLP	Strontium, non-isotopic	0.082	mg/L	1216.67	8.3
	SMETCLP	Thallium, non-isotopic	0.007	mg/L	0.14	0.015
	SMETCLP	Vanadium	0.0925	mg/L	2.03	0.012
	SMETCLP	Zinc	0.0993	mg/L	608.33	0.118
Dissolved Radionuclides	DRADS	Strontium-89/90	2.172	pCi/L	573.53	278
	DRADS	Uranium-233/234	0.1366	pCi/L	600.30	20.1
	DRADS	Uranium-235	0.0495	pCi/L	609.79	21.7
	DRADS	Uranium-238	0.194	pCi/L	663.14	22.3
Total Radionuclides	TRADS	Americium-241	0.024	pCi/L	408.09	43.8
	TRADS	Cesium-137	0.2324	pCi/L	1396.09	42.6
	TRADS	Plutonium-238	0.01343	pCi/L	323.98	
	TRADS	Plutonium-239/240	0.043	pCi/L	314.38	18.7
	TRADS	Radium-226	4.9	pCi/L	110.24	1.02
	TRADS	Strontium-89/90	1.8	pCi/L	573.53	278
	TRADS	Tritium	751	pCi/L	837104.91	265000000
	TRADS	Uranium-233/234	5.1	pCi/L	600.30	20.1
	TRADS	Uranium-235	0.29	pCi/L	609.79	21.7
	TRADS	Uranium-238	4.9	pCi/L	663.14	22.3
Volatiles	VOACLP	2-Butanone	3	ug/L	1216666.67	2200
	VOACLP	Acetone	28	ug/L	1825000.00	1500
	VOACLP	Methylene Chloride	16	ug/L	10120.82	940
Wet Chemistry	WQPL	Cyanide	0.0024	mg/L	40.56	500
	WQPL	Fluoride	0.64	mg/L	121.67	2.12
	WQPL	Nitrate / Nitrite	2	mg/L	3244.44	
	WQPL	Nitrite (as nitrogen)	0.058	mg/L	202.78	0.00443
	IONS	Fluoride (as fluorine)	0.41	mg/L	121.67	2.12
	E300	Fluoride	0.48	mg/L	121.67	2.12
	E300	Fluoride (as fluorine)	0.53	mg/L	121.67	2.12
	EPA 300.0	Fluoride	1	mg/L	121.67	2.12
	EPA 300.0	Fluoride (as fluorine)	0.34	mg/L	121.67	2.12

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Table B-23
Surface Water Real/Duplicate RPDs MS/MSD RPD

Analysis Group	Test Method	Analyte	Maximum RPD	Average RPD	Number of MS/MSD Pairs
Total Metals	EPA 600	Aluminum	1.15	1.15	1
	EPA 600	Antimony, non-isotopic	0.25	0.25	1
	EPA 600	Arsenic	0.24	0.24	1
	EPA 600	Barium, non-isotopic	0.24	0.24	1
	EPA 600	Beryllium	0.52	0.52	1
	EPA 600	Cadmium, non-isotopic	0.52	0.52	1
	EPA 600	Calcium	1.53	1.53	1
	EPA 600	Chromium	0.25	0.25	1
	EPA 600	Cobalt, non-isotopic	0.00	0.00	1
	EPA 600	Copper	0.25	0.25	1
	EPA 600	Iron, non-isotopic	3.13	3.13	1
	EPA 600	Lead, non-isotopic	0.00	0.00	1
	EPA 600	Lithium	0.74	0.74	1
	EPA 600	Magnesium	0.99	0.99	1
/	EPA 600	Manganese, non-isotopic	1.09	1.09	1
	EPA 600	Mercury, non-isotopic	0.00	0.00	1
	EPA 600	Molybdenum	0.00	0.00	1
	EPA 600	Nickel, non-isotopic	0.25	0.25	1
	EPA 600	Potassium, non-isotopic	0.75	0.75	1
	EPA 600	Selenium, non-isotopic	0.24	0.24	1
	EPA 600	Silver	0.24	0.24	1
	EPA 600	Sodium, non-isotopic	0.98	0.98	1
	EPA 600	Strontium, non-isotopic	0.25	0.25	1
	EPA 600	Thallium, non-isotopic	0.00	0.00	1
	EPA 600	Tin, non-isotopic	0.00	0.00	1
	EPA 600	Uranium, total	0.50	0.50	1
	EPA 600	Vanadium	0.00	0.00	1
	EPA 600	Zinc	2.26	2.26	1
Dissolved Metals	CLP-SOW-DISSOLVED	Mercury, soluble	0.79	0.79	1
Volatiles	VOACLP	1,1-Dichloroethene	3.49	1.01	8
	VOACLP	Benzene	1.58	0.93	8
	VOACLP	Chlorobenzene	1.50	0.80	8
	VOACLP	Toluene	2.68	1.27	8
	VOACLP	Trichloroethene	1.23	0.62	8
Wet Chemistry	WQPL	Chloride	0.00	0.00	1
	WQPL	Fluoride	0.98	0.98	1
	WQPL	Nitrate / Nitrite	2.16	2.16	1
	WQPL	Nitrite (as nitrogen)	0.00	0.00	1
	WQPL	Phosphate	0.46	0.46	1

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Analysis Group	Test Method	Analyte	Maximum RPD	Average RPD	Number of MS/MSD Pairs
	WQPL	Phosphorus	0.00	0.00	1
	WQPL	Sulfate	0.00	0.00	1
	E130.2	Hardness (as calcium carbonate)	0.25	0.10	5
	E340.2	Fluoride (as fluorine)	9.49	1.97	9
	E375.1	Sulfate	9.59	2.79	9
Wet Chemistry	EPA 300.0	Chloride	3.16	0.93	8
	IONS	Chloride	1.20	0.48	3
	IONS	Fluoride (as fluorine)	0.29	0.18	3
	IONS	Sulfate	0.69	0.23	3

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Table B-24
Matrix Spike Recoveries

Analyte	Minimum Recovery	Maximum Recovery	Average Recovery	Number of MS and MSD Samples
1,1-Dichloroethene	48	115	94.13	16
Alkalinity (as calcium carbonate)	97	97	97.00	2
Aluminum	58.1	458.7	144.92	12
Antimony, non-isotopic	68.4	114	96.24	13
Arsenic	70.4	185	105.93	13
Barium, non-isotopic	90.5	104	98.41	12
Benzene	86	103	94.25	16
Beryllium	93.3	106	98.48	12
Bicarbonate	94	94	94.00	1
Bicarbonate Alkalinity (as calcium carbonate)	101	101	101.00	2
Bromide	100	102	101.00	2
Cadmium, non-isotopic	90.2	116	97.79	13
Calcium	0	101	78.40	5
Carbonate	94	94	94.00	1
Cesium, non-isotopic	83	118	101.67	6
Chloride	69	140	104.72	57
Chlorobenzene	87	106	97.44	16
Chromium	92.2	129	102.11	13
Cobalt, non-isotopic	90.3	104	98.61	12
Copper	89.8	103	98.20	12
Cyanide	97	98.4	97.70	2
Dissolved Organic Carbon	80	100	96.00	8
Fluoride	80	109	95.81	43
Fluoride (as fluorine)	79	126	100.69	35
Hardness (as calcium carbonate)	98	102	99.11	18
Iron, non-isotopic	18.9	262.7	123.32	14
Lead, non-isotopic	77	206	106.98	13
Lithium	92	111	102.78	13
Magnesium	0	103	80.80	5
Manganese, non-isotopic	90	105	98.04	12
Mercury, non-isotopic	75	126	97.68	15
Mercury, soluble	94	97	95.50	2
Molybdenum	88.6	101.24	96.10	12
Nickel, non-isotopic	89.1	108	98.24	12
Nitrate (as nitrogen)	88	107	95.25	4
Nitrate / Nitrite	94	121	103.00	5
Nitrite	103	103	103.00	1
Nitrite (as nitrogen)	100	100	100.00	2
Oil and Grease	89	89	89.00	1

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Analyte	Minimum Recovery	Maximum Recovery	Average Recovery	Number of MS and MSD Samples
Ortho-phosphate	118	118	118.00	1
Phosphate	89	110	100.20	5
Phosphorus	91	100	97.00	3
Potassium, non-isotopic	97.74	101	99.15	5
Selenium, non-isotopic	12	190	90.71	13
Silicon	102	342.2	150.16	6
Silver	89.1	103	95.72	13
Sodium, non-isotopic	0	104	81.60	5
Strontium, non-isotopic	88.2	108	98.57	11
Sulfate	0	149	100.40	80
Sulfide	85	105	95.00	2
Thallium, non-isotopic	49	207	102.41	13
Tin, non-isotopic	19	108	90.35	11
Toluene	85	108	94.31	16
Total Organic Carbon	87	110	95.20	10
Trichloroethene	84	104	94.81	16
Uranium, total	100	102	101.00	2
Vanadium	92.4	102	98.61	13
Zinc	90.9	104	97.78	13

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Table B-25
Surface Water Field Blank Summary

Field Blank	Test Method	Analyte	Maximum Result	Result Unit	ESL	WRW PRG 1E-06	Number of Blanks	Number of Detections
RNS	DMETCLP	Lead, non-isotopic	0.0015	mg/L	0.0025		2	2
RNS	DMETCLP	Lead, non-isotopic	0.0017	mg/L	0.0025		2	2
RNS	EPA 600	Lead, non-isotopic	0.00066	mg/L	0.0025		1	1
RNS	METCLP	Lead, non-isotopic	0.0037	mg/L	0.0025		2	1
RNS	TRADS	Uranium-233/234	83.095	pCi/L	20.1	600.30	3	2
RNS	VOACLP	Trichloroethene	27	ug/L	21900	189.77	7	1

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Table B-26
Surface Water Detected Analytes With ESLs or PRGs

Analysis Group	Test Method	Analyte	Maximum Detection Limit	ESL	WRW PRG 1E-06
Semivolatiles	BNACLP	Anthracene	10	0.73	608333.33
	BNACLP	Benzo(a)anthracene	10	0.03	103.98
	BNACLP	Benzo(a)pyrene	10	0.01	10.40
	BNACLP	Benzoic Acid	51	42.00	8111111.11
	BNACLP	Dibenzofuran	10	4.00	4055.56
	BNACLP	Di-n-butylphthalate	10	9.70	202777.78
	BNACLP	Hexachlorobutadiene	10	9.30	405.56
	BNACLP	Pentachlorophenol	51	6.73	632.55
	BNACLP	Phenanthrene	10	2.40	
	BNACLP	Pyrene	10	0.03	60833.33
Dissolved Metals	DHSLMET	Arsenic	0.2	0.15	0.05
	DHSLMET	Thallium, non-isotopic	0.35	0.02	0.14
Total Metals	HSLMET	Arsenic	0.2	0.15	0.05
	HSLMET	Thallium, non-isotopic	0.35	0.02	0.14
Pesticides	PESTCLP	4,4'-DDD	0.1	0.06	316.28
	PESTCLP	Dieldrin	0.1	0.06	4.74
	PESTCLP	Heptachlor	0.052	0.00	16.87
	PESTCLP	PCB-1016	0.52	0.01	38.00
	PESTCLP	PCB-1221	0.52	0.01	38.00
	PESTCLP	PCB-1232	0.52	0.01	38.00
	PESTCLP	PCB-1242	0.52	0.01	38.00
	PESTCLP	PCB-1248	0.52	0.01	38.00
	PESTCLP	PCB-1254	1	0.01	38.00
	PESTCLP	PCB-1260	1	0.01	38.00
Volatiles	VOACLP	Carbon Disulfide	5	0.92	202777.78

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Table B-27
Surface Water Verification and Validation Summary

Validation Qualifier Code	Total of Analytes	Semivolatiles	Total Metals	Dissolved Metals	Total Radionuclides	Dissolved Radionuclides	Pesticides	Volatiles	Wet Chemistry
	81	0	6	31	6	0	0	33	5
1	39	0	38	0	0	0	0	0	1
A	64	0	0	0	56	7	0	1	0
J	344	0	144	152	2	0	0	42	4
J1	106	0	105	0	0	0	0	0	1
R	101	0	10	7	55	24	0	3	2
R1	2	0	2	0	0	0	0	0	0
UJ	12	0	12	0	0	0	0	0	0
UJ1	28	0	27	0	0	0	0	0	1
V	1496	60	491	342	43	3	27	449	81
V1	523	0	505	0	0	0	0	0	18
Y	24	0	23	0	0	0	0	0	1
Z	68	0	26	26	14	0	0	0	2
Total	2888	60	1389	558	176	34	27	528	116
Verified	696	0	675	0	0	0	0	0	21
Percent Verified	24.10%	0.00%	48.60%	0.00%	0.00%	0.00%	0.00%	0.00%	18.10%
Validated	1940	60	670	494	101	10	27	492	86
Percent Validated	67.17%	100.00%	48.24%	88.53%	57.39%	29.41%	100.00%	93.18%	74.14%
Rejected	103	0	12	7	55	24	0	3	2
Percent Rejected	3.57%	0.00%	0.86%	1.25%	31.25%	70.59%	0.00%	0.57%	1.72%

Notes:
Total Metals consists of CLPSOW, CLPSOW-TOTAL, EPA 600, HSLMET, METADD, METCLP, and SMETCLP
Dissolved Metals consists of DHSLMET, DMETADD, DMETCLP, and DSMETCLP
Wet Chemistry consists of EPA 300, IONS, and WQPL

Table B-28
Groundwater Field Duplicate Frequency

Analysis Group	Real Test Method	Real Samples	Duplicate Samples	Percent Frequency	Percent Frequency by Analysis
Total Metals	EPA 600	1	1	100.00%	6.35%
	EPA SW-846 METHOD 6020A	2	1	50.00%	
	METADD	30	1	3.33%	
	SMETCLP	30	1	3.33%	
Dissolved Metals	DMETADD	51	1	1.96%	1.96%
	DSMETCLP	51	1	1.96%	
Total Radionuclides	ALPHA SPEC	1	1	100.00%	3.57%
	TRADS	55	1	1.81%	
Dissolved Radionuclides	DRADS	52	1	1.92%	1.92%
Pesticides	PESTCLP	7	0	0.00%	0.00%
Semivolatiles	BNACLP	8	0	0.00%	0.00%
Volatiles	VOA524.2	28	0	0.00%	3.64%
	VOACLP	26	1	3.84%	

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Table B-29
Groundwater Real/Duplicate RPDs

Location Code	Collection Date	Test Method	Analyte	Duplicate Result	Real Result	Result Unit	Relative Percent Difference/Duplicate Error Ratio
46192	30-Jun-04	EPA 600	Barium, non-isotopic	0.0778	0.0706	mg/L	10
46192	30-Jun-04	EPA 600	Cadmium, non-isotopic	0.000216	0.00022	mg/L	1
46192	30-Jun-04	EPA 600	Calcium	17.3	16.2	mg/L	7
46192	30-Jun-04	EPA 600	Iron, non-isotopic	0.0844	0.085	mg/L	1
46192	30-Jun-04	EPA 600	Lithium	0.00549	0.00501	mg/L	9
46192	30-Jun-04	EPA 600	Magnesium	4.2	4	mg/L	5
46192	30-Jun-04	EPA 600	Molybdenum	0.00264	0.00321	mg/L	19
46192	30-Jun-04	EPA 600	Nickel, non-isotopic	0.000856	0.00121	mg/L	34
46192	30-Jun-04	EPA 600	Potassium, non-isotopic	0.861	0.898	mg/L	4
46192	30-Jun-04	EPA 600	Sodium, non-isotopic	7.98	7.96	mg/L	0
46192	30-Jun-04	EPA 600	Strontium, non-isotopic	0.126	0.113	mg/L	11
46192	30-Jun-04	EPA 600	Uranium, total	0.000363	0.00027	mg/L	28
5186	24-Apr-92	SMETCLP	Aluminum	1.25	1.32	mg/L	5
5186	24-Apr-92	SMETCLP	Iron, non-isotopic	1.88	2.76	mg/L	38
5186	24-Apr-92	TRADS	Americium-241	0.0007301	0.00334	pCi/L	0.713
5186	24-Apr-92	TRADS	Plutonium-239/240	0.001728	0.00129	pCi/L	-0.124
5186	24-Apr-92	WQPL	Nitrate / Nitrite	4.5	4.5	mg/L	0
46192	30-Jun-04	IONS	Nitrate / Nitrite (as nitrogen)	0.64	0.62	mg/L	3

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Table B-30
Groundwater Detected Analytes With ESLs or PRGs

Analysis Group	Test Method	Analyte	Maximum Result	Result Units	WLRW PRG 1E-06
Semivolatile	BNACLP	bis(2-ethylhexyl)phthalate	56	ug/L	5421.87
	BNACLP	Diethylphthalate	0.6	ug/L	1622222.22
	BNACLP	Di-n-butylphthalate	2	ug/L	202777.78
Dissolved Metals	DMETADD	Lithium	0.0065	mg/L	40.56
	DMETADD	Molybdenum	0.0527	mg/L	10.14
	DMETADD	Molybdenum, dissolved	0.0437	mg/L	10.14
	DMETADD	Molybdenum, soluble	0.0446	mg/L	10.14
	DMETADD	Strontium, dissolved	0.263	mg/L	1216.67
	DMETADD	Strontium, non-isotopic	0.256	mg/L	1216.67
	DMETADD	Strontium, soluble	0.244	mg/L	1216.67
	DMETADD	Tin, non-isotopic	0.0678	mg/L	1216.67
	DSMETCLP	Aluminum	0.0475	mg/L	2027.78
	DSMETCLP	Antimony, dissolved	0.0036	mg/L	0.81
	DSMETCLP	Antimony, non-isotopic	0.0325	mg/L	0.81
	DSMETCLP	Arsenic	0.0022	mg/L	0.05
	DSMETCLP	Arsenic, soluble	0.0011	mg/L	0.05
	DSMETCLP	Barium, dissolved	0.083	mg/L	141.94
	DSMETCLP	Barium, non-isotopic	0.0818	mg/L	141.94
	DSMETCLP	Barium, soluble	0.0731	mg/L	141.94
	DSMETCLP	Cadmium, non-isotopic	0.003	mg/L	1.01
	DSMETCLP	Chromium	0.0064	mg/L	3041.67
	DSMETCLP	Cobalt, non-isotopic	0.0052	mg/L	40.56
	DSMETCLP	Cobalt, soluble	0.0065	mg/L	40.56
	DSMETCLP	Copper	0.016	mg/L	81.11
	DSMETCLP	Copper, dissolved	0.012	mg/L	81.11
	DSMETCLP	Iron, dissolved	0.0248	mg/L	608.33
	DSMETCLP	Iron, non-isotopic	0.235	mg/L	608.33
	DSMETCLP	Magnesium	5.59	mg/L	94.60
	DSMETCLP	Magnesium, dissolved	5.4	mg/L	94.60
	DSMETCLP	Magnesium, soluble	4.49	mg/L	94.60
	DSMETCLP	Manganese, dissolved	0.169	mg/L	94.60
	DSMETCLP	Manganese, non-isotopic	0.147	mg/L	94.60
	DSMETCLP	Manganese, soluble	0.178	mg/L	94.60
	DSMETCLP	Mercury, dissolved	0.00024	mg/L	0.61
	DSMETCLP	Mercury, non-isotopic	0.00024	mg/L	0.61
	DSMETCLP	Nickel, non-isotopic	0.0062	mg/L	40.56
	DSMETCLP	Selenium, non-isotopic	0.0042	mg/L	10.14
	DSMETCLP	Silver	0.0042	mg/L	10.14
	DSMETCLP	Silver, dissolved	0.0054	mg/L	10.14
	DSMETCLP	Thallium, non-isotopic	0.0093	mg/L	0.14
	DSMETCLP	Vanadium	0.025	mg/L	2.03
	DSMETCLP	Vanadium, dissolved	0.0219	mg/L	2.03

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Analysis Group	Test Method	Analyte	Maximum Result	Result Units	WLRW PRG 1E-06
	DSMETCLP	Vanadium, soluble	0.0188	mg/L	2.03
	DSMETCLP	Zinc	0.0418	mg/L	608.33
	DSMETCLP	Zinc, dissolved	0.0229	mg/L	608.33
Total Metals	EPA 600	Aluminum	0.023	mg/L	2027.78
	EPA 600	Antimony, non-isotopic	0.000305	mg/L	0.81
	EPA 600	Barium, non-isotopic	0.0706	mg/L	141.94
Total Metals	EPA 600	Cadmium, non-isotopic	0.000219	mg/L	1.01
	EPA 600	Cobalt, non-isotopic	0.00521	mg/L	40.56
	EPA 600	Copper	0.00121	mg/L	81.11
	EPA 600	Iron, non-isotopic	0.085	mg/L	608.33
	EPA 600	Lithium	0.00501	mg/L	40.56
	EPA 600	Magnesium	4	mg/L	94.60
	EPA 600	Manganese, non-isotopic	0.00958	mg/L	94.60
	EPA 600	Molybdenum	0.00321	mg/L	10.14
	EPA 600	Nickel, non-isotopic	0.00121	mg/L	40.56
	EPA 600	Strontium, non-isotopic	0.113	mg/L	1216.67
	EPA 600	Uranium, total	0.000274	mg/L	6.08
	EPA SW-846 METHOD 6020A	Uranium, total	0.001024	mg/L	6.08
	METADD	Lithium	0.0259	mg/L	40.56
	METADD	Molybdenum	0.0531	mg/L	10.14
	METADD	Strontium, non-isotopic	0.411	mg/L	1216.67
	METADD	Tin, non-isotopic	0.0587	mg/L	1216.67
	SMETCLP	Aluminum	34.1	mg/L	2027.78
	SMETCLP	Antimony, non-isotopic	0.031	mg/L	0.81
	SMETCLP	Arsenic	0.0083	mg/L	0.05
	SMETCLP	Barium, non-isotopic	0.462	mg/L	141.94
	SMETCLP	Beryllium	0.002	mg/L	4.06
	SMETCLP	Cadmium, non-isotopic	0.002	mg/L	1.01
	SMETCLP	Chromium	0.0524	mg/L	3041.67
	SMETCLP	Cobalt, non-isotopic	0.0272	mg/L	40.56
	SMETCLP	Copper	0.0434	mg/L	81.11
	SMETCLP	Iron, non-isotopic	30.4	mg/L	608.33
	SMETCLP	Magnesium	11.6	mg/L	94.60
	SMETCLP	Manganese, non-isotopic	1.93	mg/L	94.60
	SMETCLP	Mercury, non-isotopic	0.00045	mg/L	0.61
	SMETCLP	Nickel, non-isotopic	0.0457	mg/L	40.56
	SMETCLP	Selenium, non-isotopic	0.0032	mg/L	10.14
	SMETCLP	Thallium, non-isotopic	0.0044	mg/L	0.14
	SMETCLP	Vanadium	4.1	mg/L	2.03
	SMETCLP	Zinc	0.201	mg/L	608.33
Dissolved Radionuclides	DRADS	Americium-241	0.00823906	pCi/L	408.09
	DRADS	Cesium, radio	0.731243	pCi/L	1396.09
	DRADS	Cesium-137	1.4	pCi/L	1396.09
	DRADS	Plutonium-238	0	pCi/L	323.98
	DRADS	Plutonium-239/240	0.0039657	pCi/L	314.38

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Analysis Group	Test Method	Analyte	Maximum Result	Result Units	WLRW PRG 1E-06
	DRADS	Radiocesium	1.47102688	pCi/L	1396.09
	DRADS	Radium-226	0.25	pCi/L	110.24
	DRADS	Strontium-89/90	0.7641	pCi/L	573.53
	DRADS	Uranium-233/234	1.8	pCi/L	600.30
	DRADS	Uranium-235	0.33474928	pCi/L	609.79
	DRADS	Uranium-238	1.8	pCi/L	663.14
Total Radionuclides	TRADS	Americium-241	0.09057066	pCi/L	408.09
	TRADS	Cesium, radio	0.66250495	pCi/L	1396.09
	TRADS	Cesium-137	0.6598	pCi/L	1396.09
	TRADS	Plutonium-238	0.00253921	pCi/L	323.98
	TRADS	Plutonium-239/240	0.23461058	pCi/L	314.38
	TRADS	Radiocesium	3.8	pCi/L	1396.09
	TRADS	Radium-226	3.3	pCi/L	110.24
	TRADS	Strontium-89/90	0.9669	pCi/L	573.53
	TRADS	Tritium	580	pCi/L	837104.91
	TRADS	Uranium-233/234	3.3	pCi/L	600.30
	TRADS	Uranium-235	0.23783637	pCi/L	609.79
	TRADS	Uranium-238	2.2	pCi/L	663.14
Voaltiles	VOA524.2	Methylene Chloride	2	ug/L	10120.82
	VOA524.2	Tetrachloroethene	0.4	ug/L	140.57
	VOA524.2	Trichloroethene	0.1	ug/L	189.77
	VOACLP	1,1,2,2-Tetrachloroethane	1	ug/L	379.53
	VOACLP	1,1,2-Trichloroethane	0.7	ug/L	1331.69
	VOACLP	Bromoform	0.6	ug/L	9608.37
	VOACLP	Carbon Disulfide	2	ug/L	202777.78
	VOACLP	Carbon Tetrachloride	5	ug/L	583.89
	VOACLP	Chloroform	0.2	ug/L	20277.78
	VOACLP	Methylene Chloride	3	ug/L	10120.82
	VOACLP	Toluene	0.3	ug/L	405555.56
Wet Chemistry	WQPL	Cyanide	0.00508	mg/L	40.56
	WQPL	Fluoride	1.5	mg/L	121.67
	WQPL	Nitrate / Nitrite	5.72	mg/L	3244.44
	WQPL	Nitrate / Nitrite (as nitrogen)	13	mg/L	3244.44
	IONS	Nitrate / Nitrite (as nitrogen)	0.62	mg/L	3244.44

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Table B-31
Real/Duplicate RPDs MS/MSD RPD

Analysis Group	Test Method	Analyte	Maximum RPD	Average RPD	Number of MS/MSD Pairs
Semivolatiles	BNACLP	1,2,4-Trichlorobenzene	1.3	1.3	1
	BNACLP	1,4-Dichlorobenzene	0.9	0.9	1
	BNACLP	2,4,6-Tribromophenol	3.0	3.0	1
	BNACLP	2,4-Dinitrotoluene	0.9	0.9	1
	BNACLP	2-Chlorophenol	3.8	3.8	1
	BNACLP	4-Chloro-3-methylphenol	2.1	2.1	1
	BNACLP	4-Nitrophenol	0.8	0.8	1
	BNACLP	Acenaphthene	15.4	15.4	1
	BNACLP	N-Nitroso-di-n-propylamine	4.1	4.1	1
	BNACLP	Pentachlorophenol	4.5	4.5	1
	BNACLP	Phenol	0.7	0.7	1
	BNACLP	Pyrene	7.0	7.0	1
Pesticides	PESTCLP	4,4'-DDT	3.2	3.2	1
	PESTCLP	Aldrin	2.8	2.8	1
	PESTCLP	Dibutyl chlorendate	2.1	2.1	1
	PESTCLP	Dieldrin	2.0	2.0	1
	PESTCLP	Endrin	2.0	2.0	1
	PESTCLP	gamma-BHC (Lindane)	0.8	0.8	1
	PESTCLP	Heptachlor	2.3	2.3	1
Volatiles	SW-846 8260 LOW LEVEL	1,1-Dichloroethene	0.8	0.8	1
	SW-846 8260 LOW LEVEL	Benzene	1.6	1.6	1
	SW-846 8260 LOW LEVEL	Chlorobenzene	1.4	1.4	1
	SW-846 8260 LOW LEVEL	Dibromofluoromethane	0.7	0.7	1
	SW-846 8260 LOW LEVEL	Toluene	1.4	1.4	1
	SW-846 8260 LOW LEVEL	Trichloroethene	1.0	1.0	1
	VOA524.2	1,1,1,2-Tetrachloroethane	1.1	1.1	1
	VOA524.2	1,1,1-Trichloroethane	0.2	0.2	1
	VOA524.2	1,1,2,2-Tetrachloroethane	1.4	1.4	1
	VOA524.2	1,1,2-Trichloroethane	1.8	1.8	1
	VOA524.2	1,1-Dichloroethane	0.8	0.8	1
	VOA524.2	1,1-Dichloroethene	0.2	0.2	1
	VOA524.2	1,1-Dichloropropene	0.8	0.8	1
	VOA524.2	1,2,3-Trichlorobenzene	1.4	1.4	1
	VOA524.2	1,2,3-Trichloropropane	0.9	0.9	1
	VOA524.2	1,2,4-Trichlorobenzene	0.7	0.7	1
	VOA524.2	1,2,4-Trimethylbenzene	0.5	0.5	1

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Analysis Group	Test Method	Analyte	Maximum RPD	Average RPD	Number of MS/MSD Pairs
	VOA524.2	1,2-Dibromo-3-chloropropane	2.6	2.6	1
	VOA524.2	1,2-Dibromoethane	1.5	1.5	1
	VOA524.2	1,2-Dichlorobenzene	0.2	0.2	1
	VOA524.2	1,2-Dichloroethane	0.4	0.4	1
	VOA524.2	1,2-Dichloropropane	2.2	2.2	1
	VOA524.2	1,3,5-Trimethylbenzene	0.2	0.2	1
	VOA524.2	1,3-Dichlorobenzene	1.4	1.4	1
	VOA524.2	1,3-Dichloropropane	0.9	0.9	1
	VOA524.2	1,4-Dichlorobenzene	1.1	1.1	1
Volatiles	VOA524.2	2,2-Dichloropropane	0.4	0.4	1
	VOA524.2	2-Chlorotoluene	0.2	0.2	1
	VOA524.2	4-Chlorotoluene	0.0	0.0	1
	VOA524.2	4-Isopropyltoluene	0.2	0.2	1
	VOA524.2	Benzene	0.4	0.4	1
	VOA524.2	Bromobenzene	1.6	1.6	1
	VOA524.2	Bromochloromethane	0.2	0.2	1
	VOA524.2	Bromodichloromethane	0.5	0.5	1
	VOA524.2	Bromoform	1.8	1.8	1
	VOA524.2	Bromomethane	0.7	0.7	1
	VOA524.2	Carbon Tetrachloride	0.2	0.2	1
	VOA524.2	Chlorobenzene	1.3	1.3	1
	VOA524.2	Chloroethane	0.6	0.6	1
	VOA524.2	Chloroform	0.4	0.4	1
	VOA524.2	Chloromethane	0.6	0.6	1
	VOA524.2	cis-1,2-Dichloroethene	1.5	1.5	1
	VOA524.2	cis-1,3-Dichloropropene	1.5	1.5	1
	VOA524.2	Dibromochloromethane	0.5	0.5	1
	VOA524.2	Dibromomethane	1.1	1.1	1
	VOA524.2	Dichlorodifluoromethane	0.6	0.6	1
	VOA524.2	Ethylbenzene	0.9	0.9	1
	VOA524.2	Hexachlorobutadiene	1.2	1.2	1
	VOA524.2	Isopropylbenzene	0.9	0.9	1
	VOA524.2	Methylene Chloride	1.9	1.9	1
	VOA524.2	Naphthalene	0.7	0.7	1
	VOA524.2	n-Butylbenzene	0.2	0.2	1
	VOA524.2	n-Propylbenzene	1.1	1.1	1
	VOA524.2	sec-Butylbenzene	0.2	0.2	1
	VOA524.2	Styrene	1.3	1.3	1
	VOA524.2	tert-Butylbenzene	0.2	0.2	1
	VOA524.2	Tetrachloroethene	0.4	0.4	1
	VOA524.2	Toluene	0.2	0.2	1
	VOA524.2	trans-1,2-Dichloroethene	0.4	0.4	1
	VOA524.2	trans-1,3-Dichloropropene	2.0	2.0	1

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Analysis Group	Test Method	Analyte	Maximum RPD	Average RPD	Number of MS/MSD Pairs
	VOA524.2	Trichloroethene	0.2	0.2	1
	VOA524.2	Trichlorofluoromethane	0.7	0.7	1
	VOA524.2	Vinyl Chloride	0.6	0.6	1
	VOA524.2	Xylene	0.4	0.4	1

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Table B-32
Groundwater Matrix Spike Recovery Summary

Analyte	Minimum Recovery	Maximum Recovery	Average Recovery	Number of MS and MSD Samples
1,1,1,2-Tetrachloroethane	92	116	105.20	5
1,1,1-Trichloroethane	95	117	106.00	5
1,1,2,2-Tetrachloroethane	85	115	104.60	5
1,1,2-Trichloroethane	95	114	104.00	5
1,1-Dichloroethane	99	124	111.80	5
1,1-Dichloroethene	69	148	104.24	21
1,1-Dichloropropene	99	124	112.00	5
1,2,3-Trichlorobenzene	102	114	107.20	5
1,2,3-Trichloropropane	86	116	104.20	5
1,2,4-Trichlorobenzene	73	116	99.57	7
1,2,4-Trimethylbenzene	97	110	104.20	5
1,2-Dibromo-3-chloropropane	95	113	104.20	5
1,2-Dibromoethane	85	118	102.40	5
1,2-Dichlorobenzene	91	115	107.80	5
1,2-Dichloroethane	98	119	110.20	5
1,2-Dichloropropane	95	118	106.40	5
1,3,5-Trimethylbenzene	99	111	107.20	5
1,3-Dichlorobenzene	97	111	105.20	5
1,3-Dichloropropane	96	113	106.00	5
1,4-Dichlorobenzene	78	114	100.17	6
2,2-Dichloropropane	89	117	104.80	5
2,4,6-Tribromophenol	70	79	74.50	2
2,4-Dinitrotoluene	86	89	87.50	2
2-Chlorophenol	61	71	66.00	2
2-Chlorotoluene	95	111	102.40	5
4,4'-DDT	58	66	62.00	2
4-Chloro-3-methylphenol	58	63	60.50	2
4-Chlorotoluene	100	114	109.40	5
4-Isopropyltoluene	97	111	107.00	5
4-Nitrophenol	29	30	29.50	2
Acenaphthene	45	85	65.00	2
Aldrin	68	76	72.00	2
Aluminum	94.3	341	143.59	12
Aluminum, dissolved	107.8	107.8	107.80	1
Ammonia	51	102	88.20	5
Ammonia (as nitrogen)	17	68.7	42.85	2
Antimony, dissolved	109.1	109.1	109.10	1
Antimony, non-isotopic	85.5	113	97.89	11
Arsenic	73	111	95.20	11
Arsenic, dissolved	114.8	114.8	114.80	1

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Analyte	Minimum Recovery	Maximum Recovery	Average Recovery	Number of MS and MSD Samples
Barium, dissolved	101.3	101.3	101.30	1
Barium, non-isotopic	88.8	101.8	96.81	11
Benzene	82	122	101.19	21
Beryllium	94.5	113.6	100.41	11
Beryllium, dissolved	100.2	100.2	100.20	1
Bicarbonate	92	98	95.00	2
Bromobenzene	99	114	107.20	5
Bromochloromethane	93	119	107.60	5
Bromodichloromethane	101	111	105.20	5
Bromoform	98	123	111.60	5
Bromomethane	94	114	106.00	5
Cadmium, dissolved	113.9	113.9	113.90	1
Cadmium, non-isotopic	95.1	112	102.06	11
Calcium	60	101.8	87.53	3
Carbon Tetrachloride	101	127	112.80	5
Carbonate	92	98	95.00	2
Cesium, dissolved	617	617	617.00	1
Cesium, non-isotopic	82	617	149.34	10
Chemical Oxygen Demand	112	112	112.00	1
Chloride	90	105.3	96.92	6
Chlorobenzene	85	117	99.43	21
Chloroethane	86	135	110.60	5
Chloroform	100	121	109.80	5
Chloromethane	97.7	127	115.14	5
Chromium	92.4	107.7	99.63	11
Chromium, dissolved	108.8	108.8	108.80	1
cis-1,2-Dichloroethene	105	121	110.60	5
cis-1,3-Dichloropropene	105	119	112.00	3
Cobalt, dissolved	108.4	108.4	108.40	1
Cobalt, non-isotopic	95.9	103.4	99.95	11
Copper	96.2	104.3	100.15	11
Copper, dissolved	104.2	104.2	104.20	1
Cyanide	28	123	82.80	5
Dibromochloromethane	97	111	105.80	5
Dibromofluoromethane	108	111	109.50	2
Dibromomethane	98	118	106.40	5
Dibutyl chlorendate	69	75	72.00	2
Dichlorodifluoromethane	111	166	142.00	5
Dieldrin	83	90	86.50	2
Endrin	85	92	88.50	2
Ethylbenzene	97	114	106.20	5
Fluoride	101	112	106.93	6
gamma-BHC (Lindane)	62	64	63.00	2

Analyte	Minimum Recovery	Maximum Recovery	Average Recovery	Number of MS and MSD Samples
Heptachlor	74	81	77.50	2
Hexachlorobutadiene	100	113	106.40	5
Iron, dissolved	108.8	108.8	108.80	1
Iron, non-isotopic	-33.1	166.3	97.57	13
Isopropylbenzene	96	110	105.00	5
Lead, dissolved	95	95	95.00	1
Lead, non-isotopic	92	113.5	101.17	11
Lithium	83	109.4	98.84	11
Lithium, dissolved	102.3	102.3	102.30	1
m,p-Xylene	99	111	103.33	3
Magnesium	64.5	102.1	88.93	3
Manganese, dissolved	107.1	107.1	107.10	1
Manganese, non-isotopic	61.6	102.2	93.74	11
Mercury, dissolved	108.5	108.5	108.50	1
Mercury, non-isotopic	82.7	139	107.13	12
Methylene Chloride	100	126	110.20	5
Molybdenum	92	102.6	98.58	11
Molybdenum, dissolved	104.8	104.8	104.80	1
Naphthalene	95	110	103.00	5
n-Butylbenzene	93	111	105.80	5
Nickel, dissolved	109.9	109.9	109.90	1
Nickel, non-isotopic	94.4	106	100.00	11
Nitrate / Nitrite	87	167	106.83	6
Nitrate / Nitrite (as nitrogen)	94	100.7	97.18	4
N-Nitroso-di-n-propylamine	34	40	37.00	2
n-Propylbenzene	95	113	105.20	5
Ortho-phosphate	96	96	96.00	1
Ortho-phosphate (as phosphorus)	95	100	98.00	3
o-Xylene	98	107	103.00	3
Pentachlorophenol	70	84	77.00	2
Phenol	33	34	33.50	2
Phosphate	98.3	104.7	101.80	5
Potassium, non-isotopic	95.6	100.4	98.37	3
Pyrene	65	86	75.50	2
sec-Butylbenzene	96	108	104.00	5
Selenium, dissolved	77	77	77.00	1
Selenium, non-isotopic	69	114	95.23	11
Silicon	102	483.9	251.04	8
Silicon, dissolved	77.5	77.5	77.50	1
Silver	88	112	97.65	11
Silver, dissolved	109.6	109.6	109.60	1
Sodium, non-isotopic	92.5	101.7	98.57	3

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Analyte	Minimum Recovery	Maximum Recovery	Average Recovery	Number of MS and MSD Samples
Strontium, dissolved	102.6	102.6	102.60	1
Strontium, non-isotopic	91.6	103	97.76	11
Styrene	98	115	107.80	5
Sulfate	85.56	115	99.27	7
tert-Butylbenzene	98	110	106.20	5
Tetrachloroethene	97	114	107.00	5
Thallium, dissolved	48.4	48.4	48.40	1
Thallium, non-isotopic	76.4	101	89.47	11
Tin, dissolved	107.5	107.5	107.50	1
Tin, non-isotopic	91	110	98.41	11
Toluene	83	117	101.38	21
Total Organic Carbon	94	96	95.00	2
trans-1,2-Dichloroethene	100	122	109.80	5
trans-1,3-Dichloropropene	99	118	108.67	3
Trichloroethene	77	117	97.95	21
Trichlorofluoromethane	86.3	114	99.86	5
Uranium, total	103.1	103.1	103.10	1
Vanadium	85.2	107.7	95.80	11
Vanadium, dissolved	111.4	111.4	111.40	1
Vinyl Chloride	94	124	111.40	5
Xylene	117	119	118.00	2
Zinc	95	106.4	100.78	11
Zinc, dissolved	113.8	113.8	113.80	1

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Table B-33
Groundwater Sensitivity Summary

Analysis Group	Test Method	Analyte	Maximum Detection Limit	WRW PRG 1E-06
Volatiles	SW-846 8260 LOW LEVEL	1,2-Dibromoethane	1	0.89
	SW-846 8260 LOW LEVEL	Carbon Disulfide	5	202777.78
	VOA524.2	1,2-Dibromoethane	1	0.89
	VOACLP	Carbon Disulfide	5	202777.78

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Table B-34
Groundwater Verification and Validation Summary

Validation Qualifier Code	Total of Analytes	Semivolatiles	Dissolved Metals	Total Metals	Dissolved Radionuclides	Total Radionuclides	Pesticides	Volatiles	Wet Chemistry
	187	0	97		0	3	0	47	4
A	228	2	0	36	139	67	0	20	0
J	621	22	213	0	14	0	28	166	15
R	68	1	4	2	9	7	0	43	2
UJ1	3	0	0	163	0	0	0	0	0
V	4166	244	1030	3	142	114	108	1810	134
V1	80	0	0	583	0	0	0	50	1
Y	522	159	84	25	57	51	56	45	14
Z	8	0	0	56	0	1	0	0	7
Total	5883	428	1428	868	361	243	192	2181	177
Verified	83	0	0	746	0	0	0	50	1
Percent Verified	1.41%	0.00%	0.00%	85.94%	0.00%	0.00%	0.00%	2.29%	0.56%
Validated	5724	427	1424	64	352	235	192	2088	167
Percent Validated	97.30%	99.77%	99.72%	7.37%	97.51%	96.71%	100.00%	95.74%	94.35%
Rejected	68	1	4	2	9	7	0	43	2
Percent Rejected	1.16%	0.23%	0.28%	0.23%	2.49%	2.88%	0.00%	1.97%	1.13%

Note:
Dissolved metals consisted of DMETADD and DSMETCLP
Total metals consisted of EPA 600, EPA SW-846 6020, METADD, and SMETCLP
Dissolved radsionuclides consisted of DRAD
Volatiles consisted of SW 846 8260 Low Level VOA 524.2, and VOACLP
Wet Chemistry consisted of EPA 300 and WQPL

DRAFT COMPREHENSIVE RISK ASSESSMENT

VOLUME 3: APPENDIX C
Statistical Analyses

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ACRONYMS

CRA	Comprehensive Risk Assessment
COC	chemical of concern
EPC	exposure point concentration
EU	exposure unit
PCOC	potential contaminant of concern
UCL	upper confidence limit of the mean
UTL	upper confidence limit of the 90^{th} percentile
WRS	Wilcoxon Rank Sum test

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1.0 INTRODUCTION

This document describes the statistical analyses used to select chemicals of concern (COCs) and to calculate exposure point concentrations (EPCs) for COCs. The COC selection process includes statistical procedures for a background comparison and for calculating EPCs, which are described in this appendix. The statistical methods used are documented in the Comprehensive Risk Assessment (CRA) Methodology (DOE 2004).

1.1 Overview of Statistical Procedures

The following statistical procedures are described:

- Determination of data distributions;
- Background comparisons;
- Calculation of the 95 percent upper confidence limit of the mean (UCL), used for the EPC in both human health and ecological assessments; and
- Calculation of the 95 percent upper confidence limit of the 90th percentile (UTL) used for the EPC for small home range receptors in ecological assessments.

Data distribution testing for Site and background data is conducted to identify the appropriate statistical methods and tests for the background analyses and EPC calculations. Distribution testing is performed using EPA supported software, ProUCL (Singh et al. 2004), as required by the CRA Methodology.

The background comparisons consist of two-sample tests that evaluate whether the mean or median for potential contaminant of concern (PCOC) in an exposure unit (EU) data set is significantly elevated over the corresponding background statistic. This is the 4th step in the COC selection process as documented in the CRA Methodology. Additional statistics or graphics may be used for comparison of EU and background data sets in the professional judgment step. The S-Plus statistical software package (Insightful 2002) is used for all calculations.

UCLs calculated by ProUCL may be used in the professional judgment step and are also used to determine EPCs for all chemicals that are retained as COCs. EPCs are chemical concentration estimates for EUs that are used in the risk characterization. UTLs for the small home range receptor assessments are calculated using the S-plus statistical package.

1.2 Data Distribution Testing

Data distribution testing is conducted according to EPA guidance (EPA 2002) and EPA QA/G-9 methods (EPA 2000), using the ProUCL (Version 3) computer program (Singh et al. 2004). ProUCL statistical software was developed for EPA's Technical Support Center to support risk assessment and cleanup decisions at contaminated sites.

ProUCL tests for normality, lognormality, gamma and nonparametric distribution of the data using the following statistical tests:

- Shapiro-Wilk W-Test ($n < 50$);
- Lilliefors Test ($n > 50$; note: can be used for $n < 50$ also);
- Anderson-Darling Test for gamma distribution ($n < 2{,}500$); and

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- Kolmogorov-Smirnov Test for gamma distribution (n < 2,500).

The ProUCL output recommends a distribution type for each tested dataset (Figure 1-1). The distributions, which are recommended by ProUCL, are used for subsequent analyses in the CRA.

1.3 Background Comparisons

Background comparisons are performed using the S-Plus statistical program. If the two data sets to be compared are both normally or lognormally distributed, the two-sample *t*-test is used; if the data sets have different distributions or have a nonparametric distribution, the Wilcoxon Rank Sum (WRS) test is used. The tests evaluate the null hypothesis that there is no difference between the population means (*t*-test) or medians (WRS test) of the background and EU data sets at the specified level of significance. As specified in the CRA Methodology, the level of significance to be used for the background comparisons in the CRA is 0.9. Examples of the S-Plus interface and output are shown in Figures1-2 and 1-3.

For chemicals that do not pass the statistical analysis, but are very similar to background or there is other evidence that the chemical may not be site-related, additional statistical evaluations may be performed. These may include visual comparisons using graphics such as box plots and comparison of descriptive statistics such as means, maximum detected concentrations, and UCLs.

1.4 Upper Confidence Limits

UCLs are estimated using ProUCL which computes parametric UCLs based on normal, lognormal or gamma distributions, and nonparametric UCLs using one of several nonparametric methods. ProUCL recommends the UCLs for use in the risk assessment, based upon the data distribution and the associated skewness. The UCL chosen by the ProUCL output is always used in the CRA, as called for in the CRA Methodology (Figure 1-1). EPCs are chemical concentration estimates for exposure areas that are used to evaluate risks in the CRA. EPCs are usually the 95 percent UCLs on the mean of site datasets. The UTLs are calculated using S-Plus.

1.5 Results for the West Area Exposure Unit

The results of the distribution testing, background comparisons, UCLs, and UTLs for inorganics and radionuclides for surface soil, sediment, and subsurface soil are shown in Tables C.1 through C.3.

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Figure 1-1 ProUCL Output

Data File	H:\Projects\FY2005\SiteData\WestArea\WestArea_SS_SITE.xls	
Variable:	Aluminum	
Raw Statistics		
Number of Observations	10	
Number of Missing Data	0	
Number of Valid Observations	10	
Number of Distinct Observations	7	
Minimum	8200	
Maximum	18000	
Mean	13520	
Standard Deviation	3168.1751	
Variance	10037333	
Coefficient of Variation	0.2343325	
Skewness	-0.065174	
Too Few Distinct Observations?	NO	
Normal Statistics		
Lilliefors Test Statistic	N/R	Shapiro Wilk method yields a more accurate result
Lilliefors 5% Critical Value	N/R	Shapiro Wilk method yields a more accurate result
Shapiro-Wilk Test Statistic	0.9587479	
Shapiro-Wilk 5% Critical Value	0.842	
5% Normality Test Result	NORMAL	Data are normal at 5% significance level
95% Student's-t UCL	15356.531	
Gamma Statistics		
k hat	19.081819	
k star (bias corrected)	13.42394	
Theta hat	708.52786	
Theta star	1007.1559	
nu hat	381.63637	
nu star	268.47879	
5% Approximate Chi Square Value	231.52659	
Adjusted Level of Significance	0.0267	
Adjusted Chi Square Value	225.5588	
Anderson-Darling Test Statistic	0.2323412	
Anderson-Darling 5% Critical Value	0.7245968	
Anderson-Darling 5% Gamma Test Result	AD GAMMA	Data follow gamma distribution at 5% significance level.
Kolmogrov-Smirnov Test Statistic	0.1322589	
Kolmogrov-Smirnov 5% Critical Value	0.2662122	
Kolmogrov-Smirnov 5% Gamma Test Result	KS GAMMA	Data follow gamma distribution at 5% significance level
5% Gamma Test Result	GAMMA	Data follow gamma distribution at 5% significance level
95% Approximate Gamma UCL	15677.825	
95% Adjusted Gamma UCL	16092.626	
Lognormal Statistics		
Minimum of log data	9.0118894	
Maximum of log data	9.798127	
Mean of log data	9.4854936	
Standard Deviation of log data	0.2473439	
Variance of log data	0.061179	
Lilliefors Test Statistic	N/R	Shapiro Wilk method yields a more accurate result
Lilliefors 5% Critical Value	N/R	Shapiro Wilk method yields a more accurate result
Shapiro-Wilk Test Statistic	0.9485927	
Shapiro-Wilk 5% Critical Value	0.842	
5% Lognormality Test Result	LOGNORMAL	Data are lognormal at 5% significance level
MLE Mean	13576.33	
MLE Standard Deviation	3410.0427	
MLE Coefficient of Variation	0.2511756	
MLE Skewness	0.7693733	
MLE Median	13167.324	
MLE 80% Quantile	16228.093	
MLE 90% Quantile	18093.906	
MLE 95% Quantile	19778.965	
MLE 99% Quantile	23407.586	
MVU Estimate of Median	13127.096	
MVU Estimate of Mean	13533.936	
MVU Estimate of Standard Deviation	3364.1695	
MVU Estimate of SE of Mean	1063.7119	
95% H-UCL	15910.591	
95% Chebyshev (MVUE) UCL	18170.549	
97.5% Chebyshev (MVUE) UCL	20176.815	
99% Chebyshev (MVUE) UCL	24117.737	
Non-parametric Statistics		
95% CLT UCL	15167.921	
95% Adjusted-CLT UCL	15145.858	
95% Modified-t UCL	15353.09	
95% Jackknife UCL	15356.531	
95% Chebyshev (Mean, Sd) UCL	17887.028	
97.5% Chebyshev (Mean, Sd) UCL	19776.644	
99% Chebyshev (Mean, Sd) UCL	23488.43	
Bootstrap Statistics		
Number of Bootstrap Runs	2000	
95% Standard Bootstrap UCL	15053.705	
95% Bootstrap-t UCL	15497.1	
95% Hall's Bootstrap UCL	15420.872	
95% Percentile Bootstrap UCL	15020	
95% BCA Bootstrap UCL	15000	
Recommendations		
Human Inspection Recommended?	NO	
Appropriate Distribution	NORMAL	
1st Recommended UCL	15356.531	95% Student's-t UCL
2nd Recommended UCL		
3rd Recommended UCL		
Recommended UCL > Max Data Value		
Recommendation Warning!	NONE	
Alternative UCL	NONE	

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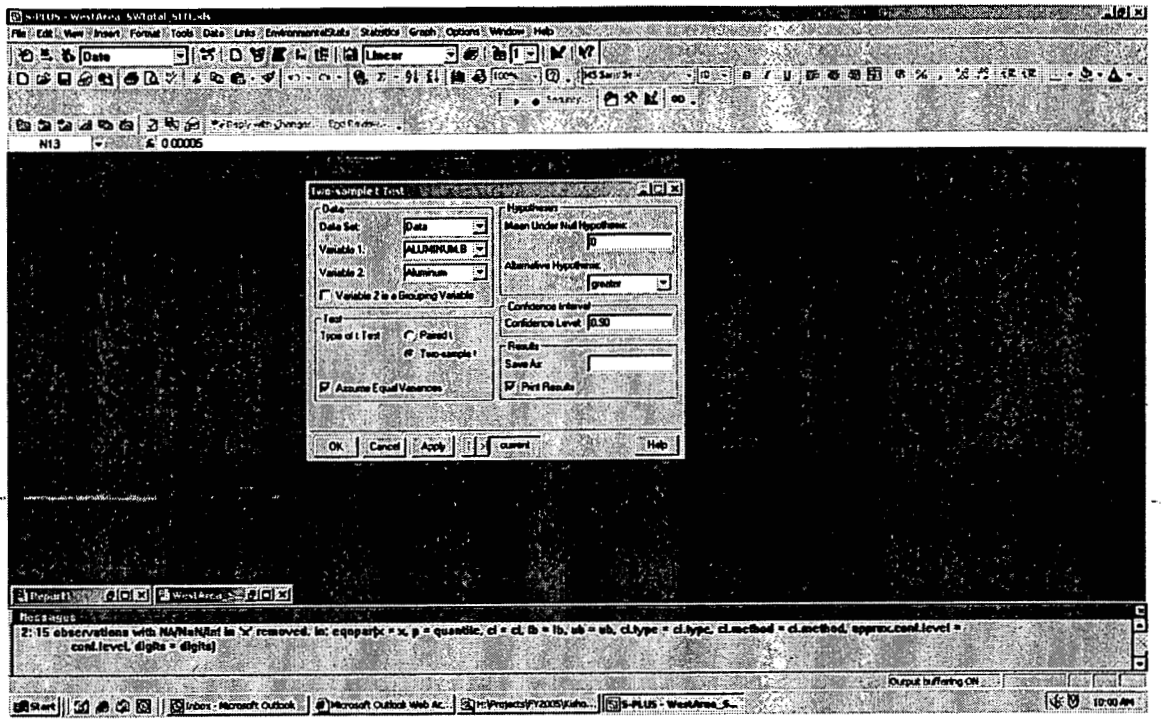
Figure 1-2 Example of Student's t-test Dialog Box



Results of Hypothesis Test

Null Hypothesis:	difference in means = 0
Alternative Hypothesis	True difference in means is greater than 0
Test Name:	Standard Two-Sample t-Test
Estimated Parameter(s):	mean of x = 0.7035975
	mean of y = 9.656868
Data:	x: ALUMINUM.BKGD in Data , and y: Aluminum in Data
Test Statistic:	t = -4.171769
Test Statistic Parameter:	df = 148
P-value:	0.9999743
90% Confidence Interval	LCL = -11.71601
	UCL = NA

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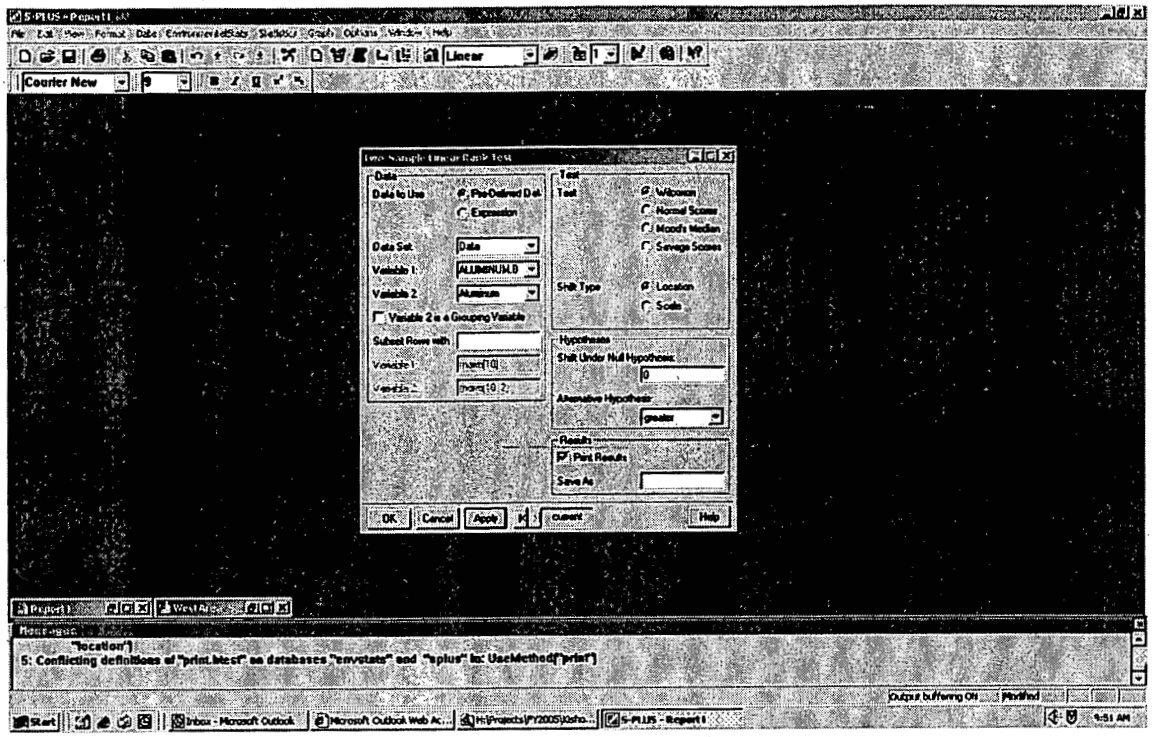
Figure 1-3 Example of Wilcoxon Rank Sum Dialog Box



Results of Hypothesis Test

Null Hypothesis:	Fy(t) = Fx(t)
Alternative Hypothesis:	Fy(t) > Fx(t) for at least one t
Test Name:	Two-Sample Linear Rank Test:
	Wilcoxon Rank Sum Test
	Based on Normal Approximation
Data:	x = ALUMINUM.BKGD
	y = Aluminum
Parent of Data:	Data
Sample Sizes:	nx = 99
	ny = 51
Number NA/NaN/Inf's:	x = 15
	y = 63
Test Statistic:	z = -6.848628
P-value:	1

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2.0 REFERENCES

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EPA, 2000, Guidance for Data Quality Assessment: Practical Methods for Data Analysis, QA/G-9, EPA/600-R-96/084, U.S. Environmental Protection Agency, Washington, D.C., September

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Singh, and R.W. Maichle, 2004, ProUCL Version 3.0 Users Guide, Las Vegas, Nevada, April.

Insightful Corporation, 2002, S-Plus 6 for Windows, Seattle, WA.

Table C.1 WAEU Surface Soil Data Distributions and Background Comparisons

Analyte	Total Samples		Statistical Distribution Testing Results								Comparison Test			Max Detect	UTL
			Background				WAEU								
	Back-ground	WAEU	Distribution Recommended by ProUCL	UCL Recommended by ProUCL	UCL Value	Detcects %	Distribution Recommended by ProUCL	UCL Recommended by ProUCL	UCL Value	Detcects %	Test	p Value	Decision		Result
Inorganic (mg/kg)															
Aluminum	20	10	NORMAL	95% Student's-t UCL	11716	100	NORMAL	95% Student's-t UCL	15357	100	t-Test_N	0.9885	**Not BKG**	18000	20980
Antimony	20	10	GAMMA	95% Approximate Gamma UCL	0.36	5	NON-PARAMETRIC	95% Student's-t UCL	0.30	20	WRS	0.0011	BKG	0.60	0.6
Arsenic	20	10	NORMAL	95% Student's-t UCL	6.89	100	GAMMA	95% Approximate Gamma UCL	11.6	100	WRS	0.9327	**Not BKG**	22	22
Barium	20	10	NON-PARAMETRIC	95% Student's-t UCL	110	100	NORMAL	95% Student's-t UCL	123	100	WRS	0.8336	BKG	140	140
Beryllium	20	10	NORMAL	95% Student's-t UCL	0.72	100	NORMAL	95% Student's-t UCL	0.42	40	t-Test_N	0.0000	BKG	0.52	0.59
Boron	N/A	10	N/A	N/A	N/A	NA	NORMAL	95% Student's-t UCL	5.80	100	WRS	N/A	N/A	7.1	7.1
Cadmium	20	10	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	1.16	70	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	0.11	0	WRS	0.0000	BKG	N/A	0.18
Calcium	20	10	NORMAL	95% Student's-t UCL	3263	100	GAMMA	95% Approximate Gamma UCL	2959	100	WRS	0.0047	BKG	4600	4600
Chromium	20	10	NORMAL	95% Student's-t UCL	12.6	100	NORMAL	95% Student's-t UCL	14.8	100	t-Test_N	0.9501	**Not BKG**	17	19.5
Cobalt	20	10	NORMAL	95% Student's-t UCL	8.07	100	NORMAL	95% Student's-t UCL	5.58	100	t-Test_N	0.0006	BKG	6.40	7.24
Copper	20	10	NON-PARAMETRIC	95% Student's-t UCL	14.0	100	NORMAL	95% Student's-t UCL	11.0	100	WRS	0.0007	BKG	13.00	13
Iron	20	10	NORMAL	95% Student's-t UCL	13960	100	NORMAL	95% Student's-t UCL	14589	100	t-Test_N	0.6498	BKG	16000	18874
Lead	20	10	NORMAL	95% Student's-t UCL	37.7	100	NORMAL	95% Student's-t UCL	37.1	100	t-Test_N	0.2273	BKG	48	57.2
Lithium	20	10	NORMAL	95% Student's-t UCL	8.54	100	NORMAL	95% Student's-t UCL	10.3	100	t-Test_N	0.9744	**Not BKG**	12	13.4
Magnesium	20	10	NORMAL	95% Student's-t UCL	2110	100	NORMAL	95% Student's-t UCL	2170	100	t-Test_N	0.4879	BKG	2500	2936
Manganese	20	10	NORMAL	95% Student's-t UCL	264	100	NORMAL	95% Student's-t UCL	292	100	t-Test_N	0.8108	BKG	320	391
Mercury	20	10	NON-PARAMETRIC	95% Student's-t UCL	0.08	40	NORMAL	95% Student's-t UCL	0.03	100	WRS	0.0000	BKG	0.03	0.03
Molybdenum	20	10	NORMAL	95% Student's-t UCL	0.67	10	NORMAL	95% Student's-t UCL	0.73	100	t-Test_N	0.6264	BKG	0.91	1.08
Nickel	20	10	NORMAL	95% Student's-t UCL	10.7	100	NORMAL	95% Student's-t UCL	9.73	100	t-Test_N	0.1770	BKG	11	12.6
Potassium	20	10	NORMAL	95% Student's-t UCL	2260	100	NORMAL	95% Student's-t UCL	2314	100	t-Test_N	0.4354	BKG	2800	3122
Selenium	20	10	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	0.95	65	NON-PARAMETRIC	95% Student's-t UCL	0.47	0	WRS	0.0933	BKG	N/A	0.55
Silver	20	10	NORMAL	95% Student's-t UCL	0.21	0	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	0.16	10	WRS	0.0000	BKG	0.12	0.20
Sodium	20	10	NORMAL	95% Student's-t UCL	69.7	100	NON-PARAMETRIC	95% Student's-t UCL	117	20	WRS	0.9863	**Not BKG**	N/A	200
Strontium	20	10	NORMAL	95% Student's-t UCL	32.5	100	NON-PARAMETRIC	95% Student's-t UCL	22.7	100	WRS	0.0138	BKG	24	24
Thallium	16	10	NORMAL	95% Student's-t UCL	0.42	0	NON-PARAMETRIC	95% Student's-t UCL	0.72	10	WRS	0.9959	**Not BKG**	1.3	1.3
Tin	20	10	GAMMA	95% Approximate Gamma UCL	2.65	10	NON-PARAMETRIC	95% Student's-t UCL	0.84	0	WRS	0.0000	BKG	N/A	1.1
Titanium	N/A	10	N/A	N/A	N/A	NA	NORMAL	95% Student's-t UCL	270	100	WRS	N/A	N/A	320.0	320
Uranium	N/A	10	N/A	N/A	N/A	NA	NON-PARAMETRIC	95% Student's-t UCL	0.79	0	WRS	N/A	N/A	N/A	0.85
Radionuclides (ug/kg)															
Americium-241	50	10	GAMMA	95% Approximate Gamma UCL	0.01	100	NORMAL	95% Student's-t UCL	0.05	100	WRS	0.9086	**Not BKG**	0.08	0.08
Plutonium-239/240	50	10	GAMMA	95% Approximate Gamma UCL	0.04	100	NORMAL	95% Student's-t UCL	0.12	100	WRS	0.7716	BKG	0.25	0.25
Uranium-233/234	20	10	NON-PARAMETRIC	95% Student's-t UCL	1.32	100	LOGNORMAL	95% Student's-t UCL	1.01	100	WRS	0.1087	BKG	1.27	1.27
Uranium-235	20	10	GAMMA	95% Approximate Gamma UCL	0.06	100	NORMAL	95% Student's-t UCL	0.13	100	WRS	0.6540	BKG	0.19	0.19
Uranium-238	20	10	NON-PARAMETRIC	95% Student's-t UCL	1.27	100	GAMMA	95% Approximate Gamma UCL	1.19	100	WRS	0.1046	BKG	1.7	1.7
Vanadium	20	10	NORMAL	95% Student's-t UCL	31.2	100	NORMAL	95% Student's-t UCL	30.9	100	t-Test_N	0.4944	BKG	34	39.9
Zinc	20	10	NORMAL	95% Student's-t UCL	54.5	100	NORMAL	95% Student's-t UCL	42.2	100	t-Test_N	0.0034	BKG	50	58.2

UCL = The 95 percent upper confidence limit of the mean concentration.
t-Test_N = t-test for normally distributed data.
WRS = Wilcxon Rank Sum Test for data sets that have different distibutions or are both non-parametric.
UTL = The 905th upper confidence limit of the 90th percentile concentration.

Table C.2 WAEU Sediment Soil Data Distributions and Background Comparisons

Analyte	Total Samples		Statistical Distribution Testing Results								Comparison Test			Max Detect	UTL
			Background				WAEU								
	Back-ground	WAEU	Distribution Recommended by ProUCL	UCL Recommended by ProUCL	UCL Value	Detcects %	Distribution Recommended by ProUCL	UCL Recommended by ProUCL	UCL Value	Detcects %	Test	p Value	Decision		Result
Inorganic (mg/kg)															
Aluminum	40	10	GAMMA	95% Approximate Gamma UCL	7243	100	NORMAL	95% Student's-t UCL	13028	100	WRS	0.9859	**Not BKG**	19400	19400
Antimony	35	10	LOGNORMAL	95% H-UCL	3.62	9	NORMAL	95% Student's-t UCL	7.4	20	WRS	0.3114	BKG	12.4	12.4
Arsenic	40	10	GAMMA	95% Approximate Gamma UCL	3.12	92	GAMMA	95% Approximate Gamma UCL	4.5	100	WRS	0.9617	**Not BKG**	5.3	5.3
Barium	38	10	GAMMA	95% Approximate Gamma UCL	97.4	100	NORMAL	95% Student's-t UCL	145	100	WRS	0.8196	BKG	244	244
Beryllium	38	10	LOGNORMAL	95% H-UCL	0.948	37	GAMMA	95% Approximate Gamma UCL	0.761	60	WRS	0.0607	BKG	1.4	1.4
Cadmium	34	10	LOGNORMAL	95% H-UCL	0.655	9	NORMAL	95% Student's-t UCL	0.74	30	WRS	0.0009	BKG	1.3	1.3
Calcium	40	10	GAMMA	95% Approximate Gamma UCL	6210	98	NORMAL	95% Student's-t UCL	3548	100	WRS	0.6237	BKG	4800	4800
Cesium	37	10	GAMMA	95% Approximate Gamma UCL	103	16	LOGNORMAL	99% Chebyshev (MVUE) UCL	123	10	WRS	0.0006	BKG	4.9	138
Cesium-137	23	8	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	0.551	100	GAMMA	95% Approximate Gamma UCL	1.22	100	WRS	0.8288	BKG	1.5	1.5
Chromium	40	10	GAMMA	95% Approximate Gamma UCL	10.4	75	NORMAL	95% Student's-t UCL	14.5	100	WRS	0.9049	**Not BKG**	24.8	24.8
Cobalt	40	10	GAMMA	95% Approximate Gamma UCL	6.11	70	NORMAL	95% Student's-t UCL	7.87	100	WRS	0.9129	**Not BKG**	10.1	10.1
Copper	40	10	GAMMA	95% Approximate Gamma UCL	13.5	73	NORMAL	95% Student's-t UCL	18.8	90	WRS	0.8429	BKG	25.9	25.9
Iron	40	10	GAMMA	95% Approximate Gamma UCL	10416	100	NORMAL	95% Student's-t UCL	16660	100	WRS	0.9894	**Not BKG**	23400	23400
Lead	40	10	LOGNORMAL	95% H-UCL	43.4	100	NORMAL	95% Student's-t UCL	18.6	100	WRS	0.5435	BKG	25.5	25.5
Lithium	38	10	GAMMA	95% Approximate Gamma UCL	9.07	74	NORMAL	95% Student's-t UCL	11.8	100	WRS	0.4245	BKG	20.3	20.3
Magnesium	40	10	GAMMA	95% Approximate Gamma UCL	1867	90	NORMAL	95% Student's-t UCL	2926	100	WRS	0.9738	**Not BKG**	4330	4330
Manganese	40	10	GAMMA	95% Approximate Gamma UCL	318	100	NORMAL	95% Student's-t UCL	309	100	WRS	0.7553	BKG	470	470
Mercury	33	10	LOGNORMAL	95% H-UCL	0.103	6	NORMAL	95% Student's-t UCL	0.078	0	WRS	0.0013	BKG	N/A	N/A
Molybdenum	39	10	GAMMA	95% Approximate Gamma UCL	5.97	23	NORMAL	95% Student's-t UCL	1.66	30	WRS	0.0001	BKG	2.4	2.4
Nickel	38	10	GAMMA	95% Approximate Gamma UCL	8.75	66	NORMAL	95% Student's-t UCL	12.4	90	WRS	0.8885	BKG	17.6	17.6
Potassium	39	10	GAMMA	95% Approximate Gamma UCL	1072	74	NORMAL	95% Student's-t UCL	1740	100	WRS	0.9778	**Not BKG**	2890	2890
Selenium	40	10	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	0.947	25	GAMMA	95% Approximate Gamma UCL	0.288	0	WRS	0.0001	BKG	N/A	N/A
Silver	36	9	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	1.13	6	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	1.40	11	WRS	0.0003	BKG	2	2
Sodium	40	10	GAMMA	95% Approximate Gamma UCL	164	8	NORMAL	95% Student's-t UCL	341	100	WRS	0.9944	**Not BKG**	559	559
Strontium	39	10	GAMMA	95% Approximate Gamma UCL	56.1	85	NORMAL	95% Student's-t UCL	30	100	WRS	0.2926	BKG	41.2	41.2
Thallium	33	10	GAMMA	95% Approximate Gamma UCL	0.372	3	NORMAL	95% Student's-t UCL	0.318	10	WRS	0.0014	BKG	0.4	0.4
Tin	36	10	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	38.4	30	GAMMA	95% Approximate Gamma UCL	13.0	30	WRS	0.0059	BKG	17.5	22.9
Vanadium	38	10	GAMMA	95% Approximate Gamma UCL	22.5	92	NORMAL	95% Student's-t UCL	34	100	WRS	0.9754	**Not BKG**	51.9	51.9
Zinc	40	10	GAMMA	95% Approximate Gamma UCL	48.1	95	GAMMA	95% Approximate Gamma UCL	475	100	WRS	0.9970	**Not BKG**	720	720
Radionuclides (ug/kg)															
Americium-241	26	8	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	0.686	100	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	0.061	75	WRS	0.5963	BKG	0.09	0.09
Gross Alpha	30	8	GAMMA	95% Approximate Gamma UCL	26.0	100	NORMAL	95% Student's-t UCL	48.2	100	WRS	0.9905	**Not BKG**	72	72
Gross Beta	29	8	NORMAL	95% Student's-t UCL	36.7	100	NORMAL	95% Student's-t UCL	48.3	100	t-Test_N	0.9927	**Not BKG**	59	62.4
Plutonium-239/240	30	8	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	2.16	97	NORMAL	95% Student's-t UCL	0.02	100	WRS	0.5921	BKG	0.04	0.04
Radium-226	14	4	NORMAL	95% Student's-t UCL	0.841	100	NORMAL	95% Student's-t UCL	1.88	100	t-Test_N	0.9351	**Not BKG**	1.8	3.95
Radium-228	13	4	NORMAL	95% Student's-t UCL	1.90	100	NORMAL	95% Student's-t UCL	4.04	100	t-Test_N	0.9430	**Not BKG**	4.1	8.18
Strontium-89/90	29	8	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	0.353	100	NORMAL	95% Student's-t UCL	0.278	75	WRS	0.9416	**Not BKG**	0.319	0.319
Uranium-233/234	33	8	GAMMA	95% Approximate Gamma UCL	2.17	100	NORMAL	95% Student's-t UCL	2.37	100	WRS	0.7341	BKG	3.08	3.08
Uranium-235	34	8	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	0.096	100	NORMAL	95% Student's-t UCL	0.093	100	WRS	0.7070	BKG	0.14	0.14
Uranium-238	26	8	GAMMA	95% Approximate Gamma UCL	1.94	100	NORMAL	95% Student's-t UCL	2.28	100	WRS	0.8351	BKG	2.81	2.81

UCL = The 95 percent upper confidence limit of the mean concentration.
t-Test_N = t-test for normally distributed data.
WRS = Wilcxon Rank Sum Test for data sets that have different distibutions or are both non-parametric.
UTL = The 905th upper confidence limit of the 90th percentile concentration.

Table C.3 WAEU Subsurface Soil Data Distributions and Background Comparisons

Analyte	Total Samples		Statistical Distribution Testing Results								Comparison Test			Max Detect	UTL
			Background				WAEU								
	Back	WAEU	Distribution Recommended by ProUCL	UCL Recommended by ProUCL	UCL Value	Detects %	Distribution Recommended by ProUCL	UCL Recommended by ProUCL	UCL Value	Detects %	Test	p Value	Decision		Result
Inorganics (mg/kg)															
Aluminum	98	7	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	17704	99	NORMAL	95% Student's-t UCL	12641	100	WRS	0.1505	BKG	15400	15400
Antimony	66	7	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	6.5	15	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	6	0	WRS	0.0657	BKG	N/A	5.9
Arsenic	99	7	GAMMA	95% Approximate Gamma UCL	4.17	71	GAMMA	95% Approximate Gamma UCL	4.42	100	WRS	0.6991	BKG	5.9	5.9
Barium	99	7	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	138	89	NORMAL	95% Student's-t UCL	55.6	100	WRS	0.0080	BKG	64	64
Beryllium	99	7	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	6.75	82	NORMAL	95% Student's-t UCL	0.918	100	WRS	0.0001	BKG	1.20	1.20
Cadmium	81	7	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	0.727	7	NON-PARAMETRIC	95% Student's-t UCL	0.421	0	WRS	0.0007	BKG	N/A	0.50
Calcium	99	7	LOGNORMAL	95% H-UCL	7068	99	NORMAL	95% Student's-t UCL	1968	100	WRS	0.0001	BKG	3160	3160
Cesium	95	7	NON-PARAMETRIC	95% Student's-t UCL	153	1	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	5.79	29	WRS	0.0000	BKG	1.7	4.4
Chromium	99	7	LOGNORMAL	95% H-UCL	20.4	85	GAMMA	95% Approximate Gamma UCL	18.6	100	WRS	0.6742	BKG	22.8	22.8
Cobalt	99	7	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	9.57	22	NORMAL	95% Student's-t UCL	9.59	100	WRS	0.9496	**Not BKG**	13.7	13.7
Copper	99	7	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	18.2	95	NORMAL	95% Student's-t UCL	10.8	100	WRS	0.0929	BKG	12.5	12.5
Iron	99	7	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	20340	100	NORMAL	95% Student's-t UCL	13742	100	WRS	0.0619	BKG	18100	18100
Lead	99	7	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	13.9	99	NORMAL	95% Student's-t UCL	9.83	100	WRS	0.0744	BKG	13.9	13.9
Lithium	99	7	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	13.7	62	NORMAL	95% Student's-t UCL	6.87	100	WRS	0.0043	BKG	7.8	7.8
Magnesium	99	7	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	4275	96	NORMAL	95% Student's-t UCL	1923	100	WRS	0.0017	BKG	3160	3160
Manganese	99	7	LOGNORMAL	95% H-UCL	230	100	GAMMA	95% Approximate Gamma UCL	209	100	WRS	0.4343	BKG	295	295
Mercury	86	7	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	0.351	26	GAMMA	95% Approximate Gamma UCL	0.07	14	WRS	0.0002	BKG	0.1	0.1
Molybdenum	99	7	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	14.7	51	NORMAL	95% Student's-t UCL	1.89	0	WRS	N/A	Not BKG	N/A	N/A
Nickel	96	7	GAMMA	95% Approximate Gamma UCL	22.3	85	NORMAL	95% Student's-t UCL	9.96	86	WRS	0.0012	BKG	12.6	12.6
Potassium	98	7	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	2313	52	NORMAL	95% Student's-t UCL	963	100	WRS	0.2242	BKG	1010	1010
Selenium	82	7	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	1.47	4	NORMAL	95% Student's-t UCL	0.272	14	WRS	0.0008	BKG	0.39	0.39
Silver	83	7	NON-PARAMETRIC	97.5% Chebyshev (Mean, Sd) UCL	12.1	40	NON-PARAMETRIC	95% Student's-t UCL	0.363	0	WRS	0.0000	BKG	N/A	N/A
Sodium	99	7	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	488	17	NON-PARAMETRIC	99% Chebyshev (Mean, Sd) UCL	911	100	WRS	0.0062	BKG	559	559
Strontium	99	7	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	73.2	36	GAMMA	95% Approximate Gamma UCL	31	100	WRS	0.0062	BKG	45	45
Strontium-89/90	99	2	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	0.188	100	N/A	Too Few Observations	N/A	100	WRS	0.6155	BKG	0.133	0.133
Thallium	75	7	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	0.768	4	GAMMA	95% Approximate Gamma UCL	0.11	0	WRS	0.0000	BKG	N/A	N/A
Tin	92	7	NON-PARAMETRIC	97.5% Chebyshev (Mean, Sd) UCL	135	27	NON-PARAMETRIC	99% Chebyshev (Mean, Sd) UCL	69.5	29	WRS	0.0075	BKG	33.9	33.9
Vanadium	99	7	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	44	98	NORMAL	95% Student's-t UCL	27.7	100	WRS	0.0465	BKG	36.1	36.1
Zinc	98	7	NON-PARAMETRIC	97.5% Chebyshev (Mean, Sd) UCL	68.7	93	NORMAL	95% Student's-t UCL	19.3	57	WRS	0.0059	BKG	26.9	26.9
Radionuclides (pCi/g															
Americium-241	28	5	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	0.004	100	NORMAL	95% Student's-t UCL	0.01	20	WRS	0.9981	**Not BKG**	0.013	0.013
Gross Alpha	99	2	NORMAL	95% Student's-t UCL	26.5	100	N/A	Too Few Observations	N/A	100	WRS	0.0939	BKG	21.10	21.10
Gross Beta	99	2	NORMAL	95% Student's-t UCL	25.7	100	N/A	Too Few Observations	N/A	100	WRS	0.0681	BKG	20.6	20.6
Plutonium-239/240	99	5	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	0.007	100	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	0.035	20	WRS	0.4433	BKG	0.032	0.032
Uranium-233/234	99	5	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	1.19	100	NORMAL	95% Student's-t UCL	2.08	100	WRS	0.9995	**Not BKG**	2.3	2.3
Uranium-235	99	5	NON-PARAMETRIC	95% Chebyshev (Mean, Sd) UCL	0.042	100	NORMAL	95% Student's-t UCL	0.088	20	WRS	0.9994	**Not BKG**	0.1	0.1
Uranium-238	99	5	NON-PARAMETRIC	95% Student's-t UCL	0.796	100	NORMAL	95% Student's-t UCL	2.1	100	WRS	0.9990	**Not BKG**	2.3	2.3

UCL = The 95 percent upper confidence limit of the mean concentration.
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WRS = Wilcxon Rank Sum Test for data sets that have different distibutions or are both non-parametric.
UTL = The 905th upper confidence limit of the 90th percentile concentration.