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

Volume 15B1 of 15

Risk Assessment for the Aquatic Exposure Units: No Name Gulch Aquatic Exposure Unit, Rock Creek Aquatic Exposure Unit, McKay Ditch Aquatic Exposure Unit, Southeast Aquatic Exposure Unit

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for the U.S. Department of Energy

ADMIN RECORD

October 2005

1/434

SW-A-005560

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ACRONYMS AND ABBREVIATIONS

µg/kg	micrograms per kilogram
µg/L	micrograms per liter
AET	apparent effects threshold
AEU	aquatic exposure unit
AT	alternative toxicity value
AVS	acid volatile sulfides
BZ	buffer zone
CAD/ROD	corrective action decision/record of decision
CD	compact disc
CDH	Colorado Department of Health
CDPHE	Colorado Department of Public Health and Environment
cfs	cubic feet per second
CNHP	Colorado Natural Heritage Program
CRA	comprehensive risk assessment
DOE	U.S. Department of Energy
DQA	data quality assessment
DQO	data quality objective
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
ERM	effects range moderate

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ESL	ecological screening level
EU	exposure unit
HQ	hazard quotient
HRR	historical release report
IA	industrial area
IAEU	industrial area exposure unit
IAG	interagency agreement
IHSS	individual hazardous substance site
K-H	Kaiser-Hill Company, L.L.C.
LEL	lowest effect level
LOAEL	lowest observed adverse effect level
LOE	line of evidence
MDC	maximum detected concentration
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MIDEQ	Michigan Department of Environmental Quality
MK AEU	McKay Ditch aquatic exposure unit
NAWQC	National Ambient Water Quality Criteria
NEC	no-effect concentration
NFAA	no further accelerated action
NN AEU	No Name Gulch aquatic exposure unit
NOAEL	no observed adverse effect level
NPDES	National Pollutant Discharge Elimination System
NW AEU	North Walnut Creek aquatic exposure unit

OC	organic carbon
OU	operable unit
PAC	potential area of concern
PCB	polychlorinated biphenyl
pCi/kg	picocuries per kilogram
pCi/L	picocuries per liter
PCOC	potential contaminant of concern
PEL	probable effects level
PMJM	Preble's meadow jumping mouse
ppm	parts per million
PRG	preliminary remediation goal
PVC	polyvinyl chloride
QAPP	quality assurance project plan
RC AEU	Rock Creek aquatic exposure unit
RCRA	Resource Conservation and Recovery Act
RFCA	Rocky Flats cleanup agreement
RFETS	Rocky Flats environmental technology site
RI/FS	remedial investigation/feasibility study
SAP	sampling and analysis plan
SCM	site conceptual model
SE AEU	Southeast aquatic exposure unit
SEC	sediment effect concentration
SID	South Interceptor Ditch
SQG	sediment quality guideline

SW AEU	South Walnut Creek aquatic exposure unit
TCDD	tetrachlorodibenzo-para-dioxin
TEC	threshold effect concentration
TEF	toxicity equivalency factor
TEL	toxic effects level
TEQ	toxicity equivalency quotient
TNRCC	Texas Natural Resource Conservation Commission
TOC	total organic carbon
UBC	under building contamination
UCL	upper confidence limit
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
UTL	upper tolerance limit
WC AEU	Woman Creek aquatic exposure unit
WRS	Wilcoxon rank sum

EXECUTIVE SUMMARY

This report presents the Ecological Risk Assessment (ERA) for the Aquatic Exposure Units (AEUs) at the Rocky Flats Environmental Technology Site (RFETS). The AEUs represent a logical framework for evaluating risks to populations of aquatic receptors from exposure to surface water and sediment within aquatic systems at RFETS. Seven AEUs were defined through the consultative process with the regulatory agencies (Figure 1.1): the North Walnut Creek AEU (NW AEU), South Walnut Creek AEU (SW AEU), Woman Creek AEU (WC AEU), No Name Gulch AEU (NN AEU), Rock Creek AEU (RC AEU), McKay Ditch AEU (MK AEU), and Southeast AEU (SE AEU). This report presents the CRA for the following four AEUs: the NN AEU, RC AEU, MK AEU, and SE AEU. The remaining AEUs are addressed in Appendix A, Volume 15B2 of the RI/FS Report.

The RC AEU, MK AEU, and SE AEU are located in buffer zone areas of the site away from where the main industrial activities occurred. The RC AEU is currently a U.S. Fish and Wildlife Service (USFWS) preserve. The NN AEU is downgradient from the former landfill, but was hydrologically separated from the landfill retaining pond. Therefore, these AEUs were expected to have relatively low potential for environmental contamination compared to the AEUs adjacent to the industrial area.

The overall risk management goal identified for developing this ERA is that residual contamination should not represent significant risk of adverse ecological effects to receptors. For the AEU aquatic species, the assessment endpoints for this goal included the prevention of adverse effects on populations due to lethal, mutagenic, reproductive, systemic, or general toxic effects associated with site contaminants. These assessment endpoints were evaluated by comparing measured contaminant concentrations in surface water and sediment first to ecological screening levels (ESLs), which represent media concentrations at which minimal to no effects are predicted. Risks were further evaluated using alternative toxicity (AT) values, at which concentrations pose a probable potential for adverse effects.

The ecological contaminants of potential concern (ECOPC) identification process for the ERA examined ecological contaminants of interest (ECOIs) to distinguish between contaminants that pose no risk to receptors and those that require further evaluation. The ECOPC identification results are summarized in Tables ES.1 and ES.2 for surface water and sediment, respectively. The following ECOPCs were evaluated further in risk characterization:

- Barium (total), lead (dissolved), silver (dissolved), zinc (dissolved), pentachlorophenol, and phenanthrene in surface water at the NN AEU;
- Aluminum, barium, iron, lead, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene in sediment at the NN AEU;

- Aluminum (total), cadmium (dissolved), selenium (total), and zinc (dissolved) in surface water at the MK AEU; and

- Aluminum, chromium, fluoride, nickel, and selenium in sediment at the MK AEU.

- No ECOPCs were identified in surface water or sediment at RC AEU or SE AEU.

Results by AEU indicate that there are no continuing, significant risks to aquatic life from residual ECOPCs due to RFETS-related operations. Overall, the aquatic communities in RFETS AEUs are limited by natural environmental conditions (i.e., low flows and poor habitat) characteristic of this area along the Colorado Front Range. Therefore, aquatic receptor exposure pathways are often incomplete when discharge is low in these ephemeral streams.

Weight-of-evidence conclusions for specific AEUs were as follows:

- **NN AEU** – The potential for risk could not be excluded for surface water and sediment ECOPCs in conservative screening. Further risk characterization was completed, and the weight of evidence determined that these chemicals do not pose a significant risk to water column organisms or benthic macroinvertebrates within the NN AEU.

- **RC AEU** – Conservative screening and professional judgment determined that ECOIs in surface water and sediment do not pose a significant risk to water column organisms or benthic macroinvertebrates in the RC AEU.

- **MK AEU** – The potential for risk could not be excluded for surface water and sediment ECOPCs in conservative screening. Further risk characterization was completed, and the weight of evidence determined that these chemicals do not pose a significant risk to water column organisms or benthic macroinvertebrates within the MK AEU.

- **SE AEU** – Conservative screening and professional judgment determined that ECOIs in surface water and sediment do not pose a significant risk to water column organisms or benthic macroinvertebrates in the SE AEU.

1.0 AQUATIC EXPOSURE UNITS

The purpose of this Comprehensive Risk Assessment (CRA) is to identify and evaluate ecological risks posed by organics, metals, and radionuclides remaining at the Rocky Flats Environmental Technology Site (RFETS) following accelerated actions.

The Aquatic Exposure Units (AEUs) represent a framework for evaluating population risks to aquatic receptors from exposure to surface water and sediment within aquatic systems on at RFETS. The AEUs established for RFETS include the North Walnut Creek AEU (NW AEU), South Walnut Creek AEU (SW AEU), Woman Creek AEU (WC AEU), No Name Gulch AEU (NN AEU), Rock Creek AEU (RC AEU), McKay Ditch AEU (MK AEU), and the Southeast AEU (SE AEU). This volume, 15B1, presents the ERA for the NN AEU, RC AEU, MK AEU, and SE AEU (Figure 1.1). This Section encompasses information for all of the AEUs even though only the NN AEU, RC AEU, MK AEU, and SE AEU are evaluated since an understanding of site-wide features is critical to the CRA process.

This ERA follows the Final CRA Work Plan and Methodology (DOE 2005), hereafter referred to as the CRA Methodology, and encompasses both ecological contaminant of potential concern (ECOPC) selection and risk characterization. These two processes were applied in the same manner for each AEU. In order to streamline presentation of the ERA for each AEU, this report, Volume 15B1, first presents results common to all four AEUs, followed by AEU-specific results.

1.1 Aquatic Exposure Unit Description

1.1.1 Aquatic Exposure Unit Characteristics and Locations

This section provides a brief description of all the AEUs, including their location at RFETS, historical activities in the area, topography, surface water features, and ecological characteristics. A more detailed description of these features and additional information regarding the geology, hydrology, and soil types at RFETS is included in Appendix A, Volume 2 of the Remedial Investigation/Feasibility Study (RI/FS) Report.

The Historical Release Report (HRR) (DOE 1992) and its annual updates provide descriptions of known or suspected releases of hazardous substances that have occurred since the inception of the Rocky Flats Plant. The original HRR organized these known or suspected historical source areas as historical Individual Hazardous Substance Sites (IHSSs), Potential Areas of Concern (PACs), or Under Building Contamination (UBC) sites (hereafter collectively referred to as IHSSs) (Figure 1.2). Historical IHSSs and groups of historical IHSSs were also designated as Operable Units (OUs). Over the course of cleanup under the 1991 Interagency Agreement (IAG) and the 1996 Rocky Flats Cleanup Agreement (RFCA), the U.S. Department of Energy (DOE) has thoroughly investigated and characterized contamination associated with these historical documented source areas. Historical IHSSs have been dispositioned through appropriate remedial actions or by determining that No Further Accelerated Action (NFAA) is required, pursuant to the applicable IAG and RFCA requirements. Some OUs have also been dispositioned in accordance with an OU-specific Corrective Action Decision/Record of Decision (CAD/ROD).

A more detailed description of the OU and IHSS history at RFETS is included in Appendix A, Volume 2 of the Draft RI/FS Report (DOE 2005) and Section 1.0, Site Background of the RI/FS Report.

1.1.2 Aquatic Exposure Unit Characteristics and Location

NN AEU

The 302-acre NN AEU is located in the north-central portion of RFETS (Figure 1.3). The NN AEU is located within the Buffer Zone (BZ) just north of the Industrial Area (IA) and encompasses several historical IHSSs, most notably the Present Landfill. Runoff and groundwater at the Present Landfill discharge to the East Landfill Pond, which was historically pumped to the A-series ponds.

The NN AEU is bounded on all sides by other AEUs, including the MK AEU to the north and west, and the NW AEU and SW AEU to the south and east, respectively.

RC AEU

The 735-acre RC AEU is located in the northern and western portion of RFETS (Figure 1.4. The RC AEU is located within the BZ and is outside areas that were used historically for operation of RFETS and it is located generally upwind and hydraulically cross-gradient of the IA. RC AEU is a functionally distinct exposure area encompassing much of the Rock Creek drainage area and containing relatively abundant vegetation, water, and wetland habitat.

The RC AEU is bounded by the RFETS property boundary to the north and west, and by the MK AEU to the south.

MK AEU

The 996-acre MK AEU is located in the northern and central portions of the RFETS (Figure 1.5).: The MK AEU is located within the BZ and is generally outside areas that were used for RFETS operations and it is located generally upwind and hydraulically upgradient of the IA. The MK AEU is a functionally distinct exposure area. It is predominantly a level terrace of the Rocky Flats plain lying between two stream-cut valleys (Rock Creek and Walnut Creek), with sparse vegetation and a relative scarcity of water and wetland habitat.

The MK AEU is bounded by the RC AEU to the northeast, State Highway 128 to the north, Indiana Avenue to the east (the RFETS property boundary), and the NW AEU, SW AEU, NN AEU, and WC AEU as well as the RFETS property boundary to the southwest.

SE AEU

The 1,245-acre SE AEU is located in the southern portion of the RFETS (Figure 1.6). The SE AEU is located within the BZ and is outside areas that were used for RFETS operations; it is located south of the IA OU, with the two areas separated by the WC AEU. The SE AEU is generally categorized as being located crosswind and hydraulically cross-gradient relative to the IA.

Most of the surface water flow in the SE AEU is through Smart Ditch, a drainage that includes two small ponds in the far southern section of RFETS. This area receives no runoff from the IA.

The SE AEU is bounded by the RFETS property boundary on the west, east, and south, and by the WC AEU to the north.

1.1.3 Topography and Surface Water Hydrology

This subsection describes the topography and hydrology for the entire RFETS site, inclusive of the AEUs not evaluated within this document. This was completed in order to provide a context of the setting in regards to the evaluation.

Within RFETS, streams and seeps are largely ephemeral or intermittent, with stream reaches gaining or losing flow depending on the season and precipitation amounts. Surface water flow across RFETS is primarily from west to east, with four drainages traversing the site (Figure 1.7):

- Walnut Creek – Major drainage in the north-central portion of RFETS, receiving runoff from most of the IA. The MK AEU and NN AEU are included in this drainage;
- Woman Creek – Major drainage on the southern side of RFETS, receiving runoff from the southern portion of the IA;
- Rock Creek – Major drainage in the northwestern part of RFETS that does not receive runoff from the IA. The RC AEU is included in this drainage; and
- Smart Ditch – Minor drainage in the far southern section of RFETS that does not receive runoff from the IA. The SE AEU is included in this drainage.

Even the largest drainages at RFETS typically have defined channels that are relatively narrow, ranging in bottom width from 2 to 10 feet, often with exposed sediments and cobbles and occasionally with vegetated channels. Vegetation near the streams is dominated by riparian woodland/shrubland community types, with wet meadow and marsh species near seeps and ponds. A brief description of each of these drainages is

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provided below. Additional details are provided in Appendix A, Volume 2 of the RI/FS Report and Section 2.0, Physical Characteristics of the RI/FS Report.

Walnut Creek Drainage

The Walnut Creek drainage receives runoff from the majority of the IA as well as the northeastern BZ. The Walnut Creek drainage area is approximately 1,878 acres, which include the area west of the RFETS boundary. The tributaries to Walnut Creek include, from north to south, McKay Ditch, No Name Gulch, North Walnut Creek, and South Walnut Creek. The stream channel downstream of the confluence between North and South Walnut Creeks is known as Walnut Creek.

<u>McKay Ditch</u>

McKay Ditch runs from west to east across the northern BZ and is hydrologically isolated from the IA. The City of Broomfield can divert water from either Coal Creek or the South Boulder Diversion Canal (both west of RFETS) into the open channel of McKay Ditch across the northern RFETS BZ, into an underground pipeline, and underneath Indiana Street. On the eastern side of Indiana Street, the pipeline daylights and the water flows directly to Great Western Reservoir, where it is stored by the City of Broomfield to be used for irrigation. McKay Ditch is generally dry. Flows in the ditch historically occur in the spring when the City of Broomfield is able to exercise its water rights and divert water into the ditch, or when overland runoff is captured and transported by the ditch. Future flows in McKay Ditch are expected to be similar to past flows because site accelerated actions do not impact the configuration of the ditch and operations are managed by the City of Broomfield.

<u>No Name Gulch</u>

No Name Gulch is located in the northern BZ downstream from the East Landfill Pond. The East Landfill Pond receives runoff and treated leachate from the Present Landfill area and the watershed immediately surrounding the pond, and is hydrologically isolated from the IA. No Name Gulch is ephemeral, with periodic runoff occurring most frequently in the spring. Closure of the former Present Landfill entailed construction of a Resource Conservation and Recovery Act (RCRA)-compliant cover constructed over the Present Landfill area. This cover is expected to generate additional runoff compared to the historic runoff pattern.

<u>North Walnut Creek</u>

Stormwater runoff from the northern portion of the IA flows into North Walnut Creek, which has four retention ponds (Ponds A-1, A-2, A-3, and A-4). In contrast to many other site drainages, North Walnut Creek has continuous flow, located immediately northeast and downstream from the IA). The hydrology of the North Walnut Creek drainage following closure is expected to be very different than in the past. Removal of buildings and pavement from the IA will significantly reduce the volumes and peak discharge rates of runoff.

South Walnut Creek

Runoff from the central portion of the IA flows into South Walnut Creek, which has five retention ponds (Ponds B-1, B-2, B-3, B-4, and B-5). Similar to North Walnut Creek, South Walnut Creek has continuous flow. The hydrology of the South Walnut Creek drainage following closure is expected to be different than in the past. Removal of buildings, elimination of water historically imported for RFETS operations, elimination of the Sewage Treatment Plant discharge, and removal of pavement from the IA will significantly reduce the volumes and peak discharge rates of runoff in this drainage (Kaiser-Hill 2002).

Walnut Creek

Downstream from terminal ponds A-4 and B-5, North and South Walnut Creeks merge to form Walnut Creek. As previously noted, the flows in Walnut Creek following site closure will be substantially reduced compared to past flows.

Downstream from RFETS, east of Indiana Street, Walnut Creek flows into a splitter box operated by the City of Broomfield. The splitter box is normally configured to divert flows from Walnut Creek into the Broomfield Diversion Ditch, an open channel that runs around the southern side of Great Western Reservoir. Downstream from the reservoir, the Broomfield Diversion Ditch angles northward before rejoining Walnut Creek. Further east, Walnut Creek flows into Big Dry Creek. The Big Dry Creek drainage basin is an 86-square-mile watershed that is a tributary to the South Platte River. The confluence of Big Dry Creek with the South Platte River is located north of Brighton, Colorado, approximately 30 miles northeast of RFETS.

Woman Creek Drainage

Woman Creek traverses the southern side of RFETS and captures runoff from the southern portion of the IA OU as well as the majority of the southern BZ OU. The on-site portion of the Woman Creek watershed is approximately 3.1 square miles.

The tributaries to Woman Creek include the South Interceptor Ditch (SID), North Woman Creek, Owl Branch (South Woman Creek), and Antelope Springs Gulch. The stream channel downstream of the confluence between North Woman Creek and the Owl Branch is known as Woman Creek.

South Interceptor Ditch

Runoff from the southern portion of the IA flows into the SID, which was constructed to prevent runoff into Woman Creek. The SID, which runs off into Pond C-2, is a grass-lined, trapezoidal channel that flows intermittently. Removal of impervious surfaces (that is, buildings and pavement) from the IA will reduce the historic discharge volumes and peak flow rates. In addition, the western 1,500 feet of the SID were eliminated when the cover was constructed for the Original Landfill (IHSS 115).

Pond C-2 discharges into Woman Creek. Historically, discharge from Pond C-2 was necessary approximately once per year. However, with the reduced runoff from the IA OU flowing into the SID, Pond C-2 discharges to Woman Creek will be even less frequent and based on normal climate conditions. Because Pond C-2 discharges were historically a small percentage of the volume measured in Woman Creek, the less frequent discharges should not have a major impact on the overall Woman Creek hydrology.

<u>North Woman Creek</u>

North Woman Creek flows from the west onto the southwest quadrant of the RFETS property and converges with the Owl Branch (South Woman Creek) at a point approximately 1,800 feet east of RFETS' western boundary. North Woman Creek is hydrologically isolated from the IA OU. Changes to the site resulting from accelerated action activities are not expected to alter the watershed or hydrology in North Woman Creek.

<u>Owl Branch</u>

The Owl Branch of Woman Creek (South Woman Creek) flows west onto the southwest quadrant of the RFETS property and roughly parallels North Woman Creek before joining with it. Owl Branch is hydrologically isolated from the IA OU. Changes to the site resulting from accelerated actions are not expected to alter the watershed or hydrology in the Owl Branch of Woman Creek.

<u>Antelope Springs Gulch</u>

Antelope Springs Gulch conveys water from Antelope Springs, which is a seep on the southern side of Woman Creek that normally flows throughout the year. The seep is likely influenced by Rocky Flats Lake, located off-site to the west. Antelope Springs Gulch flows northeast and joins Woman Creek approximately 2,500 feet upstream from Pond C-1. The Antelope Springs drainage is hydrologically isolated from the IA OU. The future hydrology of the Antelope Springs Gulch is expected to be similar to the past because accelerated actions are not impacting the hydrology of this undeveloped watershed.

<u>Woman Creek</u>

As cited previously, the stream channel downstream of the confluence between North Woman Creek and Owl Branch (South Woman Creek) is known as Woman Creek. Between the North Woman Creek and Owl Branch confluence and Pond C-2, Woman Creek is largely isolated from the IA OU in terms of surface runoff because the SID intercepts surface flow and diverts it into Pond C-2. However, groundwater from portions of the southern IA discharges into Woman Creek. In the western reach of Woman Creek, the watershed was enlarged when the Original Landfill remediation eliminated the western 1,500 feet of the SID, thereby allowing runoff from the Original Landfill area to flow directly to Woman Creek. However, because the vegetated cover on the Original

Landfill will minimize runoff, this change is expected to have a negligible effect on the total flow volume in Woman Creek.

Woman Creek flows through Pond C-1, which was reconfigured as a low-profile, flow-through structure in 2004. Below Pond C-1 and upstream from Pond C-2, Woman Creek is diverted via a concrete diversion wall and channel around the northern side of Pond C-2. Below Pond C-2, the diversion channel rejoins the original Woman Creek channel.

Rock Creek Drainage

The Rock Creek drainage covers the northwestern portion of the site's BZ. The watershed area (measured by gauging station GS04) is approximately 1,499 acres and includes an area west of the RFETS boundary. The Rock Creek drainage does not receive runoff from the IA. The drainage basin is characterized by east-sloping alluvial plains to the west, several small ponds within the creek bed, and multiple steep gullies and stream channels to the east. Flow in Rock Creek is ephemeral. Within the RFETS boundaries, the hydrology of the Rock Creek drainage is not expected to change as a result of accelerated actions.

Smart Ditch Drainage

Smart Ditch is an irrigation ditch in the southern portion of the BZ OU owned and operated by the Church Estate. The ditch does not receive runoff from the IA. Smart Ditch fills two ponds (D-1 and D-2) located in the southeastern corner of the site that are used for irrigation. Water from Rocky Flats Lake, located off-site and west of the RFETS boundary, flows through Smart Ditch for approximately 2.5 miles before reaching a splitter box, which diverts water toward the southeast, away from the main channel of Woman Creek and into Ponds D-1 and D-2. Overland runoff is also intercepted and conveyed by Smart Ditch. Smart Ditch is typically dry, although it has an estimated capacity of 10 cubic feet per second (cfs). Because the ditch is hydrologically separated and far removed from the IA, limited flow and water quality data exist for this conveyance.

1.1.4 Aquatic Life

Aquatic habitats at RFETS have been highly modified by the diversion and impoundment of water, which occurred historically for agricultural use and more recently for water control. Prior to agricultural development, Walnut Creek and Woman Creek were seasonally intermittent streams fed primarily by snowmelt and runoff. Aquatic communities were limited by both the periodic lack of flows and the generally low flows. Reliable surface flows occurred only near seeps and springs (DOE 1996).

Construction of detention ponds in both watersheds severely altered the natural hydrologic conditions. Creation of the ponds resulted in permanent lentic (standing water) habitats in areas where water previously was present only seasonally. In Walnut

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Creek, batch-release of water from the terminal ponds (Pond A-4 and Pond B-5) has caused stream segments immediately downstream to be dry most of the time. Establishment of aquatic life in these stream segments is limited because batch-releases are of short duration and occur at irregular intervals. Much of the water in Woman Creek has historically been diverted to Mower Ditch, leaving the segment below Pond C-2 dry much of the year. Flow in portions of Woman Creek upstream of Pond C-2 is relatively natural, although runoff and some groundwater is intercepted by the SID. This water is diverted into Pond C-2. Water in this pond has historically been delivered to other systems and not into the Mower Ditch. From 1993 to 1997, Pond C-2 water was pump discharged to the Broomfield Diversion Ditch after reaching a pre-designated level. Beginning in January 1997, water from Pond C-2 was sampled and released directly into Woman Creek, which flows to the Woman Creek Reservoir, east of RFETS. Water has typically only been released into Woman Creek once per year.

Stream communities at RFETS are composed of species that are typical of limited-flow or seasonal-flow environments. Under these conditions, assessment of impacts due to contaminant input is difficult because of natural variability of populations (DOE 1996). The potential aquatic habitats within RFETS are shown in Figure 1.8. Any area identified as having intermittent/perennial flows or standing water was identified as a potential habitat area. Other information pertaining to previously observed aquatic species records (i.e., amphibians, fish, and invertebrates) was layered into this map, which represents all potential habitat areas based on historic flow conditions.

Historically, water levels in Ponds A-3, A-4, B-2, B-3, and B-5 were manipulated for site water management purposes. Ponds A-1, A-2, B-1, and B-2 are relatively shallow (less than 1 meter), have had no regular input besides local runoff, and have had no regular output other than evaporation. As a result, the ponds historically have had abundant aquatic plant life. However, faunal communities are limited, most likely because of high daytime temperatures in summer and low dissolved oxygen at night.

The most common aquatic macroinvertebrates (aquatic insects) found at RFETs are the larvae of the blackfly (*Diptera, Simulidae.*), midge (*Diptera, Chironomidae*), and mayfly (*Ephemeroptera*). Other species include caddisflies (*Trichoptera*), craneflies (*Tipulidae*), and damselfly larvae (*Odonata*), as well as snails (*Gastropoda*) and amphipods (*Amphipoda*). Large macroinvertebrates such as crayfish (*Decapoda Astacidae*) and snails are potentially important prey for other fish, waterfowl, and mammal species.

Each of the primary drainages at RFETS contains a variety of pond and stream habitats, varying amounts of habitat modification, and seasonal water flows. The Walnut Creek drainage was modified by adding retention ponds to manage precipitation runoff in the IA.

A variety of non-native fish species such as rainbow trout (*Salmo gairdneri*), goldfish (*Carassius auratus*), carp (*Cyprinus carpio*), and bass (*Micropterus*), were introduced into the Walnut Creek reservoirs. Although all introductions did not establish reproducing fish populations, bass are present in Pond A-2 and golden shiners (*Notemigonus crysoleucas*) are found in Ponds A-2, A-3, and A-4. Fathead minnows (*Pimephales promelas*) are a native species found in every pond except the Landfill Pond.

Woman Creek retains contains a significant amount of stream habitat and holds the majority of RFETS fish species. Native fish species that reproduce within Woman Creek include white suckers (*Catostomus commersoni*), fathead minnows, green sunfish (*Lepomis cyanellus*), stonerollers (*Campostoma anomalum*), and creek chubs (*Semotilus atromaculatus*). A single specimen of long-nosed dace (*Rhinichthys cataractae*) was found in Woman Creek (AAE 2003). Two non-native fish species, golden shiners (*Notemigonus crysoleucas*) and largemouth bass (*Micropterus salmoides*), also are found in the drainage.

1.1.5 Site Conceptual Model

A site conceptual model (SCM) is presented in the CRA Methodology and described in detail in Appendix A, Volume 2 of the RI/FS Report. The SCM presents the pathways of potential exposure from documented historical source areas (IHSSs and PACs) to the receptors of concern. A summary of the SCM components as they pertain to the AEUs is described below.

For the purposes of this evaluation, the targeted receptor representative of the ecological functional group most appropriate for the watershed ERAs is general aquatic life, which includes fish, amphibians, and benthic macroinvertebrates. Wading birds and waterfowl were also considered important receptors; however, an assessment of Site-related risk had been previously completed by DOE (1996). The results are briefly revisited within this document as a line of evidence. Details regarding the methods (i.e. ingestion rates, exposure and area use assumptions) can be found in the DOE (1996) report. The endpoints for this assessment are the following:

- Assessment Endpoint – Survival, growth, and reproduction adequate to sustain populations at RFETS within the AEU; and
- Measurement Endpoints – Comparison of concentrations of contaminants in environmental media (surface water and sediment), calculated from abiotic data ECOPCs to ESLs and other toxicity criteria, as appropriate.

Aquatic receptors can be exposed to contaminants directly through contact with contaminated media (surface water and sediment) or indirectly through consumption of organisms that have been exposed to (and bioaccumulated) contaminants. For purposes of the CRA, surface water and sediment were considered to be the media providing the greatest contaminant exposure to aquatic organisms.

Soils in the immediate vicinity of the wetted channels and pond edges were also evaluated as part of this CRA. Adjacent soil was defined as soil within 20 feet of the wetted edge of a given AEU feature such as a stream channel, pond, or seep. Because

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these soils could erode or transport to a receiving drainage as a result of overland flows, they may represent potential future sediment that would act as a source of exposure to future aquatic life receptors.

The magnitude of exposure to environmental contaminants depends not only on concentration but also frequency and duration of contact. In the case of sediment, concentrations of contaminants are likely static (although varying with depth in the sediment). The exception is areas where active remediation has taken place (i.e., Ponds B-1, B-2, and B-3). Concentrations in surface water may change seasonally and particularly in response to precipitation and snowmelt events or other factors affecting flows and associated contaminant transport. The dominant factor controlling the exposure of aquatic receptors is their behavior and overlap, both spatially and temporally. Daily, weekly, and seasonal use patterns and dietary habits determine the amount of time an organism is in contact with contaminated media and the extent of exposure. In the case of the AEUs, the limited flows often affect aquatic organism distribution, abundance, and behavior. Some aquatic invertebrate communities are adapted to episodic flow conditions, as is typical for these AEUs. Species of fish, however, are less capable of such adjustment and, therefore, are unlikely to occur in areas that do not have sustained flows except through seasonal migrations from permanently wetted areas.

1.1.6 Data Description

Data have been collected at RFETS under regulatory agency-approved Work Plans, Sampling and Analysis Plans (SAPs), and Quality Assurance Project Plans (QAPjPs) to meet data quality objectives (DQOs) and appropriate U.S. Environmental Protection Agency (EPA) and Colorado Department of Public Health and Environment (CDPHE) guidance. Surface water and sediment samples were collected from the AEUs (Table 1.2). The sampling locations for these media are shown on Figures 1.9 through 1.12, and data summaries for detected analytes in each medium are provided in Tables 1.3 through 1.10. Ecological contaminants of interest (ECOIs)s that were analyzed for but not detected are presented in Attachment 1. Detection limits are compared to ecological screening levels (ESLs), as discussed in Attachment 1 (Tables A1.1 through A1.10). A detailed description of data storage and processing methods is provided in Appendix A, Volume 2 of the RI/FS Report. The complete data set for the AEUs is provided in Attachment 4 on a compact disc (CD).

In accordance with the CRA Methodology, only data collected on or after June 28, 1991, are used in the CRA. The sampling data available for the assessment of the AEUs are used as follows:

- Surface water data;
- Sediment data; and
- Surface soil data within 20 feet of the wetted areas (discussed as sediment, below).

NN AEU

Surface Water

The surface water data set for the NN AEU consists of up to 148 samples for various analyte groups. The samples were collected in the NN AEU over several months from July, 1991, through August, 2005. Sample locations are shown on Figure 1.9.

The NN AEU surface water samples were analyzed for inorganics (up to 87 total and 32 dissolved samples), organics (up to 148 total samples), and radionuclides (up to 86 total and 14 dissolved samples) (Table 1.2). Detected analytes included inorganics, organics, and radionuclides (Table 1.3). A summary of analytes that were not detected in surface water in the NN AEU is presented and discussed in Attachment 1.

Sediment

The sediment data set for NN AEU consists of up to 23 samples for various analyte groups collected from depths less than 0.5 foot from the sediment surface. The samples were collected in the NN AEU over several months from August, 1991, through October, 1994, and again in August, 1997, and October, 2000. Sample locations are shown on Figure 1.9. Adjacent surface soils were also evaluated as potential future sediments.

The NN AEU sediment samples were analyzed for inorganics (up to 20 samples), organics (up to 16 samples), and radionuclides (up to 23 samples) (Table 1.2). Detected analytes included inorganics, organics, and radionuclides (Table 1.4). A summary of analytes that were not detected in sediment in the NN AEU is presented and discussed in Attachment 1.

RC AEU

Surface Water

The surface water data set consists of up to 110 samples for various analyte groups (Table 1.2). Surface water samples were collected from 15 locations (including six designated background locations) in the RC AEU (Figure 1.10) between July, 1991, and August, 2005. The samples were analyzed for inorganics (110 total and 42 dissolved samples), organics (43 total samples), and radionuclides (43 total and 5 dissolved samples) (Table 1.2). The data summary for surface water is presented in Table 1.5. Constituents from all three analyte groups were detected.

Sediment

The sediment data set for RC AEU consists of up to 22 samples for various analyte groups (Table 1.2). The sediment data set includes data from eight shallow sediment sampling locations shown on Figure 1.10. The sediment samples were collected from depths less than 0.5 ft from the sediment surface. The samples were collected between 1991 and 1993, as well as in 2004, and were analyzed for inorganics, organics, and radionuclides.

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The RC AEU sediment samples were analyzed for inorganics (up to 22 samples), organics (up to 22 samples), and radionuclides (up to 20 samples) (Table 1.2). Detected analytes included inorganics, organics, and radionuclides (Table 1.6). A summary of analytes that were not detected in sediment in the NN AEU is presented and discussed in Attachment 1,

MK AEU

Surface Water

The surface water data set for MK AEU consists of up to 40 samples for various analyte groups. The samples were collected in the MK AEU over several months from July, 1991, through July, 1996, and again in December, 2004, through January, 2005. Sample locations are shown on Figure 1.11.

The MK AEU surface water samples were analyzed for inorganics (up to 40 total and 27 dissolved samples), organics (up to 14 total samples), and radionuclides (up to 38 total samples and 1 dissolved sample) (Table 1.2). Detected analytes included inorganics and radionuclides as well as several organics (Table 1.7). A summary of analytes that were not detected in surface water in the MK AEU is presented and discussed in Attachment 1.

Sediment

The sediment data set for MK AEU consists of up to 13 samples for various analyte groups collected from depths less than 0.5 foot from the sediment surface. The samples were collected in the MK AEU over several months from August, 1991, through March, 1995, and again in December, 2004. Sample locations are shown on Figure 1.11. Adjacent surface soils were also evaluated as potential future sediments.

The MK AEU sediment samples were analyzed for inorganics (up to 12 samples), organics (up to 8 samples), and radionuclides (up to 13 samples) (Table 1.2). Detected analytes included inorganics, organics, and radionuclides (Table 1.8). A summary of analytes that were not detected in sediment in the MK AEU is presented and discussed in Attachment 1.

SE AEU

Surface Water

The surface water data set for SE AEU consists of up to 14 samples for various analyte groups. The samples were collected in the SE AEU over several months from August 1991 through March, 1993, and again in December, 2004, through January, 2005. Sample locations are shown on Figure 1.12.

The SE AEU surface water samples were analyzed for inorganics (up to 14 total and 7 dissolved samples), organics (up to 7 total samples), and radionuclides (up to 11 total and 2 dissolved samples) (Table 1.2). Detected analytes included inorganics and radionuclides. Methylene chloride was the only organic detected in the SE AEU surface water (Table 1.9). A summary of analytes that were not detected in surface water in the SE AEU is presented and discussed in Attachment 1.

Sediment

The sediment data set for SE AEU consists of up to nine samples for various analyte groups collected from depths less than 0.5 foot from the sediment surface. The samples were collected in the SE AEU in October, 2000, and again in December, 2004 through January, 2005. Sample locations are shown on Figure 1.12. Adjacent surface soils were also evaluated as potential future sediments.

The SE AEU sediment samples were analyzed for inorganics (up to seven samples) and radionuclides (up to nine samples) (Table 1.2). Detected analytes included inorganics and radionuclides; no organics were analyzed in the SE AEU (Table 1.10). A summary of analytes that were not detected in sediment in the SE AEU is presented and discussed in Attachment 1.

1.2 Data Adequacy

A data adequacy assessment was performed to determine whether the available data sets discussed in the previous section are adequate for risk assessment purposes. The data adequacy assessment guidelines are presented in the CRA Methodology. A detailed data adequacy assessment for the data used in the CRA is presented in Appendix A, Volume 2 of the RI/FS Report. The assessment concludes that the data are well distributed across the site and are sufficient to estimate risks to ecological receptors at RFETS. The data for the AEUs are considered adequate for the CRA because sampling locations for surface water and sediment are generally well distributed within each AEU. Therefore, the data are considered representative for the AEU and are adequate for quantitative risk assessment.

1.3 Data Quality Assessment

A Data Quality Assessment (DQA) of the AEU data sets was conducted to determine whether the data were of sufficient quality for risk assessment use. The AEU-specific DQA is presented in Attachment 2, and an evaluation of the entire RFETS data set is presented in Appendix A, Volume 2 of the RI/FS Report. It was concluded that the data are of sufficient quality for use in this CRA.

2.0 IDENTIFICATION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN

The ECOPC identification process streamlines the ecological risk characterization by focusing the assessment on ECOIs that are present in surface water and sediment media from each AEU. This process is based on the SCM presented in the CRA Methodology and described in detail in Appendix A, Volume 2 of the RI/FS Report. Generally, as described in Section 1.1.5, the most significant exposure pathways to aquatic life

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receptors are through direct contact and ingestion of potentially contaminated surface water and sediment.

2.1 Data Used in the Ecological Risk Assessment

Surface water and sediment media were evaluated for the AEU ERAs. Data used for the AEU ECOPC evaluations represent the AEU data set gathered since June 28, 1991 with post-accelerated action confirmation sample results incorporated as well as the additional pond sampling results gathered July, 2005. Table 1.2 summarizes the number of samples by type of analysis for each AEU. Additional data sets relied upon for the AEU risk characterization included post-1999 surface water, surface sediment (0-6") and adjacent surface soils (within 20' of the wetted perimeter of the water body). These additional data sets were reviewed as part of the lines of evidence describing chemical risk characterization.

Surface water samples for both total and dissolved fractions were collected. ESLs for inorganics contaminants are based on either dissolved or total metal fractions depending on the underlying data for the ESL. The fraction appropriate for comparison to the ESL was used for the ECOPC process. For instance, many divalent metals have ESLs for the dissolved fraction (e.g., cadmium, copper, chromium, iron, lead, mercury, nickel, silver, and zinc), while the remaining have ESLs for the total fraction.

The ESL for ammonia is based on the "un-ionized" fraction of that compound. As is standard practice, only the total aqueous ammonia fraction was measured, and not the un-ionized (more toxic) fraction; therefore, the un-ionized fraction was calculated from the total aqueous measurement using a temperature and pH dependant conversion factor (EPA 1985). This calculation method is discussed in Attachment 5. The calculated un-ionized concentrations are shown within the ECOPC summary tables and spatial distribution figures.

Sediment samples were collected from all depth fractions. ESLs for inorganic and organic contaminants were compared to the detected sample results. ECOPCs evaluated further in risk characterization were also assessed as surface sediment concentrations (limited to results from the top six inches), as distinguished from the comprehensive data set (Section 5). Additional data evaluation in risk characterization included an evaluation of total polycyclic aromatic hydrocarbons (PAHs). These organic contaminants tend to act in an additive manner because of similar modes of toxic action. To account for this interactive toxicity a total concentration was calculated for PAHs within each sample in risk characterization. The total PAH concentrations were calculated for an AEU if any individual PAHs were retained as ECOPCs for risk characterization (Attachment 6).

Surface water and sediment from NN AEU, RC AEU, MK AEU, and SE AEU included samples from locations considered part of the background data set for RFETS. These background samples were included in the AEU data evaluated in the initial steps of ECOPC identification as a conservative assessment measure. Background samples were then removed from the AEU data set for comparison of site sample concentrations to background concentrations and in professional judgment evaluations.

2.2 Identification of Surface Water and Sediment ECOPCs

ECOPCs for surface water and sediment were identified for aquatic receptors in accordance with the sequence presented in the CRA Methodology. The ECOPC identification process for the ERA examined ECOIs that were present in AEU surface water and sediment through a sequential, multi-step process. All ECOIs, including essential nutrients, were evaluated using the following process:

- The first step of the ECOPC selection process was a comparison of ECOI maximum detected concentrations (MDCs) in surface water and sediment to their respective ESLs. Those ECOIs for which ESLs were not available were removed from further consideration within the ECOPC process, and are discussed further as ECOIs with uncertain toxicity (Section 6.0). A list of ECOIs with uncertain toxicity is summarized in Attachment 1 for each AEU. Chemicals where the MDCs were greater than the ESL are retained for further analysis in the ECOPC selection process. ESLs are presented in the CRA Methodology based on the most significant exposure pathways and receptors presented in the SCM, and represent concentrations that are predicted to result in either no-adverse effects or minimal or threshold effects to aquatic receptor populations. Additional contaminants beyond those presented in the CRA Methodology were identified as requiring an ECOPC evaluation. Therefore, additional ESLs were derived using the same methods and sources as those described in the CRA Methodology. A summary of these new ESLs is provided in Attachment 5.

- A detection frequency screen is performed for those ECOIs that were not eliminated in the MDC-ESL screen to identify ECOIs with less than a 5 percent detection frequency. Infrequently detected ECOIs were determined not to pose a potential for risk to aquatic receptors. However, ECOIs' low frequency of detection were mapped. The mapping was completed in order to determine if the few detected concentrations of these ECOIs occur in depositional areas (such as ponds) that could pose a potential risk to aquatic populations areas.

- Statistical comparisons against the appropriate background data set were performed for each ECOI that was not eliminated in the detection frequency screen, in accordance with the CRA Methodology. The background analyses utilized two statistical programs: ProUCL (Version 3.0) and S-Plus. The statistical methods used are described in Attachment 3 as well as in Appendix A, Volume 2, Attachment 1 of the RI/FS Report. ProUCL was used to determine the data distributions of the AEU and background data sets. The data distribution types determined the appropriate statistical test for the background comparison. S-Plus was then used to compare the two data sets. Those chemicals found to be statistically greater than background were retained for further analysis in the

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ECOPC selection process. All other ECOIs were considered to not pose a potential risk to aquatic populations and were eliminated from the ECOPC selection process.

- For those ECOIs retained in the ECOPC selection process, the exposure point concentration (EPC), a conservative measure of central tendency represented by the 95th upper tolerance limit (UTL) (95th upper confidence limit [UCL] of the 90th percentile), was compared to the ESL. The upper-bound EPC is a conservative measure of potential exposure for organisms with low mobility. Calculation of this statistic used one-half of the detection limit as a proxy value for nondetected concentrations. Where sufficient data were unavailable to calculate statistical parameters, the MDC was used as the default EPC; or, if the UTL was greater than the MDC, the MDC was used as the EPC. This EPC was compared to the Screening ESL. ECOIs with UTLs less than their ESLs were removed from further consideration within the ECOPC process. The ECOIs screened out in this step were mapped to determine the spatial extent, and to evaluate their potential for posing a risk in depositional areas such as ponds. Those ECOIs that did not display a depositional pattern within ponds and had EPCs less than the ESLs were considered to not pose a potential risk to aquatic populations.
- The final ECOPC selection step, as per the CRA Methodology, was a professional judgment evaluation of each remaining ECOIs. This was done when there was not source area evidence that precluded the exclusion of ECOPCs from further evaluation. Therefore, any ECOIs identified as ECOPCs, were either retained for further evaluation by professional judgment or by the risk characterization.

A more detailed discussion of the ECOPC screening procedure and the assumptions inherent in this procedure are provided in Section 7.3 of the CRA Methodology and in Appendix A, Volume 2 of the RI/FS Report.

2.3 Summary of ECOPCs for AEUs

ECOPCs for surface water and sediment were identified for aquatic receptors in accordance with the screening process presented in the CRA Methodology (DOE 2004a). The following subsections present the outcome of the ECOPC process for each AEU. Special consideration was given in each step of the process for ECOIs that are eliminated to evaluate their potential to be present in isolated depositional areas which may occur within pond areas that provide unique habitat settings.

A summary of the ECOPC decision process is provided for each AEU by media in Tables 2.1 through 2.6. Justification for background decisions is provided in Attachment 3.

2.3.1 ECOPCs for the NN AEU

Surface Water

Table 2.1 summarizes the results of the surface water ECOPC identification process for the NN AEU. There were six total metals (aluminum, barium, beryllium, lithium, selenium, and vanadium), six dissolved metals (cadmium, copper, iron, lead, silver, and zinc), and seven organics (benzo[a]pyrene, bis[2-ethylhexyl]phthalate, di-n-butylphthalate, pentachlorophenol, phenanthrene, phenol, and pyrene) with MDCs greater than ESLs. Of these ECOIs, there are three that were detected in less than 5 percent of the samples. They are:

- Cadmium (dissolved) detected in 1 of 32 samples (Figure 2.1)
- Benzo(a)pyrene detected in 1 of 71 samples (Figure 2.2); and
- Pyrene detected in 1 of 71 samples (Figure 2.3).

The MDC for these chemicals is greater than their respective ESLs. However, the remaining concentrations were below detection limits. These ECOIs were eliminated from further consideration in the NN AEU because they are unlikely to present risks to the population of aquatic receptors.

Aluminum (total), copper (dissolved), iron (dissolved), and vanadium (total) were not significantly greater than background. These metals were eliminated from further consideration because they are unlikely to present risks to the populations of receptors that inhabit No Name Gulch. The risk posed by these metals does not exceed that posed by normal background conditions.

While the MDCs for beryllium (total), lithium (total), selenium (total), bis-2-ethylhexylphthalate, di-n-butylphthalate, and phenol in surface water were greater than their respective ESLs, the UTL EPCs for these ECOIs were less than the ESLs (Table 2.1); therefore, these chemicals were not considered to pose risk to aquatic receptors. However, to ensure that these ECOIs were not a concern in surface water for an isolated aquatic population associated with a pond within No Name Gulch, the spatial distributions of these ECOIs were evaluated by plotting the concentrations in relation to the ESL. The spatial distributions of these chemicals are shown in Figures 2.4 through 2.9. A summary of their spatial extent as compared to their respective ESLs is described as follows:

- Beryllium occurred with a total concentration above the ESL at one location within the channel (Figure 2.4). The MDC was greater than the chronic ambient water quality criterion (ESL) of 0.002 milligrams per liter (mg/L), and the acute ambient water quality criteria of 43 mg/L. However, this result represents a singular exceedance whereas the remaining samples were either nondetect or below the ESL value. The spatial distribution is limited to the channel and does not present a risk concern to aquatic populations.

- Lithium occurred with a total concentration above the ESL at one location within the channel at the outfall of the pond (Figure 2.5). The MDC fell above the chronic ambient water quality criterion (ESL) of 0.096 mg/L but below the acute ambient water quality criteria of 1.7 mg/L. The exceedance represents a singular occurrence whereas the remaining samples were all below the ESL value. The spatial distribution is limited to the channel and does not present a risk concern to aquatic populations.

- Selenium occurred at total concentrations above the ESL at two locations (Figure 2.6). The MDC of 0.038 mg/L was greater than the chronic ambient water quality criterion (ESL) of 0.005 mg/L and the acute ambient water quality criterion of 0.0184 mg/L. However, the total frequency of detection was only 18 percent. In addition, the locations with measured exceedances occurred in the channel portions of the NN AEU, which contain intermittent flows dependent upon seasonal precipitation. Therefore, the aquatic populations associated with the pond are not at risk, and exposure pathways for water column organisms are often incomplete. It does not appear that selenium is creating an isolated risk potential and, therefore, it was not retained for further consideration as an ECOPC.

- Bis(2-ethylhexyl)phthalate occurred at concentrations above the ESL at two locations (Figure 2.7). The MDC of 140 micrograms per liter (μg/L) was above the chronic ambient water quality criterion (ESL) of 28.5 μg/L and below the acute ambient water quality criterion of 285 μg/L. It appears that given the minimal spatial extent of bis(2-ethylhexyl)phthalate in the pond area, there is low risk to aquatic populations. Therefore, this chemical was not considered for further evaluation as an ECOPC.

- Di-n-butylphthalate and phenol typically occurred at concentrations less than the ESL or at nondetected levels with a single exception at the discharge point of release below the pond. Their distribution is not concentrated in pond areas and they are not widespread throughout the drainage at concentrations of concern. Measured concentrations of these two chemicals occur below the ESL in all instances, except for one location within the outfall outside of the pond (Figures 2.8 and 2.9). Therefore, these chemicals were not considered to pose risk to populations and are not evaluated further as ECOPCs.

Results of the ECOPC screen identified barium (total), lead (dissolved), silver (dissolved), zinc (dissolved), pentachlorophenol, and phenanthrene as surface water ECOIs requiring further evaluation using professional judgment. The spatial extent of each of these chemicals within the NN AEU is provided in Figures 2.10 through 2.15. Results of the professional judgment process indicate these ECOIs should be retained as ECOPCs for risk characterization because of the spatial plots of detected concentrations exceeding ESLs (Attachment 3).

Sediment

Table 2.2 summarizes the results of the sediment ECOPC identification process. Five metals (aluminum, barium, iron, lead, and manganese) and seven organics (benzo[a]anthracene, benzo[a]pyrene, benzo[g,h,i]perylene, chrysene, indeno[1,2,3-cd]pyrene, phenanthrene, and pyrene) had MDCs greater than ESLs. These ECOIs all had detection frequencies greater than 5 percent. Concentrations of manganese were not significantly greater than background. Therefore, manganese was eliminated from further consideration because it is unlikely to present risks to sediment receptor populations in No Name Gulch. The risk created from this metal does not exceed that posed by normal background conditions.

The UTL-ESL screen indicated that aluminum, barium, iron, lead, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene ECOIs required professional judgment evaluation. The spatial extent of these 11 ECOIs within the NN AEU are provided in Figures 2.16 through 2.26.

Professional judgment indicated these ECOIs should be retained as ECOPCs for risk characterization because their spatial distribution may be related to source areas (Attachment 3).

2.3.2 ECOPCs for the RC AEU

Surface Water

Table 2.3 summarizes the results of the surface water ECOPC identification process. There were seven total inorganic chemicals (aluminum, barium, beryllium, cyanide, lithium, selenium, and vanadium), six dissolved metals (cadmium, copper, iron, lead, mercury, and silver), and one radionuclide (radium-226) with MDCs greater than ESLs. Two of the metals were detected in less than 5 percent of the samples.

- Mercury (dissolved) was detected in 1 of 41 samples (Figure 2.27).

  Mercury has an MDC of 0.005 mg/L, which is greater than the ESL of 0.00077 mg/L. However, given the isolated nature of this single detection (Figure 2.27), it was eliminated from further consideration as an ECOPC.

- Silver (dissolved) was detected in 1 of 42 samples (Figure 2.28).

  Silver is a hardness-dependent divalent metal whereby site-specific considerations of water quality can be used to develop a more appropriate ESL. For the RC AEU, a site-wide measured hardness value was used to develop an ESL of 0.001 mg/L (Attachment 5), which is still less than, but more comparable to, the MDC of 0.002 mg/L. Given the minimal exceedance of the measured value for silver and the limited spatial extent of its occurrence (Figure 2.19), this ECOI does not create an unacceptable risk to the aquatic populations within the RC AEU and has also been eliminated from further consideration as an ECOPC.

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Aluminum (total), copper (dissolved), iron (dissolved), and vanadium (total) concentrations were not significantly greater than background. These ECOIs were eliminated from further consideration because they are unlikely to present unacceptable risks to the populations of receptors that inhabit Rock Creek. The risk created by these metals does not exceed that posed by normal background conditions.

Further review of the data identified cyanide and radium-226 as only occurring within the background data set. Therefore, these chemicals were not valid ECOIs in RC AEU surface water and were eliminated from further consideration as ECOPCs.

The UTL-ESL screen eliminated barium (total), beryllium (total), lithium (total), and selenium (total) ECOIs from further consideration as ECOPCs. While the MDCs for these metals were greater than their respective ESLs, the UTL EPCs for these ECOIs were less than the ESLs (Table 2.3). Therefore, these chemicals were not considered to pose risk to aquatic receptors. However, to ensure that these ECOIs were not a concern in surface water for an isolated aquatic population associated with a pond within Rock Creek, the spatial distributions of these ECOIs were evaluated by plotting the concentrations in relation to the ESL. The spatial distributions of these chemicals are shown in Figures 2.29 through 2.32. A summary of their spatial extent as compared to their respective ESLs is described as follows:

- Barium occurred with a total concentration above the ESL at one location (Figure 2.29). The MDC of 0.63 mg/L was greater than the ESL. The remaining samples throughout the AEU were less than the ESL. The spatial distribution of barium does not indicate that there is an unacceptable risk to isolated aquatic populations.

- Beryllium occurred with a total concentration above the ESL at one location (Figure 2.30). The MDC of 0.004 mg/L was greater than the ESL but below the acute ambient water quality criterion of 0.043 mg/L. The remaining sample locations throughout the AEU were either below the ESL or not detected. The spatial distribution of beryllium does not indicate that there is an unacceptable risk to isolated aquatic populations.

- Lithium occurred with total concentrations above the ESL at two locations (Figure 2.31). The MDC of 0.154 mg/L was greater than the ESL but below the acute ambient water quality criterion. There is no spatial pattern indicating an increase in concentration going down-gradient within the channel. The remaining locations occur at levels below the ESL or are not detected. The spatial distribution of lithium does not indicate that there is an unacceptable risk to isolated aquatic populations.

- Selenium occurred at total concentrations above the ESL at two locations (Figure 2.32). The MDC of 0.019 mg/L was greater than the chronic ambient water quality criterion (ESL) of 0.0046 mg/L and the acute ambient water quality criterion of 0.0184 mg/L. However, the remaining locations occurred at levels below the ESL or were not detected. Therefore, the aquatic populations are not at risk in the RC AEU. It does not appear that selenium is creating an isolated risk potential; therefore, it was not retained for further consideration as an ECOPC.

Cadmium (dissolved) and lead (dissolved) are evaluated in the professional judgment step (Attachment 3). The weight of evidence presented within professional judgment showed that elevated concentrations of cadmium (dissolved) and lead (dissolved) in RC AEU surface water were not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release of these chemicals from potential sources inside or outside the AEU that would impact concentrations in surface water. Therefore, these chemicals are not considered ECOPCs in surface water for the RC AEU and are not further evaluated quantitatively.

Upon completion of the above process, there were no ECOPCs identified for RC AEU surface water.

Sediment

Table 2.4 summarizes the results of the sediment ECOPC identification process. There were 12 metals (aluminum, antimony, arsenic, barium, cadmium, iron, lead, manganese, nickel, selenium, silver, and zinc) and three organics (2-butanone, 4-methylphenol, and pentachlorophenol) with MDCs greater than ESLs. All of these ECOIs were detected in more than 5 percent of the sediment samples.

Of the inorganic ECOIs, only manganese had a concentration that was not significantly greater than background. Therefore, this metal was eliminated from further consideration as an ECOPC because it is unlikely that it would present risks to the populations of benthic receptors that inhabit Rock Creek. The risk created by this metal does not differ from that posed by normal background conditions.

Further review of the data during the background comparison identified that antimony, 2-butanone, and 4-methylphenol were detected only within the background data sets. Therefore, these are not valid ECOIs for RC AEU sediment and were eliminated from further consideration as ECOPCs.

The UTL-ESL screen eliminated nickel from further consideration as an ECOPC. While the MDC for this metal was greater than the ESL, the UTL EPC for this ECOI was less than the ESL (Table 2.4); therefore, nickel was not considered to pose risk to aquatic receptors. However, to ensure that this ECOI was not a concern to an isolated aquatic population, the spatial distribution was evaluated by plotting the concentrations in relation to the ESL. The spatial distribution of nickel is shown in Figures 2.33. A summary of its spatial extent as compared to the ESL indicates that nickel occurred at one location at a concentration above the ESL (Figure 2.33). The remaining locations throughout the AEU had concentrations below the ESL. It does not appear that nickel poses an unacceptable risk to aquatic populations within the RC AEU.

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Upon completion of the above steps, aluminum, arsenic, barium, cadmium, iron, lead, selenium, silver, zinc, and pentachlorophenol were retained for evaluation using professional judgment.

The weight of evidence presented within professional judgment shows that aluminum, arsenic, barium, cadmium, iron, lead, selenium, silver, zinc, and pentachlorophenol concentrations in sediment in the RC AEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations (Attachment 3). There is no evidence of a release of these chemical from potential sources inside or outside the AEU that would impact concentrations in sediment. Therefore, these chemicals are not considered ECOPCs in sediment for the RC AEU and are not further evaluated quantitatively.

Upon completion of the above process, there were no ECOPCs identified for RC AEU sediment.

2.3.3 ECOPCs for the MK AEU

Surface Water

Table 2.5 summarizes the results of the surface water ECOPC identification process. There were three total metals (aluminum, selenium, and vanadium) and five dissolved metals (cadmium, copper, lead, silver, and zinc) with MDCs greater than the ESLs. Except for dissolved silver (1 detect in 26 samples), these ECOIs were detected in greater than 5 percent of the samples. The ECOPC screening process did not identify any organic ECOPCs in MK AEU surface water.

Based on a review of the spatial extent of dissolved silver (Figure 2.34), the measured value of 0.002 exceeds the ESL of 0.00032 mg/L. However, silver is a hardness-dependent divalent metal whereby site-specific considerations of water quality can be used to develop a more appropriate ESL (0.001 mg/L). Attachment 5 provides a thorough discussion of the impact of site-specific considerations for this metal. Given the minimal exceedance of the measured value for silver and the limited spatial occurrence of dissolved silver, this ECOI does not pose an unacceptable risk to the aquatic populations within the MK AEU.

Concentrations of copper (dissolved), lead (dissolved), and vanadium (total) were not significantly greater than background. These ECOIs were eliminated from further consideration as ECOPCs because it is unlikely that they present risks to the populations of receptors that inhabit McKay Ditch. The potential for risk posed by these metals does not exceed that posed by normal background conditions.

Aluminum (total), cadmium (dissolved), selenium (total), and zinc (dissolved) were passed into the professional judgment step (Attachment 3). Results of professional judgment evaluations indicate that these chemicals require further evaluation within risk characterization These ECOPCs demonstrate a spatial pattern associated with source areas. The spatial plots of detected concentrations exceeding ESLs are shown in Figures 2.35 through 2.38.

Sediment

Table 2.6 summarizes the results of the sediment ECOPC identification process. There were 10 metals (aluminum, antimony, chromium, copper, fluoride, iron, lead, nickel, selenium, and zinc and one organic (4-methylphenol) with MDCs greater than the ESLs. These ECOIs were all detected in greater than 5 percent of the sediment samples.

Copper, iron, lead, and zinc concentrations were not significantly greater than background. These ECOIs were eliminated from further consideration because it is unlikely that they would present risks to the populations of receptors that inhabit McKay Ditch. The risk created by these metals does not exceed that posed by normal background conditions.

Antimony and 4-methylphenol were only detected in the background samples representing MK AEU. Therefore, these are not valid ECOIs for the MK AEU sediment and were eliminated from further consideration as ECOPCs.

The UTL-ESL screen did not result in the elimination of any remaining ECOIs from further consideration as ECOPCs.

Upon completion of the above process, aluminum, chromium, fluoride, nickel, and selenium were identified in MK AEU sediment as requiring a professional judgment evaluation (Attachment 3). The spatial extent of these ECOIs are shown in Figures 2.39 through 2.43. The professional judgment step indicated that these metals required further evaluation within the risk characterization because their spatial distribution suggests that they may be related to source areas.

2.3.4 ECOPCs for the SE AEU

Surface Water

Table 2.7 summarizes the results of the surface water ECOPC identification process. There was one total metal (aluminum) and one dissolved metal (silver) with MDCs greater than the ESLs. These ECOIs were detected in greater than 5 percent of the samples.

Of the inorganic ECOIs in surface water, aluminum (total) concentrations were not significantly greater than background. This ECOI was eliminated from further consideration because it is unlikely to present risks to the populations of receptors that inhabit the SE AEU. The risk created by this metal does not exceed that posed by normal background conditions.

The UTL-ESL screen did not eliminate the potential for risk from silver from further consideration as an ECOPC.

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Silver (dissolved) was passed into the professional judgment step where it was determined by weight of evidence that concentrations in SE AEU surface water were not a result of RFETS activities, but rather are representative of naturally occurring concentrations (Attachment 3). There is no evidence of a release from potential sources inside or outside the SE AEU that would impact silver concentrations in surface water. Silver is not considered an ECOPC in surface water for the SE AEU and, therefore, is not further evaluated quantitatively

The ECOPC screening process did not identify any ECOPCs in SE AEU surface water.

Sediment

Table 2.8 summarizes the results of the sediment ECOPC identification process. There were four metals (aluminum, barium, iron, and selenium) with MDCs greater than the ESLs. These ECOIs were detected in greater than 5 percent of the sediment samples.

There were no ECOIs eliminated as a result of the statistical background comparison step. The UTL-ESL screen did not result in the elimination of any remaining ECOIs from further consideration as ECOPCs.

Upon completion of the above process, aluminum, barium, iron, and selenium required further ECOPC evaluation using professional judgment (Attachment 3). The weight of evidence presented within professional judgment showed that aluminum, barium, iron, and selenium concentrations in sediment in the SE AEU were not a result of RFETS activities, but rather were representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the EU that would impact aluminum concentrations in sediment.

The ECOPC screening process did not identify any ECOPCs in SE AEU sediment.

3.0 ECOLOGICAL EXPOSURE ASSESSMENT

An exposure pathway describes a specific environmental route by which an individual receptor could be exposed to contaminants present at or originating from a site. A complete exposure pathway includes five elements: source, mechanism of release, transport medium, exposure point, and intake route. If any of these elements are missing, the pathway is considered incomplete. It is assumed that aquatic life may be exposed to surface water and sediment-related ECOPCs via several routes (direct contact, inhalation, and ingestion) for the purposes of the AEU evaluations.

The ECOPC identification steps identified ECOPCs for both surface water and sediment for two of the AEUs (NN AEU and MK AEU). No ECOPCs were identified for the RC AEU and SE AEU. The UCL and 95th UTL for each ECOPC (or the MDC, whichever was less) were used as the EPCs for evaluating exposure from each ECOPC within these media.

It was assumed that receptors obtain 100 percent of their exposure from each respective AEU and are likely to integrate exposure over suitable habitat across the entire drainage. This assumption is particularly relevant for No Name Gulch, which is extremely habitat-limited. In the interest of being conservative, it was also assumed that ECOPCs in possible non-habitat areas (which were, nonetheless, sampled due to the presence of surface water and/or sediment, and had a possible connection to the drainage hydrology as a whole) would contribute to possible future exposure conditions to aquatic receptors that reside downgradient. This assumption likely overestimates the exposure of these receptors because the hydrologic connectivity is unknown or unlikely.

In order to evaluate more current and realistic exposure conditions within the risk characterization, surface water data collected 'post-1999' (from 1/1/2000 to present) were evaluated, as well as surface sediment (0 – 6 inches in depth) conditions for the ECOPCs. The post-1999 surface water data results reflect more current and accurate exposure conditions than older data. Similarly, the surface sediment reflects the habitat depth of sediment typically occupied or disturbed by aquatic receptor where the exposure pathway is potentially complete. These two media were evaluated as part of the chemical risk lines of evidence for the risk characterization.

4.0 ECOLOGICAL TOXICITY ASSESSMENT

ESLs are typically concentrations at which adverse effects are rarely observed and provide a conservative lower bound indicating concentrations at which the potential for adverse effects are possible.

Several ECOPCs were identified for both surface water and sediment in two AEUs (Section 2.0). Several detected ECOIs did not have ESLs provided in Appendix B of the CRA Methodology (DOE 2004a). Therefore, new ESLs were identified using the steps described in Appendix B of the CRA Methodology. These additional ESLs that were identified after completion of the CRA Methodology are provided in Attachment 5.

ESLs are conservative benchmarks that provide an upper-bound estimate of concentrations that are not expected to cause adverse effects. As an additional measure of the potential toxicity, alternative toxicity (AT) values were identified for consideration in the risk characterization of ECOPCs to provide a reasonable estimate of concentrations at which the potential for adverse effects are possible (Attachment 5). AT values represent literature-derived toxicity values for contaminants that reflect upper-bound concentrations above which adverse effects are possible. The ATs were not provided in the CRA Methodology but provide an important role in the description of potential risk to aquatic receptors.

Concentrations between the ESL and AT values are within the range of uncertain toxicity where adverse effects are occasionally observed. The use of both the ESL and AT for each ECOPC brackets the potential for risk from each ECOPC and allows an evaluation of the likelihood of potential risk.

Aquatic ATs vary in their endpoint and receptor of interest. The available literature was reviewed to identify suitable AT values for each ECOPC that are less conservative than the ESL, yet correlative to a lowest observed adverse effect level (LOAEL) or similar measure. The selection process for AT values, their endpoints, and sources are described in Attachment 5.

5.0 AEU-SPECIFIC ECOLOGICAL RISK CHARACTERIZATION

Characterization of risk focuses on weight-of-evidence conclusions from multiple lines of evidence (LOEs) for each assessment endpoint. This includes discussion of the potential for risk for each receptor group and level of biological organization (i.e., individuals and populations), as appropriate for the assessment endpoints. As noted by EPA (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." According to the CRA Methodology, the AEU risk characterization process may include the following types of analyses:

- Consider the magnitude and frequency of refined site-specific ESLs and ATs as a measure of the likelihood or extent of potential risk;
- Evaluate the spatial variability of ECOPC concentrations by mapping the location and magnitude of concentrations exceeding ESLs;
- Review the relative bioavailability of ECOPCs;
- Evaluate site-specific tissue data as evidence of exposure to selected ECOPCs;
- Review previous risk assessment data;
- Perform tiered geospatial analysis; and
- Use other risk characterization methods as necessary and appropriate to describe the potential for risk.

These types of analyses were incorporated into the approach used for the AEU risk characterization process and, specifically, development of chemical risk LOEs and review of other/drainage lines of evidence. The LOEs gathered from the chemical risk characterization were combined with the LOEs from the other/drainage studies to formulate a weight-of-evidence risk conclusion. A single chemical risk LOE can provide either an overestimate or underestimate of the actual risk conditions. Similarly, aquatic populations may be affected by the physical conditions of the stream, which would hinder definitive recognition or identification of toxic effects. Therefore, multiple LOEs need to be reviewed before a risk characterization can be completed.

Chemical Lines of Evidence

Within the chemical risk LOE evaluation, the identified ECOPCs were further evaluated in a series of steps. The actual steps taken for risk characterization depended on the type of chemical being evaluated and the media in which it was detected (surface water versus sediment). Chemical risk characterization generally followed these steps:

ECOPCs were identified based on comparison of the MDC to ESLs. While an MDC < ESL indicates that adverse effects associated with exposure to a given analyte are highly unlikely (EPA, 1997a), an MDC ≥ ESL does not indicate that risks are actually present, only that the potential for adverse effects cannot be excluded. Therefore, the **first step** in the risk characterization involved a hazard quotient (HQ) assessment, comparing the upper confidence limit on the mean concentration (UCL) and the UTL value to the ESLs (CRA Methodology ESLs or site-specific ESLs) and ATs. The UCL provided a measure of the central tendency of contaminant concentrations, while the UTL provided an upper-bound contaminant concentration.

As described in Section 2.0, the ECOPC identification process used ESLs from the CRA Methodology. For risk characterization, site-specific ESLs and ATs were developed where appropriate using site-specific water quality conditions. These ESLs and ATs were compared to surface water and sediment MDC and EPC values for the HQ process. Site-specific ESLs were developed for certain chemicals when toxicity was found to be dependant upon site-specific surface water quality conditions. Divalent metals and pentachlorophenol in surface water were all reviewed using available site-specific hardness conditions (for the divalent metals and uranium). Site measurements of pH were included in calculations to develop appropriate ESLs for pentachlorophenol. These methods and results are described in greater detail in Attachment 5.

The HQs were developed using the following standard equation:

$$HQ = EPC/ESL \text{ or } AT$$

where

EPC	=	Media-specific EPC (micrograms per kilogram [μg/kg], picocuries per kilogram [pCi/kg], or milligrams per kilogram [mg/kg] for sediment: μg/L, picocuries per liter [pCi/L], or mg/L for surface water)
ESL	=	Media-specific ESL (comparable units to the EPC)
AT	=	Media-specific Ecological AT (comparable units to the EPC)

The **second** step of chemical risk characterization was to evaluate the data distribution and frequency of exceedances for each ECOPC. The number of sample concentrations for both nondetect and detected greater than the ESL and AT values (a concentration at which the potential for adverse effects are probable) were shown as a concentration distribution curve for each ECOPC. The data concentration distribution evaluation step involves calculating the frequency of exceedance for each ECOPC and graphically displaying the individual data results relative to ESL and AT values. An example of a

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data concentration distribution curve is shown in Figure 5.1. A frequency of exceedance effect level of 20 percent was selected as a screening criteria protective of population-level endpoints such as those identified for this assessment. If 80 percent or more of a population is not affected, then the risk is not considered biologically significant (Suter et al. 2000). This level is consistent with current EPA regulatory practices (e.g., development of the National Ambient Water Quality Criteria [NAWQC] and effluent discharges regulated by the National Pollutant Discharge Elimination System [NPDES]) and measurement limits for many field and laboratory tests (Suter et al. 2000). Using available methods, changes in natural populations of less than 20 percent cannot generally be differentiated from background in the measurements. It was concluded that adverse effects to aquatic populations from an ECOPC were not significant if fewer than 20 percent of the samples exceeded the ESL values.

The **third** step of chemical risk characterization was to evaluate the spatial distribution of concentrations of ECOPCs, which involved mapping each measured concentration relative to the ESL. The spatial extent was evaluated to identify any potential areas that could present a localized risk to aquatic organisms. If all measured results were greater than the ESL within a habitat area, then the potential for risk could not be excluded. If, however, ESL exceedances were from samples collected in non-habitat areas or were widely dispersed, then there may be a low potential of risk. (Note: The maps from Section 2.0 of this volume that are used for the spatial distribution evaluation are based on the Screening ESLs. For some ECOPCs, a site-specific ESL is used to calculate HQs for the first step of risk characterization and using the site-specific ESL results in HQs less than 1. Therefore, for some ECOPCs, there are exceedances of CRA Methodology ESLs shown on the map used for the spatial distribution evaluation, but there are no exceedances of site-specific ESLs in the data set.)

The **fourth** step of chemical risk characterization involved the evaluation of ECOPCs in other applicable fractions of the media in order to understand current conditions or spatial extent. For surface water, a data set for "post-1999" was developed and used for comparison to the comprehensive AEU data sets where appropriate. For sediment, surface sediment (0 to 6 inches in depth) ECOPC values were reviewed because surface sediment data are more relevant to aquatic organism exposure. The surface sediment data were reviewed for some of the ECOPCs, and the results were compared to ESLs and ATs. In addition, sediment ECOPCs were reviewed in regards to adjacent soils concentrations. This was completed because adjacent surface soils may act as a source for future sediment-related exposure conditions to aquatic receptors through future runoff and erosion. For each sediment ECOPC, an analysis of adjacent surface soil concentrations relative to sediment ESLs was completed to determine potential future risk conditions. Surface soils within 20 feet of the wetted edge of each water body were considered in this evaluation. Attachment 6 provides detailed information pertaining to the post-1999 surface water, surface sediment, and adjacent soils data.

Additional data evaluation in risk characterization included an evaluation of total polycyclic aromatic hydrocarbons (PAHs). The total PAH concentrations were calculated for an AEU if any individual PAHs were retained as ECOPCs for risk characterization (Attachment 6). This additional evaluation was performed in addition to the evaluation of individual PAHs to account for the additive toxicity that this class of contaminants is known to exert, due to a similar mode of toxic action (narcosis).

Other/Drainage Specific Lines of Evidence

In addition to the chemical LOEs, a second component of risk characterization was the review of conclusions from other/drainage reports and studies. The ecological setting of RFETS is a key to understanding the controlling factors other than chemical concentrations that affect the ecology of each drainage. These LOEs consist of previously collected data from the OU 5/OU 6 Watershed Ecological Risk Assessment (ERA), ecological monitoring data, and others. These studies defined ecological conditions of the site over time and provided insight to the changes, adverse effects, or controlling factors that may have been affecting the site ecology. Each study provided a LOE describing the ecological risk setting.

Attachment 7 provides a summary of other LOEs gathered from previous studies that were conducted within RFETS and which focused on the AEUs. LOEs that can provide information regarding risk conditions to aquatic life can be derived using a number of strategies (measurement endpoints). Previous studies completed within RFETS that encompass aquatic life measurement endpoints fell within the following four categories:

- **Tissue Analyses** – Included sampling and analysis to determine bioaccumulation and bioconcentration trends;
- **Aquatic Population Studies** – Evaluated populations of benthic macroinvertebrates and fish within RFETS;
- **Bioassay Analyses** – Measured direct toxicity effects to laboratory test organisms from potentially contaminated surface water or sediment;
- **Waterfowl/Wading Bird Studies** – Determined the potential impacts to these higher trophic level receptors by assessing their potential exposure to aquatic species as food sources (recording feeding behaviors and ranges).

For certain AEUs, a significant amount of previous research has been completed (i.e., NW AEU and SW AEU). Other AEUs had few studies due to the lack of habitat and ecological significance (i.e., MK AEU). This presents an uncertainty for those AEUs that have few other/drainage LOEs available for risk characterization.

Attachment 7 provides a summary of previous studies by type of LOE (i.e., tissue analyses, aquatic population studies, bioassay analyses, waterfowl/wading bird studies, and chemical loading analyses, etc.) presented in a chronological timeframe. The methods, conclusions, and application to this CRA also are provided. A summary of findings is then presented within the risk characterization in order to draw weight-of-evidence risk conclusions.

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5.1 Risk Characterization of the NN AEU

ECOPCs were identified for both surface water and sediment within the NN AEU. A chemical risk characterization using the various LOEs was completed for these chemicals. The NN AEU has been studied by others in order to define the aquatic ecological setting. The results from these studies were compiled to formulate the other/drainage lines of evidence (Attachment 7). The combination of the chemical risk characterization and the other/drainage LOEs provides the risk conclusions for this AEU.

This risk characterization begins with a site ecological setting description in order to provide perspective regarding the aquatic ecosystem characteristics associated with the NN AEU. The chemical risk LOEs and the other/drainage LOEs are then described, followed by a weight-of-evidence summary of these risk descriptors.

5.1.1 Site-Specific Habitat Description

No Name Gulch is located in the north BZ downstream from the East Landfill Pond (Figure 1.3). The East Landfill Pond receives runoff from the former Present Landfill and from the watershed immediately surrounding the pond, and is hydrologically isolated from the IA. The BZ surrounding the IA generally supports a wide variety of native plant communities and wildlife. However, the areas in and around the Present Landfill have been subject to extensive physical disturbance associated with the landfill operations and construction of the East Landfill Pond and groundwater intercept system.

The closure of the Present Landfill may generate additional runoff compared to the historic runoff pattern. Drainage ditches along the perimeter of the Present Landfill cover allow the free drainage of the geosynthetic composite cover and drainage layer, and direct surface water away from the landfill and into No Name Gulch (DOE 2004c). No Name Gulch is an ephemeral stream, with periodic runoff occurring most frequently in the spring. Historically, the mean annual discharge volume in No Name Gulch, measured at gaging station GS33, is approximately 17 acre-feet per year. The peak flow rate is 6.8 cfs. Most flow occurs from March to June in response to rain events. The remainder of the year is dry, with no sustaining flow within the channel. The landfill cover is expected to generate additional runoff compared to historic runoff patterns.

Tall and short marsh wetland communities occur in the area around the East Landfill Pond. A total of 3.1 acres of wetlands, as delineated by the U.S. Army Corps of Engineers (USACE) (USACE 1994), are located in the immediate vicinity of the Present Landfill, including 0.8 acre of palustrine emergent wetlands at the margins of the East Landfill Pond and 2.3 acres of lacustrine wetlands associated with the pond bottom and open-water habitat combined. The East Landfill Pond represents approximately 5 percent of the site's open-water habitat and approximately 6 percent of the shoreline habitat. In No Name Gulch, a narrow ribbon of wetland occurs in the bottom of the drainage. The wetland types along No Name Gulch include palustrine emergent (seasonally and temporarily flooded), a small palustrine emergent impoundment, and some palustrine scrub-shrub (seasonally flooded). However, No Name Gulch is dry the majority of the time.

Viable aquatic habitat is limited in the gulch. The East Landfill Pond supports no fish and only a depauperate benthic macroinvertebrate community. Benthic marcoinvertebrate sampling conducted in 1991 documented only eight taxa of benthic organisms present in the pond, including organisms in the groups Gastropoda, Pelecypoda, Oligochaeta, Hydracarina, Amphipoda, and Diptera (DOE 1992b). Fish sampling conducted in 1999 at the pond captured no fish. The ephemeral nature of the No Name Gulch flows limits aquatic habitat to a perennially wet area approximately midway along the streambed. Unless future runoff conditions are substantially higher, it is difficult to see aquatic conditions changing from their current ephemeral conditions.

5.1.2 Exposure and Risk Characterization

Chemical Risk Characterization Lines of Evidence

Tables 5.1 to 5.5 provide the HQs for the surface water and sediment ECOPCs. HQs derived from the ESL and AT values for each chemical are provided for MDC, UCL, and UTL EPCs. Table 5.5 provides the frequency and magnitude of HQs based on ESLs. The results of the chemical risk characterization are presented below by medium (surface water and sediment) and by chemical.

<u>Surface Water ECOPCs</u>

Barium (Total)

The MDC for barium in NN AEU surface water (0.82 mg/L) exceeded the screening ESL (0.438 mg/L). The barium ESL is hardness-dependant and a site-specific value was calculated after the Michigan Department of Environmental Quality (MIDEQ) (MIDEQ 2003) using an estimated hardness of 100 for the screening ESL. Site-specific hardness in the NN AEU was determined to be 188 (Attachment 5), and a refined ESL based on this site-specific hardness is 0.856 mg/L. The hardness-adjusted AT value for barium is 4.89 mg/L (Attachment 5). The MDC for barium (total) does not exceed either the refined ESL or the AT. HQs for UTL and UCL EPCs using the refined ESL and AT values were also less than 1 (Table 5.1). These HQ results indicate there is no potential for risk from barium in surface water at the NN AEU.

The concentration distribution for barium is provided in Figure 5.2. Barium was detected in 100 percent of the samples (72 of 72 samples). All of the measured values occur below the alternative AT and the refined ESL (Table 5.5). Additionally, the average concentration and UTL occur below the refined ESL and the AT value. Therefore, this LOE supports a no risk conclusion.

The spatial distribution of concentrations of barium relative to the screening ESL is shown in Figure 2.10. Three locations within the NN AEU at the west end of the East Landfill Pond had measured values just slightly greater than the screening ESL. The

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remaining samples collected from the pond and the channel outlet had concentrations below the screening ESL. In addition, as noted above, all concentrations were less than the refined ESL. Therefore, risk to aquatic life from exposure to barium is not predicted.

Post-1999 data collected at the NN AEU were compared to the refined ESL and AT (Table 5.2). All barium concentrations in the post-1999 data set were below the refined ESL and AT. Therefore, there is no current risk to aquatic life from barium concentrations at NN AEU.

All chemical LOEs for barium support a no risk conclusion. The MDC was less than the refined ESL and AT value, none of the samples exceeded the refined ESL, and all post-1999 data had refined ESL-HQs of less than 1. Although exceedances of the screening ESL were noted in some habitat areas, these concentrations did not exceed the refined ESL. Therefore, the chemical LOE conclusion is that there is almost no potential for adverse effects to aquatic life from barium (total) in surface water at NN AEU.

Lead (Dissolved)

The MDC for lead in NN AEU surface water (0.0047 mg/L) exceeded the screening ESL (0.0025 mg/L). The lead ESL is hardness-dependant and was calculated after CDPHE (2005a) using an estimated hardness of 100 for the screening ESL. Site-specific hardness in the NN AEU was determined to be 188 (Attachment 5), and a refined ESL based on this site-specific hardness is 0.005 mg/L. The AT value for lead is 0.127 mg/L. The MDC for lead (dissolved) does not exceed the refined ESL. Additionally, HQs for UCL and UTL EPCs using the refined ESL and AT values were both less than 1 (Table 5.1). These HQ results indicate there is no potential for risk from lead in surface water at the NN AEU.

The concentration distribution is provided in Figure 5.3. All of the measured values occur below the refined ESL and the AT (i.e., all HQs were less than 1; Table 5.5). Additionally, the average concentration and the UTL occur below the ESL and AT. It is also notable that the potential risk attributable to lead (dissolved) is within the range of risk attributable to background (i.e., the maximum background concentration was greater than the MDC for NN AEU).

Lead had a frequency of detection of 15.6 percent. Only two detected concentrations (five of 32 detected) from NN AEU surface waters exceeded the screening ESL for lead. These samples were collected between July and October 1991 (Figure 2.11). One location within the inlet of the NN AEU pond has a measured value just slightly greater than the screening ESL. The remaining samples collected from the channel and adjacent storm channel had concentrations below the screening ESL or below detectable levels. Additionally, as noted above, all concentrations were less than the refined ESL. Therefore, risk to aquatic life from exposure to lead is not predicted.

Lead was not detected in the one sample analyzed in NN AEU surface water after 1999. The current potential for risk to water column organisms uncertain (Table 5.2).

As with barium, all chemical LOEs for lead (dissolved) support a no risk conclusion. The MDC was less than the refined ESL and AT value, none of the samples exceeded the refined ESL, and all post-1999 data had refined ESL-HQs of less than 1. Although exceedances of the screening ESL were noted in one habitat area, these concentrations did not exceed the refined ESL. Therefore, the chemical LOE conclusion is that there is no potential for adverse effects to aquatic life from lead (dissolved) in surface water at NN AEU.

Silver (Dissolved)

The MDC for silver in NN AEU surface water (0.013 mg/L) exceeded the screening ESL (0.0014 mg/L). The silver ESL is hardness-dependant and was calculated after CDPHE (2005a) using an estimated hardness of 100 for the screening ESL. Site-specific hardness in the NN AEU was determined to be 188 (Attachment 5), and a refined ESL based on this site-specific hardness is 0.0009 mg/L. The AT value for silver is 0.006 mg/L (Attachment 5). The MDC for silver (dissolved) still exceeded the refined ESL (HQ=15) and AT (HQ = 2) (Table 5.1). EPC-HQs for the ESL and AT were all greater than one, except for the AT-HQ for the UCL (HQ<1). Therefore, potential for risk to aquatic organisms could not be excluded due to these refined ESL and AT exceedances by silver in surface water at NN AEU.

As depicted in the concentration distribution (Figure 5.4), the refined ESL is lower than the majority (27 of 32) of detected and non-detected values, and all 5 detected values exceeded the refined ESL (16 percent)(Table 5.5). Non-detected concentrations greater than the ESL indicate inadequately low detection limits and contributes to uncertainty regarding the potential for risk. These samples were collected in March 1992 and July 1995. Only 1 detected concentration (HQ = 15) and none of the non-detected concentrations had an HQ greater than 10 (Table 5.5). Two detected concentrations had HQs between 5 and 10 and 2 had HQs less than 5. In addition to these low magnitudes of exceedance, only two of the 5 detected values exceeded the AT (HQs only slightly > 1) and none of the non-detected values or the average concentration exceeded the AT (Figure 5.4). This low frequency of exceedances by detected concentrations, suggest that risk to aquatic organisms from silver concentrations in NN AEU is low.

The spatial distribution of concentrations of silver relative to the screening ESL is shown in Figure 2.12. Four locations, one within the NN AEU pond inlet and three outside of the pond in the channels, had detected values greater than the ESL. The remaining samples collected from the pond and the channel were below detection limits. It is also notable that these ESL exceedances were within the range of background concentrations. Because elevated silver concentrations were detected within habitat areas, risk cannot be excluded using this LOE, but the low frequency of these exceedances supports the conclusion that risks are not widespread.

Silver was not detected in the one sample analyzed in NN AEU surface water after 1999. The current potential for risk to water column organisms is uncertain (Table 5.2).

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The refined ESL and AT comparison to UCL and UTL-EPCs for silver (dissolved) suggest that the potential for risk cannot be excluded. Additionally, elevated detected concentrations were observed within aquatic habitat, and there is uncertainty regarding potential for risk due to inadequate detection limits driving ESL exceedances based on non-detected concentrations. However, the magnitudes of refined ESL exceedances were low for both detected (4 of the 5 detected HQs < 7) and non-detected concentrations (all HQs < 4); and the frequency of ESL exceedances by detected concentrations was low. Therefore, the chemical LOE conclusion is that there is low but uncertain potential for risk to aquatic life from silver (dissolved) in surface water at NN AEU.

Zinc (Dissolved)

The MDC for zinc in NN AEU surface water (1.5 mg/L) exceeded the screening ESL (0.211 mg/L). ESL-HQs for UCL and UTL-EPCs from the comprehensive surface water data set were also greater than 1 in both cases. The zinc ESL is hardness-dependant and was calculated after CDPHE (2005a) using an estimated hardness of 100 for the screening ESL. Site-specific hardness was determined to be 188 (Attachment 5), and a refined ESL based on this site-specific hardness is 0.202 mg/L. Alternative screening benchmarks for dissolved zinc presented in MacDonald et al. (1999) range from 0.0065 mg/L for the Netherlands ecotoxicological value (Stortelder et al. 1989) up to 0.120 mg/L for the U.S. NAWQC at a default hardness of 100 (EPA 1998). Based on these data, an AT value 0.21 mg/L was selected (USEPA 2002; acute criteria); however, this value does not differ significantly from the ESL. The MDC for zinc (dissolved) exceeds both the refined ESL (HQ=7.4) and the AT (HQ = 8), and refined ESL-HQs and AT-HQs for UCL and UTL-EPCs were greater than 1. Therefore, potential for risk to aquatic organisms could not be excluded due to these refined ESL and AT exceedances by zinc.

The concentration distribution for zinc is provided in Figure 5.5. As depicted in this figure, the refined ESL and AT values are lower than 29 percent (9 of 31) of detected values (Table 5.5). All non-detected values are less than the refined ESL. These samples were collected between July 1991 and April 1993. None of the detected concentrations had an HQ greater than 10 (Table 5.5). Four detected concentrations had HQs between 5 and 10, 5 had HQs less than 5, and 14 detected concentrations were less than the refined ESL. Although the frequency of exceedance is moderate (29 percent), the low magnitude of exceedance (all HQs < 8) of both the refined ESL and AT value suggest that risk to aquatic organisms from zinc concentrations in NN AEU cannot be excluded.

The spatial distribution of concentrations of zinc relative to the screening ESL is shown in Figure 2.13. One sample within the East Landfill pond inlet had a detected concentration greater than the ESL. The samples from the remaining locations collected from the pond inlet and channel had concentrations below the ESL. It is also notable that the potential risk attributable to zinc (dissolved) is within the range of risk attributable to background (i.e., the maximum background concentration was greater than the MDC for NN AEU).

Zinc was not detected in the one sample analyzed in NN AEU surface water after 1999. The current potential for risk to water column organisms uncertain (Table 5.2).

The chemical comparison of refined ESL and AT values to UCL and UTL-EPCs for zinc (dissolved) suggests that the potential for risk cannot be excluded. There was a moderate frequency of exceedance (29 percent), and elevated detected concentrations were observed within aquatic habitat. However, the magnitudes of refined ESL exceedances were low (all HQs < 8). It is also notable that the potential risk attributable to zinc (dissolved) is within the range of risk attributable to background. Therefore, the chemical LOE conclusion is that there is a low potential for adverse effects to aquatic life from zinc (dissolved) in surface water at NN AEU.

Pentachlorophenol

The MDC for pentachlorophenol in NN AEU surface water (10 µg/L) exceeded the screening ESL (6.69 µg/L). ESL-HQs for UCL and UTL-EPCs from the comprehensive surface water data set were also greater than 1 in both cases. (Note: because both the UCL and UTL were greater than the MDC, the MDC was used as the UCL and UTL.) The pentachlorophenol ESL for surface water is pH-dependent and, therefore, a site-specific ESL was calculated based on the following equation (CDPHE 2005a):

$$\text{Pentachlorophenol ESL} = 2 * e^{[1.005(\text{pH}) - 5.134]}$$

Using the average pH of 7.5 found in surface waters at RFETS (Attachment 5), the site-specific ESL for pentachlorophenol is 8.1 µg/L. The AT for pentachlorophenol (corrected for site-specific pH) is 21.1 µg/L. The MDC for pentachlorophenol exceeded the refined ESL (HQ=1.2), but did not exceed the AT. Therefore, potential for risk to aquatic organisms could not be excluded due to these refined ESL and AT exceedances by zinc in surface water at NN AEU.

The concentration distribution for pentachlorophenol is provided in Figure 5.6. As depicted in this figure, the refined ESL is lower than the majority (69 of 72) of detected values and non-detected values exceeded the refined ESL, although only 1 of 4 detected concentrations exceeded the refined ESL (Table 5.5). This detected concentration that exceed the refined ESL had a low HQ (<1.5) and did not exceed the AT. Non-detected concentrations greater than the ESL indicate inadequately low detection limits and contributes to uncertainty regarding the potential for risk.. This low magnitude of exceedance for the detected concentrations suggests that risk to aquatic organisms from pentachlorophenol concentrations in NN AEU is low. However, this conclusion is very uncertain because all of the non-detected concentrations exceeded the refined ESL.

The spatial distribution of concentrations of pentachlorophenol relative to the screening ESL is shown in Figure 2.14. One sample within the East Landfill pond inlet had a detected concentration greater than the ESL. The remaining samples collected from the pond and the channel outlet had concentrations below detection limits or below the ESL,

2P

including the sample collected at the farthest downgradient location from the East Landfill Pond. Because elevated pentachlorophenol concentrations were detected within habitat areas and due to the uncertainty associated with elevated detection limits, risk cannot be excluded using this LOE.

Pentachlorophenol was not detected in the few samples analyzed in NN AEU surface water after 1999. The current potential for risk to water column organisms is uncertain (Table 5.2).

The chemical comparison of the refined ESL to UCL and UTL-EPCs for pentachlorophenol suggests that the potential for risk cannot be excluded. Elevated detected concentrations were observed within aquatic habitat, and there is uncertainty regarding potential for risk due to inadequate detection limits driving ESL exceedances based on non-detected concentrations. However, the magnitudes of refined ESL exceedances were low for both detected (only 1 exceedance with an HQ < 1.5), and non-detected concentrations (all HQs, except 1 < 4), and all post-1999 samples (representative of current conditions) were non-detected with HQs < 4. Therefore, the chemical LOE conclusion is that there is low but uncertain potential for adverse effects to aquatic life from pentachlorophenol in surface water at NN AEU.

Phenanthrene

The MDC for phenanthrene in NN AEU surface water (6 µg/L) exceeded the screening ESL (2.4 µg/L). Additionally, the UTL and UCL-EPCs exceeded the screening ESL. This ESL is based on a chronic screening benchmark from MIDEQ (2003). A proposed NAWQC for phenanthrene (Buchman 1999) provides a chronic criterion of 6.3 µg/L for phenanthrene. Based on this benchmark concentration, there are no exceedances, except one non-detected concentration. Additionally, this non-detected concentration was the only exceedance of the AT (43 µg/L; Attachment 5). Both the UCL and UTL-EPCs had AT-HQs less than 1. These results suggest that the potential for risk to aquatic organisms from phenanthrene concentrations in the NN AEU is low.

The concentration distribution for phenanthrene is provided in Figure 5.7. As depicted in this figure, the ESL is lower than the majority of detected and non-detected values, although only 1 of the 4 detected concentrations exceeded the ESL (Table 5.5). Non-detected concentrations greater than the ESL indicate inadequately low detection limits and contributes to uncertainty regarding the potential for risk. The only detected concentration to exceed the screening ESL had a low HQ (<3) and did not exceed the AT. This low magnitude of exceedance for the detected concentrations suggests that risk to aquatic organisms from pentachlorophenol concentrations in NN AEU is low. However, this conclusion is very uncertain because numerous non-detected concentrations exceeded the ESL.

The concentration distribution for phenanthrene is plotted in Figure 5.7. Phenanthrene was detected in 39.7 percent of the samples. The average concentration exceeds the ESL and below the AT value. The average is affected by the incorporation of detection limits which have elevated the calculated central tendency statistics. One nondetected value exceeded the AT. The magnitude and frequency of HQ values are presented in Table 5.5. All of the detected concentrations were greater than the ESL, but had HQ values less than 5. Additionally, all but one of the nondetected concentrations had HQ values less than 5. These results indicate that phenanthrene has a low potential for adverse aquatic effects.

The spatial distribution of concentrations of phenanthrene relative to screening ESL is shown in Figure 2.15. Two samples within the East Landfill pond had detected values greater than the ESL. The remaining samples collected from locations at the pond and the channel outlet all had concentrations below detection limits. The sample collected furthest downgradient from the East Landfill Pond also had concentrations below detection limits. Because elevated phenanthrene concentrations were detected within a habitat area and due to the uncertainty associated with elevated detection limits, risk cannot be excluded using this LOE, but the potential for adverse effects is low.

Review of the post-1999 (January 2000 through 2005) surface water data set indicated that the MDC for current conditions (3.5 μg/L) is slightly greater than ESL (HQ > 1), but less than the AT (Table 5.2). Therefore, current exposure conditions are within the uncertain toxicity range, but are comparable to the ESL. This indicates a low risk to aquatic populations.

The chemical comparison of the ESL to UCL and UTL-EPCs for phenanthrene suggests that the potential for risk cannot be excluded. Additionally, elevated detected concentrations were observed within aquatic habitat, and there is uncertainty regarding potential for risk due to inadequate detection limits driving ESL exceedances based on non-detected concentrations. However, the magnitudes of refined ESL exceedances were low for both detected and non-detected concentrations (only one HQ > 4), and all post-1999 samples (representative of current conditions) had HQs < 2. Therefore, the chemical LOE conclusion is that there is low but uncertain potential for adverse effects to aquatic life from phenanthrene in surface water at NN AEU.

<u>Sediment ECOPCs</u>

Aluminum

The MDC for aluminum in NN AEU sediment (24,000 mg/kg) exceeded the sediment screening ESL of 15,900 mg/kg. The aluminum ESL in the CRA Methodology is based on the 85th percentile concentration in streams (TNRCC 1996; cited in MacDonald et al. 1999), which defined the sediment quality guideline (SQG) by the Texas Natural Resource Conservation Commission (TNRCC). The potential for adverse effects associated with this ESL is uncertain; however, the samples that exceeded the aluminum ESL did not exceed that level by a high magnitude (HQs less than 2). Alternative

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screening benchmarks ranged from 14,000 mg/kg effects range low (ERL[1]), to 58,000 mg/kg effects range moderate (ERM), and a high no-effects concentration (NEC) of 73,000 mg/kg (Ingersoll et al. 1996). The AT adopted for this assessment was the 58,000 mg/kg ERM value which is not exceeded by the MDC. HQs for UCL and UTL EPCs using the ESL are 1 and 2, respectively (Table 5.3). HQs for UCL and UTL EPCs using the ATs are less than 1.

The magnitude and frequency of HQ values are presented in Table 5.5. A total of 45 percent of samples exceeded the ESL, but had HQs less than 5. All of the measured values fall below the AT, while the average concentration is less than the ESL and AT (Figure 5.8). Nine of the 20 samples (20 of 20 detected) from NN AEU sediments exceeded the ESL for aluminum. These samples were collected between March 1992 and January 2005, and the moderate frequency of exceedances (45 percent) suggests that potential adverse effects cannot be excluded. Therefore, although the MDC exceeds the screening level ESL, the low magnitude of the exceedance and lack of AT exceedances suggests that it is unlikely that aluminum in sediment poses a potential for adverse effects to benthic organisms in the NN AEU.

The spatial distribution of aluminum concentrations relative to the screening ESL is shown in Figure 2.16. There are seven locations within the pond and two locations within the channel with measured values greater than the ESL. The remaining samples collected from the pond and downgradient locations all have concentrations below ESL levels. The sample locations downstream of the pond, and at the point of confluence with Walnut Creek, had concentrations less than the ESL, indicating that chemical concentrations are diminished downgradient of the pond.

Review of the surface sediment AEU results indicated an MDC for aluminum (24,000 mg/kg) was not different than the comprehensive MDC (Table 5.4). This indicates that realistic, surface exposure conditions are within the uncertain toxicity range but comparable to the ESL, indicating a low risk to aquatic populations. In addition, the aluminum MDC was less than the maximum background concentration.

Aluminum in surface soils adjacent to the channel indicate that the MDC is greater than the sediment ESL but below the AT (Attachment 6). There is much uncertainty in extrapolating potential future sediment contamination issues based on nearby soil chemistry. The extent of surface soil contributions to site sediments cannot be predicted.

The measured concentrations of aluminum are all below the AT and the magnitude of ESL exceedances by detected concentrations were not high (Max HQ<5). Therefore, the

[1] Not used as an ESL because this value was noted as unreliable (Ingersoll et al. 1996) where fewer than five samples designated as toxic for the chemical, or the number of toxic samples with concentrations below the sediment effect concentration (SEC) was greater than the number of toxic samples with concentrations above the SEC.

conclusion for chemical LOEs is that there is a low potential for adverse effects to benthic communities attributable to this aluminum in sediment.

Barium

The MDC for barium in NN AEU sediment (390 mg/kg) exceeded the screening ESL of 189 mg/kg. The barium ESL in the CRA Methodology is based on the 85th percentile concentration in streams (TNRCC 1996; cited in MacDonald et al. 1999), which defined the SQG for TNRCC. The potential for adverse effects associated with this ESL is uncertain; however, the samples that exceeded the barium ESL did not exceed that level by a high magnitude (HQs less than 5). Toxicity from barium in sediment is not well documented and there are no other applicable screening criteria available for this metal. Buchman (1999) proposed a probable effects level (PEL) for barium of 48 mg/kg, but this was based on an apparent effects threshold (AET) concentration from marine sediment amphipod bioassays. The AT for barium is 287, an average toxicity value from MacDonald et al. (1999) (Attachment 5). HQs for UCL and UTL EPCs using the ESL yielded values of 1 and 2, respectively (Table 5.3). HQs using the AT yielded values equal or less than 1. Therefore, it is unlikely that barium in sediment, exceeding the screening level ESL by a low magnitude, poses a potential for risk to benthic organisms in the NN AEU.

The magnitude and frequency of HQ values based on the ESLs are presented in Table 5.5. All samples yield HQ values less than 5, and 55 percent did not exceed the ESL. Barium was detected in 100 percent of the samples (Figure 5.9). All of the measured values occur below the alternative AT, with few exceptions. These results indicate that barium has a low potential for adverse effects.

There are six locations within the pond and two locations within the channel with measured values greater than the ESL (Figure 2.17). The remaining samples collected from the pond and two downgradient locations all had concentrations below the ESL. The range of detected concentrations within the pond is 150 to 390 mg/kg, while the locations within the channel downgradient of the pond had even lower surface sediment concentrations of 92.6 and 185 mg/kg.

Surface sediment concentrations for all of the NN AEU (0 – 6 inches) had an MDC (390 mg/kg) greater than the ESL and the AT (Table 5.4). However, the UCL for barium in surface soil (239 mg/kg) was less than the AT benchmark. This indicates that realistic surface sediment exposure conditions are within the range of uncertain toxicity, where the potential for risk is possible, but not probable.

The barium MDC in adjacent surface soils was greater than the sediment ESL but above the AT (Attachment 6). Although soils do not represent in-channel risk, the concentrations of barium in adjacent surface soils indicate that the potential future risk concern for barium from potentially-erosive nearby soil is low.

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A low magnitude of ESL exceedances (HQs < 5) indicate that there is low potential for adverse effects attributable to this ECOPC; however, risks to benthic organisms cannot be excluded due to aggregation of ESL exceedances in the East Landfill pond.

Iron

The MDC for iron in NN AEU sediment (21,500 mg/kg) slightly exceeded the sediment screening ESL of 20,000 mg/kg. Only two of 20 samples (20 of 20 detected) from NN AEU sediments exceeded the ESL for iron. These samples were collected between March and December 1992. This low frequency of exceedances (10 percent) suggests that potential adverse effects are not likely to be widely distributed within the NN AEU.

The ESL was based on a lowest effect level (LEL) (NYSDEC 1994; cited in MacDonald et al. 1999). The potential for adverse effects associated with this ESL is low because the two samples greater than the iron ESL did not exceed that level by a high magnitude (HQs less than 1.1). Alternative screening benchmarks ranged from 8,000 mg/kg, indicating light pollution (Pavlou & Weston 1983), to 190,000 mg/kg, with the toxic effect level (TEL) for *Hyalella azteca* 28-day sediment bioassay (Ingersoll et al. 1996), and a no-effect concentration (NEC) for *H. azteca* (Ingersoll et al. 1996). The AT for iron (280,000 mg/kg) is an effects range moderate (ERM) from Ingersoll et al. (1996) (Attachment 5).

HQs for UCL and UTL EPCs using the ESL yielded values of less than 1 and 1, respectively (Table 5.3). HQs for UCL and UTL EPCs using the AT yielded values of less than 1. The magnitude and frequency of HQ values are shown in Table 5.5. All samples yielded HQ values less than 5, and 90 percent had HQs less than or equal to 1. Iron was detected in 100 percent of the samples. All of the measured values occur below the AT (Figure 5.10).

The spatial distribution of iron relative to the screening ESL is shown in Figure 2.18. Two locations within the channel had detected concentrations greater than the ESL. The remaining samples collected from the pond and downgradient locations all had concentrations below ESL levels. The sample locations downstream of the pond, and at the point of confluence with Walnut Creek, had concentrations less than the ESL, indicating no gain in chemical concentration. In addition, the MDC for iron is less than the background maximum concentration. There does not appear to be a spatial trend that poses a risk to aquatic life.

Review of the surface sediment AEU results indicate that the MDC for iron (21,500 mg/kg) is slightly above the ESL but less than the AT (Table 5.4). This indicates that realistic, surface sediment exposure conditions are within the uncertain toxicity range where the potential for adverse effects is possible, but not probable.

The measured iron in adjacent surface soils indicates that the MDC is less than the sediment ESL. Thus, iron in adjacent surface soils is unlikely to contribute to risk in NN AEU sediments (Attachment 6).

The measured concentrations of iron are all below the AT with a low frequency and magnitude of ESL exceedances by detected concentrations. Therefore, the chemical LOE conclusion is that there is a low potential for adverse effects to benthic communities attributable to iron.

Lead

The MDC for lead in NN AEU sediment (37.6 mg/kg) slightly exceeded the sediment screening ESL of 35.8 mg/kg. Only one of 20 samples (20 of 20 detected) from the NN AEU sediments exceeded the ESL (collected in April 1993). This low frequency of exceedances (5 percent) suggests that potential adverse effects are not likely to be widely distributed within the NN AEU.

The CRA Methodology ESL was based on a consensus-based threshold effective concentration (TEC) (MacDonald et al. 2000a), where the potential for adverse effects are first observed. Validation of this benchmark found that 81.6 percent of samples (n=347) below this concentration were accurately predicted to be non-toxic to benthic macroinvertebrates. The potential for adverse effects is uncertain at concentrations greater than this ESL, and below the AT, a consensus-based PEC (128 mg/kg) (MacDonald et al. 2000a) (Attachment 5).Therefore, a low exceedance frequency and low HQ (< 1.1) and no exceedance of the AT suggests the potential for adverse effects to benthic macroinvertebrate receptors from lead in sediment at the NN AEU is unlikely. In addition, the HQs for UCL and UTL EPCs using the ESL yielded values of less than 1 and 1, respectively (Table 5.3). HQs for UCL and UTL EPCs using the AT yielded values of less than 1. All samples yielded HQ values less than 5, and 95 percent had HQs less than or equal to 1. Results indicate that lead has a low potential for adverse effects.

Lead was detected in 100 percent of the samples (Figure 5.11). All of the detected concentrations occur below the AT, while the average concentration is less than the ESL and AT.

The spatial distribution of lead in sediments relative to the screening ESL is shown in Figure 2.19. Only one location within the channel had a detected value greater than the ESL. The remaining samples collected from the East Landfill pond and all downgradient locations had concentrations below the ESL. The sample locations downstream of the pond, and at the point of confluence with Walnut Creek, had concentrations less than the ESL, indicating no gain in chemical concentration. In addition, these concentrations of lead in sediment are less than the maximum background concentration.

Review of the surface sediment AEU results indicated that the MDC for surface sediment lead (37.6 mg/kg) is unchanged from the site-wide MDC (Table 5.4).

The concentrations of lead in surface soils adjacent to No Name Gulch are greater than the sediment ESL. However, there is much uncertainty in extrapolating potential future sediment contamination issues based on nearby soil chemistry. The extent of surface soil contributions to site sediments cannot be predicted.

The low frequency and low magnitude of ESL exceedances by detected concentrations indicates that the potential for risk to benthic organisms from lead in sediment is low.

PAHs in NN AEU

The MDC for total PAHs in NN AEU sediment (5,448 µg/kg) exceeded the screening ESL (1,610 µg/kg). UCL and UTL-EPCs also exceeded the ESL (Table 5.3). The AT for total PAHs is 22,800 µg/kg, a CB-PEC (MacDonald, et al. 2000a).The lack of AT exceedances by EPCs suggests that total PAHs in sediment at NN AEU occur within the range of uncertain toxicity where the potential for adverse effects is possible, but not probable.

The number of detected concentrations exceeding the screening ESL for total PAHs is shown in Table 5.5. While all total PAH concentrations exceeded the ESL, these HQs were all less than 5. The locations of samples exceeding the ESL are shown in Figure 2-20*. There is only one ESL exceedance (14 percent) when only detected concentrations of individual PAHs are summed to determine the total detected PAH concentration. Further analysis revealed the MDC in surface (0-6 inches) sediment (5,002 µg/kg) was also greater than the screening ESL, and less than the AT (Table 5.4). Therefore, due to the lack of AT exceedances, and low magnitude ESL exceedances, these chemical lines of evidence indicate that the risk attributable to total PAHs in NN AEU sediment is low.

The MDC for seven individual PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[g,h,i]perylene, chrysene, indeno[1,2,3-cd]pyrene, phenanthrene, and pyrene) in NN AEU sediment exceeded their respective screening ESLs. Screening ESL-HQs were also > 1 for UCL and UTL-EPCs from the comprehensive sediment data set for all of these PAHs (Table 5.3). UCL and UTL-EPCs did not exceed their respective AT benchmarks (Attachment 5). The low or lack of AT exceedances by EPCs indicates that PAHs in sediment at NN AEU occur within the range of uncertain toxicity where the potential for adverse effects is possible, but not probable.

Concentration distributions for PAHs are provided in Figures 5.12 through 5.18. ESLs for two PAHs (benzo[g,h,i]perylene and indeno[1,2,3-cd]pyrene) are lower than all detected and nondetected concentrations. ESLs were also lower than many of the measured concentrations for all other PAHs. Nondetected concentrations greater than the ESL indicate inadequately low detection limits and contributes to uncertainty regarding the potential for risk from this class of contaminants.

The number of detected and nondetected concentrations exceeding each screening ESL is shown in Table 5.5. Detected concentrations greater than the ESL account for fewer than 14 percent of the total number of samples analyzed for each individual PAH. Benzo(a)pyrene, benzo(a)pyrene, chrysene, phenanthrene, and pyrene did not have detected concentrations with ESL-HQs greater than 5. Only benzo(g,h,i)perylene and indeno(1,2,3,cd)pyrene had detected concentrations with ESL-HQs greater than 5, but only nondetected concentrations were greater than 10. The low frequency of exceedances by detected concentrations suggests there is a low potential for risk from PAHs to benthic populations within the NN AEU. There is moderate confidence in this conclusion due to the uncertainty from inadequately low detection limits for nondetected samples that exceeded ESLs.

Surface sediment MDCs for all PAHs were not different from those in the comprehensive data, so MDC-HQs were unchanged (Table 5.4). UCL and UTL-EPCs were also only slightly lower or slightly higher than for the comprehensive data.

The spatial distribution of individual PAHs in sediment does not generally indicate a potential for risk to benthic populations within the NN AEU (Figures 2.20 through 2.26). Infrequent exceedances for some PAHs were not clustered in small areas that would indicate hot-spots and were limited within true aquatic habitat areas[2]. Results presented within the figures also include all sediment depth fractions, which is misleading if samples represent depths that are not bioavailable to receptors. A sample location immediately downstream of the East Landfill pond had detected concentrations of all individual PAHs, but the extent of this exceedance is uncertain. Most pond samples upgradient of this location, and all channel samples downgradient, did not exceed the ESL. Thus, the extent of potential risks are not shown to be widespread.

The potential contribution to future sediments from four PAHs (benzo[a]pyrene, chrysene, phenanthrene, and pyrene) in surface soils adjacent to NN AEU did not exceed the sediment ESL (Attachment 6). These PAHs are unlikely to contribute soil to NN AEU that would increase the potential for risk. Concentrations of three PAHs (benzo[a]anthracene, benzo[g,h,i]perylene, and indeno[1,2,3-cd]pyrene) in surface soils adjacent to NN AEU exceeded their sediment ESLs. There is much uncertainty in extrapolating potential future sediment contamination issues based on nearby soil chemistry; however, these data suggest that potential contribution of surface soils to the NN AEU is unlikely to adversely affect benthic organisms.

Sediment sample concentration comparisons to chemical toxicity benchmarks found the magnitude of exceedances were less than 10 for all detected concentrations, there was a low frequency of these exceedances, and there was minimal spatial extent of elevated concentrations within aquatic habitat areas. There is also uncertainty regarding the potential for risk conclusion due to inadequate detection limits driving ESL exceedances for nondetected concentrations. The weight-of evidence conclusion for chemical LOEs is that there is a low potential for risk to benthic populations from individual PAHs in sediment at SW AEU.

Confidence in these individual PAH risk characterizations is also low when total PAHs do no exceed the ESL or AT. Screening ESLs for individual PAHs are derived from multiple sources with varying endpoints and organism sensitivities. The consensus-based

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[2] 'True aquatic habitat areas' include the main stream channel and ponds. Samples from ephemeral habitat, overland flow, and ditches are not considered representative of true habitat (Figure 1.7).

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TEC (MacDonald et al. 2000a) used as the total PAH-ESL is a conservative estimate of the toxicity threshold where adverse effects are not expected to occur in most sediment types. There is the highest confidence in this benchmark, which is based on a review of several sources and has a high degree of accurately predicting the absence of toxicity. Likewise, the AT benchmark for total PAHs is a good predictor of when adverse effects are likely. The potential for adverse effects is uncertain for concentrations between these benchmarks.

Total-PAHs evaluate the potential for effects for all PAHs, not only those with known screening benchmarks. The additive toxicity from PAHs is also addressed by total-PAH benchmarks. In these respects the total-PAH screen has less uncertainty than individual PAH SEVs.

The weight-of evidence conclusion for chemical LOEs is that there is a low potential for risk to benthic macroinvertebrates from PAHs in sediment at NN AEU. There is low confidence in this conclusion due to the uncertainty associated with nondetected concentrations above the ESL. However, total-PAHs did not exceed the AT benchmark where the potential for risks is probable, and marginally exceeded the ESL benchmark, below which effects are unlikely.

Other/Drainage Specific Lines of Evidence

Table 5.6 summarizes the findings from other/drainage LOEs gathered for the NN AEU by others. Detailed descriptions of these studies are provided in Attachment 7. The only types of other/drainage LOEs available for the NN AEU include aquatic population studies and waterfowl/wading bird evaluations. The time periods captured by these efforts coincide with the surface water and sediment AEU sample collection dates. Therefore, these studies represent a snap shot in time that coincides with the chemical risk evaluation.

Results of the other/drainage LOEs indicate that the NN AEU is an aquatic ecological setting largely controlled by limited physical habitat and low flow. Discharge measurements along the length of this drainage suggest that the NN AEU has periods of no flow. Seasonal discharge is directly related to conditions of spring snowmelt and rainfall events. Therefore, the aquatic communities within the NN AEU are reflective of opportunistic populations able to utilize transient habitat conditions.

Specifically, aquatic population studies related to NN AEU found relatively healthy and diverse benthic macroinvertebrate communities supported by good water quality in Walnut Creek (Exponent 1998; DOE 1996). Fish and benthic macroinvertebrate communities were adapted to ephemeral flow conditions that limit diversity and abundance (Ebasco 1992; Exponent 1998; Kaiser-Hill 1999, 2000, 2001). These findings are consistent with reference streams and waterbodies in the Rocky Mountain foothills. Although there were no fish captured in the East Landfill pond, frogs, a taxonomic group very sensitive to pollution, were found there (Kaiser-Hill 1999, 2000, 2001).Risk characterizations for waterfowl and wading birds did not exclude risks from several inorganics, but it was determined that incomplete exposure pathways preclude these risks (DOE 1996).

The studies all came to the conclusion that the aquatic assemblages within the NN AEU are typical to aquatic settings with similar habitat features. In other words, there was no evidence of chemical stressor controlling factors to the ecology. One set of studies (Kaiser-Hill 1999, 2000, and 2001) indicated that aquatic species over time were consistent. This provides a LOE that the aquatic community in relatively recent years (1999-2001) is stable and of good condition for the habitat type within the area.

5.1.3 Weight of Evidence Conclusions

The Weight of Evidence (WOE) process is the integrated conclusions from each of the lines of evidence (LOEs) used in risk characterization. Those basic types of LOEs include contaminant toxicity and exposure information as well as drainage-specific studies on aquatic populations, communities, and habitat characteristics.

Overall WOE conclusions are based on best professional judgment and the preponderance of evidence. If risk conclusions were in disagreement, the multiple LOEs were balanced against each other with weights assigned based on the certainty of the risk characterization. Lower confidence was given to risks driven by single LOEs while the greatest confidence was given to those conclusions with supportive, multiple LOEs. Greater weight was also given to LOEs that evaluate the habitat and biological conditions on-site, as opposed to chemical lines of evidence based on desktop modeling with high uncertainty.

The specific LOEs used in the WOE are as follows:

<u>Chemical</u>

- Comparisons of media-specific concentration profiles to ESLs and ATs. (i.e., frequency of exceedances and magnitude of HQs).
- Spatial and temporal pattern of contamination and exceedances.

<u>Biological and habitat</u>

- Hydrology and habitat
- Toxicity studies
- Diversity and abundance characterizations

Weight of evidence conclusions for the NN AEU can be summarized as:

- Magnitude of ESL and AT exceedances:

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- Surface water ECOPCs showed low magnitude HQs for screening ESLs and/or ATs. The only exception was zinc (dissolved).
- The magnitude of sediment ESL-HQs were low (<5) for UTL and UCL-EPCs, except for benzo(g,h,i)perylene and indeno(1,2,3-cd)pyrene.
- HQs for UTL and UCL comparisons to AT benchmarks were all less than one, except for barium (HQ=1).

- Frequency of Exceedances:
  - Almost all surface water ECOPCs had a very low frequency (<20 percent) of HQ exceedances. Zinc and phenanthrene were notable exceptions.
  - Most sediment ECOPCs had a low frequency of ESL exceedances (<20 percent) by detected concentrations, except for aluminum and barium.
- Spatial Distribution:
  - The majority of samples were collected in the East Landfill Pond where the ECOPC concentrations were below detection limits.
  - PAHs had a detected concentration that exceeded individual PAH ESLs at an isolated location at the East Landfill Pond outlet. These exceedances were not widespread.
- Changes over Time:
  - A lack of recent (post-1999) data for ECOPCs prevented meaningful analysis of more recent water quality conditions for most surface water ECOPCs.
- Surface sediment MDCs were generally not different from the comprehensive sediment database ESLs and did not influence the potential for risk to benthic organism communities.
- Drainage-specific habitat and ecological studies:
  - Several studies indicate that aquatic life within the NN AEU is primarily limited by natural conditions associated with the ephemeral and intermittent character of the drainage hydrology.
  - There was no indication that contaminant stressors were affecting the ecology.
  - AT benchmarks based on acute exposure (instead of chronic) are most appropriate due to the intermittent nature of flows in the drainage. Those AT values yielded the lowest evidence of chemical risk.
  - Habitat conditions were consistent with reference locations in the front range.

- Benthic macroinvertebrate communities were healthy and consistent with reference locations.

In summary, the LOEs gathered from the risk characterization generally agree that there is no or low potential for risk to the aquatic populations within the NN AEU caused by contaminant chemistry alone. The seasonal hydrologic regime and local topography are most important in determining the makeup of the local aquatic communities and in mitigating any small potential for chemical-based risk. In contrast to the strong effects of intermittent flows and seasonal hydrologic regime, the observations indicating the possibility of low, chemically-based risk were mostly based on uncertain toxicological endpoints and low and infrequent exceedances which would be unlikely to produce population and community effects, an observation supported by the various other LOEs and special studies. The WOE conclusion is that that there is low or no potential for risk to the aquatic populations within the NN AEU.

5.2 Risk Characterization of the RC AEU

There were no ECOPCs identified for the RC AEU. Therefore, a chemical risk characterization was not completed. There is no potential for risk to aquatic populations within the RC AEU.

5.3 Risk Characterization of the MK AEU

ECOPCs were identified for surface water and sediment within the MK AEU. A chemical risk characterization using the various LOEs was completed for these chemicals. The MK AEU has seen minimal study by others in areas of other/drainage lines of evidence. This risk characterization begins with a site ecological setting description in order to provide perspective regarding the aquatic ecosystem characteristics associated with the MK AEU. The chemical risk LOEs and the other/drainage LOE are then described, followed by a weight-of-evidence summary of these risk descriptors.

5.3.1 Site-Specific Habitat Description

The MK AEU is located in the north BZ and contains McKay Ditch, McKay Bypass Canal, the McKay Ditch Diversion Pipeline, and Upper Church Ditch. These conveyance ditches carry water across the site but remain hydrologically isolated from Walnut Creek or Rock Creek and from the IA Exposure Unit. McKay Ditch typically transports water in June and July, but can receive flows from precipitation in late March into April. It was formerly a tributary to Walnut Creek within the RFETS boundaries, but was diverted in July 1999 into a new pipeline to prevent McKay Ditch water from co-mingling with RFETS water originating from discharge waters from the site retention ponds. This new configuration allows the City of Broomfield to transport water from the South Boulder Diversion Canal across the northern Rocky Flats BZ and directly into the Great Western Reservoir without entering Walnut Creek. Small flows are still allowed to reach Walnut Creek as habitat mitigation. The Upper Church Ditch typically conveys water from June through July each year. It can also have spring flows from precipitation, but these are

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ephemeral. During the remaining time, the McKay and Upper Church ditches are dry except during runoff events.

McKay Ditch contains wetland habitats including short marsh, cattails, and woody riparian vegetation (Kaiser-Hill 2000). Aquatic environments are found below rip-rap grade structures in the form of small pools. Upper Church Ditch is a grass-lined depression surrounded by xeric tallgrass prairie. There is very little wetland vegetation (Kaiser-Hill 2000) in the ditch, and aquatic habitats are largely absent.

There has been no aquatic macroinvertebrate sampling in the MK AEU. It is assumed that only ephemeral aquatic habitats are available and that aquatic communities are depauperate, if not lacking all together. Small pools located within McKay Ditch likely contain aquatic communities of colonizers and hardy taxa adapted to ephemeral conditions. Fish sampling has been attempted, but no fish have been recorded from this AEU (Kaiser-Hill 1999).

Characterization of the aquatic habitat found in the MK AEU is of primary consideration with regards to aquatic risk. Currently, ephemeral flows exist that support some aquatic species adapted to long periods of dry conditions. Given the fact that IA-accelerated actions are not expected to affect this AEU, the nature of aquatic communities is expected to remain unchanged.

5.3.2 Exposure and Risk Characterization

Tables 5.7 to 5.11 provide the HQs for the surface water and sediment ECOPCs. HQs derived from the ESL and AT values for each chemical are provided for MDC, UCL, and UTL EPCs. Table 5.11 provides the frequency and magnitude of HQs based on ESLs. The results of the chemical risk characterization are presented below by medium (surface water and sediment) and by chemical.

Chemical Risk Characterization Lines of Evidence

<u>Surface Water ECOPCs</u>

Aluminum (Total)

The MDC for aluminum in MK AEU surface water (46 mg/L) exceeded the screening ESL (0.75 mg/L). In addition, the ESL HQs for UCL and UTL-EPCs were both greater than 1. All 39 samples (39 of 39 detected) from MK AEU surface waters exceeded the screening ESL for aluminum. These samples were collected between July 1991 and January 2005. The high frequency of exceedances by detected concentrations (100 percent) suggests that the potential for adverse effects cannot be excluded.

Aluminum toxicity in surface water is complex and the ESL (CDPHE 2002; EPA 2002) is based on guidance that is not entirely appropriate for surface waters of Colorado. The EPA and the State of Colorado have recognized that total aluminum measurements often measure non-toxic clay fractions in surface water and that the true EPC would fall between the dissolved and total fraction concentrations. However, the total aluminum fraction was selected as a basis for comparison to the standards as a conservative measure (Attachment 5). Therefore, a 0.750-mg/L acute criterion value should be used instead of the 87 chronic value when pH is greater than 6.9 and hardness is more than 50 parts per million (ppm) (Colorado Basic Standards Work Group, October 8, 2004). AT HQs could not be calculated due to a lack of literature-derived AT values. The potential for adverse effects indicated by aluminum is low, because the three samples greater than the ESL did not exceed that level by a high frequency (12 percent) or magnitude (HQs less than 2). These samples exceeding the ESL represent historic samples collected between March 1992 and May 1995. While both dissolved and total fractions of aluminum in surface water exceed the ESL, it is uncertain whether the potential for adverse effects to water column organisms exists at the MK AEU due to the complexity of aluminum toxicity from to pH and clay particulates in surface waters.

The concentration distribution of aluminum (total) is shown in Figure 5.19. Aluminum was detected in 100 percent of the samples. A total of 29 of 39 detected concentrations of total aluminum (74 percent) exceeded the refined ESL; however, only three of 26 dissolved aluminum concentrations (17 of 26 detected) exceeded this refined ESL (Table 5.11). This indicates that aluminum concentrations generally occur within the range of uncertainty where s the potential for adverse effects is possible.

The spatial distribution of aluminum concentrations relative to the screening level ESL is shown in Figure 2.35. All locations had measured concentrations greater than the ESL. However, these concentrations were within the range of those reported in background samples (Attachment 3). Therefore, the potential for risk attributable to aluminum (total) is within the range of risk attributable to background.

Review of the post-1999 (January 2000 through 2005) data set identified an MDC of 1.7 mg/L for aluminum which is considerably less than the AEU comprehensive data set MDC (Table 5.8). This post-1999 MDC still exceeds the ESL (HQ=2), but the low magnitude exceedance may represent current exposure conditions more accurately than the comprehensive data.

The chemical LOEs for aluminum support a low but uncertain risk conclusion. There is a paucity of available literature from which to characterize the potential for risk with any certainty. However, the post-1999 surface water data may provide the most accurate representation of current site conditions. The low magnitude exceedance from post-1999 data suggests that the potential for risks to aquatic life from aluminum in surface water are low in MK AEU. Given the fact that the measured concentrations are within the range of background for this AEU, the chemical LOE conclusion indicates there is low but uncertain potential for adverse effects to aquatic life attributable to this ECOPC.

Cadmium (Dissolved)

The MDC for cadmium in MK AEU surface water (0.003 mg/L) exceeded the screening ESL of 0.00025 mg/L. A total of three detected samples (five of 26 detected) from MK AEU surface waters exceeded the screening ESL for cadmium. These samples were collected between March 1992 and May 1995. The low frequency of exceedances by detected concentrations (12 percent) suggests that potential adverse effects may not be widely distributed.

The cadmium ESL is hardness-dependant and was calculated after CDPHE (2005a) using an estimated hardness of 100 for the CRA Methodology. Site-specific hardness was determined to be 198 (Attachment 5), and a refined ESL based on this site-specific hardness is 0.00374 mg/L. The AT for cadmium is 0.00897 mg/L. The MDC for cadmium (dissolved) does not exceed the refined ESL and the HQs for the UCL and UTL EPCs do not exceed the refined ESL or AT; therefore, there is no potential for risk from cadmium in surface water at the MK AEU.

The data concentration distribution is provided in Figure 5.20. All of the detected concentrations occur below the AT value, while the average concentration is below the ESL and AT values.

The spatial distribution of cadmium relative to the screening ESL is shown in Figure 2.36. Three locations within the MK AEU have detected concentrations greater than the screening ESL. However, none of these samples exceeded the refined ESL. Therefore, there is no potential for risk to aquatic receptors from cadmium in MK AEU surface water.

Selenium (Total)

The MDC for selenium in MK AEU surface water (0.005 mg/L) slightly exceeded the screening ESL of 0.0046 mg/L. Only one detected sample (3 of 39 detected) from the MK AEU surface water exceeded the screening ESL for selenium. This sample was collected in November 1995. The low frequency of exceedances by detected concentrations (3 percent) suggests that potential adverse effects may not be widely distributed (Table 5.11).

The screening ESL for selenium was derived from CDPHE (2005a). Alternative screening benchmarks presented in MacDonald et al. (1999) range from 0.001 mg/L for the Canadian surface water guideline (CCME 1999) up to 0.260 mg/L for the Oregon Department of Ecology acute screening value (ODEQ 1996). An acute surface water benchmark value of 0.0184 mg/L was considered the site-wide AT value (CDPHE 2005a). The MDC does not exceed the AT for selenium. Therefore, despite the MDC marginally exceeding the screening level ESL by a low magnitude (HQ less than 1.1) and low frequency, the selenium MDC does not exceed the AT and is unlikely to pose a potential for risk to water column organisms in the MK AEU.

UCL and UTL statistics exceeded the MDC and were considered invalid. Therefore, the MDC was used as a surrogate for both EPCs and HQs did not differ from those previously calculated (Table 5.7). The magnitude and frequency of HQ values for the data set based on the screening ESL are presented in Table 5.11. The one detected concentration and seven nondetected concentrations had HQs < 5, indicating a low potential for risk to aquatic populations. The sample location for this detected exceedance is shown in Figure 2.37.

The data concentration distribution is provided in Figure 5.21. Approximately 60 percent of the values fall below the ESL and AT value, while the average concentration is comparable to the ESL and below the AT value.

Selenium (total) was not detected in the two samples collected post-1999 (January 2000 through 2005) (Table 5.8). This indicates that current conditions indicate a low likelihood for risk to aquatic populations from selenium.

The potential risk attributable to selenium (total) is within the range of risk of background concentrations. In addition, the low frequency and magnitude of ESL exceedances by detected and nondetected concentrations indicate a very low potential for adverse effects to aquatic life attributable to selenium in surface water.

Zinc (Dissolved)

The MDC for zinc in MK AEU surface water (0.245 mg/L) slightly exceeded the screening ESL of 0.118 mg/L for dissolved zinc. Two detected samples (22 of 26 detected) from the MK AEU surface waters exceeded the screening ESL for zinc. These samples were collected in August and September 1994. The low frequency of exceedances by detected concentrations (8 percent) suggests that potential adverse effects may not be widely distributed.

The zinc ESL is hardness-dependant and was calculated after CDPHE (2005a) using an estimated hardness of 100 for the screening value. Site-specific hardness was determined to be 198 (Attachment 5), and a refined ESL based on this site-specific hardness is 0.211 mg/L. The MDC for zinc (dissolved) is the only sample to exceed this refined ESL (an HQ of 1.2). Despite the MDC exceeding the refined site-specific ESL, the frequency of exceedances and the magnitude of this exceedance were low. HQs for UCL and UTL EPCs using the derived site-specific ESL yielded values ranging from less than 1 to 1, respectively (Table 5.7). HQs for UCL and UTL EPCs using the AT (0.21 mg/L), the acute value) also yielded values from less than 1 to 1. Therefore, it is unlikely that zinc in surface water poses a potential for risk to water column organisms in the MK AEU.

The magnitude and frequency of site-specific ESL derived HQ values for the data set are presented in Table 5.11. Sample concentrations drove HQs below 5, indicating a low risk potential. More than 90 percent of the sample concentrations were less than the ESL and AT value (Figure 5.22). These concentrations were also within the range of reported values for background samples.

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The spatial distribution of zinc relative to the screening ESL is shown in Figure 2.38. The one sample exceeding the ESL was collected outside of the MK AEU channel and within a stormwater drainage ditch was found to have a measured value greater than the ESL. This sample does not represent media with a complete exposure pathway to aquatic organisms. The samples collected from the channel itself had concentrations below the ESL.

The potential risk attributable to zinc (dissolved) is within the range of risk attributable to background, the sample exceeding the ESL does not represent a complete exposure pathway, and the ESL exceedance was infrequent and of low magnitude. The potential for risk to aquatic life attributable to zinc in MK AEU surface water is excluded.

Sediment ECOPCs

Aluminum

The MDC for aluminum in MK AEU sediment (30,300 mg/kg) exceeded the sediment screening ESL (15,900 mg/kg). The ESL is based on the 85th percentile concentration in streams (TNRCC 1996; cited in MacDonald et al. 1999), which defined the SQG by the TNRCC. HQs for the UCL and UTL EPCs compared to the ESL yielded values ranging from 1 to 2, respectively (Table 5.9). HQs for the UCL and UTL EPCs compared to the AT yielded values less than 1.

Alternative screening benchmarks ranged from 14,000 mg/kg effects range low (ERL[3]), to 58,000 mg/kg ERM, and a high NEC of 73,000 mg/kg (Ingersoll et al. 1996). The AT for aluminum is the ERM value of 58,000 mg/kg (Ingersoll et al. 1996), representative of a median effect level for benthic invertebrates (Attachment 5).

Aluminum was detected in 100 percent (12 of 12) of the samples. The concentration distribution is provided in Figure 5.23. Only three detected concentrations exceeded the ESL, and HQs were less than 5 (Table 5.11). All of these detected concentrations were below the AT, where the potential for adverse effects are probable. The potential for adverse effects associated with this ESL is therefore low, but uncertain.

The spatial distribution of aluminum in sediment relative to the ESL is shown in Figure 2.39. One of the locations where aluminum concentrations exceeded the ESL occurs outside of the flow pathway and represents a stormwater sediment source gathered from a stormwater ditch (rather than true aquatic habitat). The other 2 samples occur in the channel between samples with concentrations below the ESL; therefore, the extent of any potential for risk is not widespread. In addition, aluminum in the adjacent surface soils did not exceed the sediment ESL, indicating aluminum in eroded soils may not contribute to future risk.

[3] Not used as an ESL because this value was noted as unreliable (Ingersoll et al. 1996) where fewer than five samples designated as toxic for the chemical, or the number of toxic samples with concentrations below the SEC was greater than the number of toxic samples with concentrations above the SEC.

These chemical LOEs do not suggest that aluminum is a potential risk driver in MK AEU sediment. Therefore, there is a low potential for risk concern to aquatic life attributable to aluminum.

Chromium

The MDC for chromium in the MK AEU sediment (44.3 mg/kg) exceeded the screening ESL of 43.4 mg/kg. The ESL was based on a consensus-based TEC (MacDonald et al. 2000a), at which the potential for adverse effects are first observed. Validation of this benchmark found that 72 percent of samples (n=347) below this concentration were accurately predicted to be non-toxic to benthic macroinvertebrates. The potential for adverse effects is uncertain at concentrations greater than this ESL, and below the AT, a consensus-based PEC (111 mg/kg). ESL-HQs for the UCL and UTL-EPCs yielded values of less than 1 and 1, respectively (Table 5.9). HQs for the UCL and UTL-EPCs compared to the AT yielded values less than 1. The potential for risks to benthic organisms from chromium in sediment is possible, but not probable.

Chromium was detected in 100 percent (12 of 12) of the samples. All samples yielded HQ values less than 5 (Table 5.11), with only one HQ > 1. The concentration distribution is provided in Figure 5.24. All of the detected concentrations occurred below the alternative toxicity value, where the potential for adverse effects are probable. Therefore, it is unlikely that chromium, exceeding the screening level ESL in only one sample, poses an unacceptable risk to benthic populations that inhabit the MK AEU.

The spatial distribution of chromium relative to the ESL is shown in Figure 2.40. The one location where chromium exceeded the ESL represents a stormwater sediment source gathered from a stormwater ditch (rather than true aquatic habitat). Therefore, the extent of any potential for risk is not widespread. This sample represents an incomplete exposure pathway for sediment organisms and is not representative of McKay Ditch. In addition, chromium in the adjacent surface soils occurs below the sediment ESL, indicating no potential future erosional contributions to sediment that might pose a risk.

In summary, the chemical risk LOEs gathered for chromium indicate there is a low potential for risk concern to aquatic life attributable to this metal.

Fluoride

The MDC for fluoride in MK AEU sediment (8.47 mg/kg) exceeded the screening ESL of 0.010 (HQ=847). However, only one sample was analyzed for fluoride from the MK AEU sediments. This sample was collected in March 1995.

The ESL is based on the TEL for the *Hyalella azteca* 28-day sediment bioassay (Ingersoll et al. 1996). Alternative SQGs for fluoride (as fluorine) range from the 0.021-mg/kg British Columbia SQG (Nagpal et al. 1998) to the Washington Ecology SQG of 96 mg/kg (Cubbage et al. 1997). The chosen AT is 7 mg/kg. HQs for UCL and UTL EPCs could not be calculated due to the small data set (sample size of one).

The magnitude and frequency of the HQ values are shown in Table 5.11. Fluoride was analyzed in only one sample at the MK AEU and, therefore, the detected concentration distribution was not provided due to the small sample size. The measured value of 8.47 slightly exceeds the AT value (HQ=1).

The location of the single fluoride sample is shown in Figure 2.41. Spatial trends could not be evaluated. However, it should be noted that this sample was collected from a stormwater drainage ditch, which is outside of the MK AEU channel. Thus, there are no samples analyzed for fluoride that represent aquatic habitat with complete exposure pathways to benthic organisms in MK AEU.

The potential for adjacent surface soils to act as a potential future exposure consideration could not be evaluated due to a lack of available sample data.

The lack of available data from sediment in MK AEU representing complete exposure pathways to benthic organisms is an uncertainty. Therefore, the potential for risk from fluoride to benthic organisms in MK AEU is not known and it is retained as an uncertainty.

Nickel

The MDC for nickel in the MK AEU sediment (28.3 mg/kg) slightly exceeds the screening ESL of 22.7 mg/kg. The ESL was based on a consensus-based TEC (MacDonald et al. 2000a), at which the potential for adverse effects are first observed. Validation of this benchmark found that 72 percent of the samples (n=347) below this concentration were accurately predicted to be non-toxic to benthic macroinvertebrates. The potential for adverse effects is uncertain at concentrations greater than this ESL, and below the AT, a consensus-based PEC of 48.6 mg/kg.

HQs for the UCL and UTL-EPCs compared to the ESL yielded values of less than 1 and 1, respectively (Table 5.9). HQs for the UCL and UTL EPCs compared to the AT yielded values less than 1. The magnitude and frequency of ESL-HQ values are shown in Table 5.11. Only one sample yielded an HQ greater than 1 and this was less than 5. Nickel was detected in 92 percent (11 of 12) of the samples. The concentration distribution is provided in Figure 5.25. All of the detected concentrations occurred below the alternative toxicity value, where the potential for adverse effects are probable. Therefore, it is unlikely that nickel, exceeding the screening level ESL in only one sample, poses an unacceptable risk to benthic populations that inhabit the MK AEU.

The spatial distribution of nickel relative to the ESL is shown in Figure 2.42. The location of the single sample exceeding the ESL is adjacent to the channel within a stormwater drainage ditch. The exposure pathway from this sample media to benthic organisms is incomplete and not representative of aquatic habitat at MK AEU. In addition, nickel concentrations in the adjacent surface soils do not exceed the sediment ESL, indicating a low potential for future contributions to sediment that may pose a risk.

In summary, the chemical risk LOEs for nickel indicate that there is no to low potential for risk to aquatic life attributable to this metal.

Selenium

The MDC for selenium in the MK AEU sediment (2.7 mg/kg) exceeded the screening ESL of 1.0 mg/kg. This ESL was based on the 85th percentile concentration in streams (TNRCC 1996; cited in MacDonald et al. 1999), which defined the SQG by TNRCC. The potential for adverse effects associated with this ESL is low because the single sample that exceeded the selenium ESL did not exceed that level by a high magnitude (HQ less than 3). Alternative screening benchmarks ranged from 1.73 for the 85th percentile concentration in reservoirs (TNRCC 1996) up to 5.0 mg/kg for the British Columbia SQG (Nagpal et al. 1998), with a chosen AT value of 1.7 mg/kg. HQs for the UCL and UTL-EPCs compared to the ESL yielded values of 1 and 3, respectively (Table 5.9). HQs for the UCL and UTL EPCs compared to the AT yielded values of less than 1 and 2, respectively.

The magnitude and frequency of HQ values are shown in Table 5.11. The only detected result to exceed the ESL had an HQ of less than or equal to 5. Selenium was detected 1 of 12 (8 percent) of samples. The concentration distribution is provided in Figure 5.26. Only one detected concentration exceeded the AT benchmark (HQ=2), where the potential for adverse effects are probable. Therefore, despite the MDC exceeding the screening level ESL and AT, the frequency and magnitude of these exceedances were low and it is unlikely that selenium in sediment poses a potential for unacceptable risk to benthic organisms in the MK AEU.

The spatial distribution of selenium relative to the Screening ESL is shown in Figure 2.43. The location of the single sample exceeding the ESL is adjacent to the channel within a stormwater drainage ditch. The exposure pathway from this sample media to benthic organisms is incomplete and not representative of aquatic habitat at MK AEU. The distribution of selenium samples does not indicate a trend typically associated with a source or hot-spot.

Selenium concentrations in the surface soils adjacent to McKay Ditch could not be evaluated due to the lack of applicable data (Attachment 6).

The chemical risk LOEs gathered for selenium indicate that there is low to no potential for risk to aquatic life attributable to this metal.

5.3.3 Other/Drainage Specific Lines of Evidence

Table 5.12 provides a summary of the other/drainage LOEs gathered by previous studies. The MK AEU has not been extensively studied. Only one set of studies involving the evaluation of aquatic populations was obtained from the literature reviewed (Kaiser-Hill 1999, 2000, and 2001). Results provide a LOE regarding the aquatic ecosystem condition within the MK AEU.

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Specifically, Kaiser-Hill studies evaluated aquatic ecological conditions throughout RFETS over time (1999 through 2001). Results indicate that aquatic species are affected by habitat variables. The primary controlling factor to the ecology is low discharge. The MK AEU undergoes periods where flows are completely absent from the system. The MK AEU predominantly provides seasonal habitat following periods of snowmelt or high rainfall events. Otherwise, habitat and aquatic ecology are extremely limited.

There were no signs of chemical stressors affecting the aquatic ecology. The study determined that aquatic conditions were consistent over the duration of the study, indicating that the ecology was at a stable state. There appeared to be no controlling factor affecting the ecology with the exception of habitat and low flow.

5.3.4 Weight-of-Evidence Conclusions

The WOE process is the integrated conclusions from each of the LOE used in risk characterization. Those basic types of LOEs include contaminant toxicity and exposure information as well as drainage-specific studies on aquatic populations, communities, and habitat characteristics.

Overall WOE conclusions are based on best professional judgment based on the preponderance of evidence. If risk conclusions were in disagreement, the multiple LOEs were balanced against each other with weights assigned based on the certainty of the risk characterization. Lower confidence was given to risks driven by single LOEs while the greatest confidence was given to those conclusions with supportive, multiple LOEs. Greater weight was also given to LOEs that evaluate the habitat and biological conditions on-site, as opposed to chemical lines of evidence based on desktop modeling with high uncertainty.

The specific LOEs used in the WOE are as follows:

<u>Chemical</u>

- Comparisons of media-specific concentration profiles to ESLs and ATs. (i.e., frequency of exceedances and magnitude of HQs).
- Spatial and temporal pattern of contamination and exceedances.

<u>Biological and habitat</u>

- Hydrology of drainage
- Toxicity studies
- Diversity and abundance characterizations

Weight of evidence conclusions for the MK AEU can be summarized as:

- Magnitude of ESL or AT exceedances:
  - Most surface water contaminants showed low magnitude HQs for either primary ESLs or ATs. The only exception was aluminum.
  - Sediment ESL-HQs were generally low (<5) for UTL and UCL-EPCs, except for fluoride.
- Frequency of Exceedances:
  - Almost all surface water contaminants had a very low frequency of HQ exceedances. Aluminum was the only exception.
  - Most sediment ECOPCs had a low frequency of ESL exceedances (< 20 percent) by detected concentrations. Aluminum was the only exception.
- Spatial Distribution:
  - All detected sediment ECOPCs that exceeded the ESL were found outside the primary aquatic habitats (stream channels and ponds). Thus, aluminum, chromium, nickel, and selenium in MK AEU sediment were determined to pose no risk to benthic invertebrates.
  - Fluoride was retained as an uncertainty because the only sample represents an incomplete exposure pathway.
  - Most surface water ECOPCs were widely dispersed and rarely concentrated in aquatic habitat areas.
- Change in Exceedances over Time:
  - A lack of recent (post-1999) data for ECOPCs prevented meaningful analysis of more recent water quality conditions for cadmium and zinc in surface water.
  - Aluminum and selenium showed reduced concentrations in post-1999 data.
- Surface sediment MDCs were not different from the comprehensive sediment database ESLs and did not influence the potential for risk.
- Drainage-specific habitat and ecological studies:
  - Several studies indicate that aquatic life within the MK AEU is primarily limited by natural conditions associated with the ephemeral and intermittent character of the drainage hydrology.
  - There was no indication that contaminant stressors were affecting the ecology.

- AT benchmarks based on acute exposure (instead of chronic) are most appropriate due to the intermittent nature of flows in the drainage. Those AT values yielded the lowest evidence of chemical risk.
- Habitat conditions were consistent with reference locations in the Front Range.
- Benthic macroinvertebrate communities were consistent with reference locations.

In summary, the weight of evidence gathered from the risk characterization indicates that there is no or low potential for risk to the aquatic populations within the MK AEU caused from contaminant chemistry alone. The seasonal hydrologic regime and local topography are most important in determining the makeup of the local aquatic communities and in mitigating any small potential for chemical-based risk. In contrast to the strong effects of intermittent flows and seasonal hydrologic regime, the observations indicating the possibility of low, chemically-based risk were mostly based on uncertain toxicological endpoints and low and infrequent exceedances which would be unlikely to produce population and community effects, an observation supported by the various other LOEs and special studies.

5.4 Risk Characterization of the SE AEU

There were no ECOPCs identified for the SE AEU. Therefore, a chemical risk characterization was not completed. There is no potential for risk to aquatic populations within the SE AEU.

6.0 UNCERTAINTIES ASSOCIATED WITH THE ECOLOGICAL RISK ASSESSMENT

Quantitative evaluation of ecological risks is limited by uncertainties regarding the assumptions used to predict risk and the data available for quantifying risk. These limitations are usually circumvented by making estimates based on the data available or by making assumptions based on professional judgment when data are limited. Because of these assumptions and estimates, the results of the risk calculations themselves are uncertain, and it is important for risk managers and the public to view the results of the risk assessment with this in mind. The following sections summarize the various sources of uncertainty in the CRA, along with a qualitative estimate of the direction and magnitude of the likely errors attributable to the uncertainty.

6.1 Uncertainties Associated With Data Adequacy and Quality

Section 1.2 and Attachment 2 discuss the general data adequacy and data quality, respectively, for the AEUs. Data of sufficient quality for ERA purposes were collected in surface water and sediment for each AEU.

6.2 Uncertainties Associated with the Ecological Contaminants of Potential Concern Identification Process

The ECOPC process was designed to eliminate chemicals that are not likely to be of ecological concern within the AEUs. This procedure included a comparison of MDCs to ESLs, a frequency of detection evaluation, a comparison to background, an EPC screen against the ESL, and a professional judgment evaluation. Use of this ECOPC identification process ensures that only those ECOIs related to historic site operations of toxicological significance are retained for additional quantitative evaluation.

6.2.1 Uncertainties Associated with the Selection of Representative Receptors

ESLs were developed for both surface water and sediment for aquatic receptors that potentially inhabit the AEUs within RFETS. There are uncertainties associated with the selection of aquatic life receptors, which includes aquatic invertebrates and plants as well as fish for all the AEUs. These receptors were chosen based on field observations from historic investigative activities. The receptors were selected based on several criteria, including their potential to be found in the various aquatic habitats present throughout RFETS, their potential to come into contact with ECOIs, and their potential sensitivities to ECOIs. However, there is an inherent uncertainty in evaluating the risk to all potential receptors that have varying life histories and may not show the same response to contaminant exposure.

6.2.2 Uncertainties Associated with Exposure Assumptions

Exposure was quantified using conservative assumptions regarding the life history and behavioral parameters for this group of receptors. These parameters were used to estimate the amount of contact a receptor may have with contaminated media by various exposure routes. The following parameters were assumed as part of the exposure assessment:

- Aquatic receptors are exposed throughout their life cycle to ECOIs present within surface water and sediment within a given AEU; and
- Aquatic habitat is available year-round within a given AEU; therefore, receptors do not migrate to other areas (i.e., AEUs) in absence of suitable habitat and, thereby, integrate exposure elsewhere.

The use of these assumptions adds uncertainty to the CRA because they may not reflect actual site-related conditions. For example, flows within at least portions of all of the AEUs are seasonal. In particular, flows are entirely absent from No Name Gulch, McKay Ditch, and portions of Smart Ditch during most of the year, with the exception of a storm event or spring snowmelt.

Because no species-specific studies were conducted to determine site-specific habitat use patterns for aquatic receptors, conservative assumptions had to be applied. Aquatic receptors were assumed to spend 100 percent of their life cycle within a given AEU.

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Therefore, there is uncertainty involved with estimating exposure to ECOPCs by using these techniques that could overestimate the actual risk to the receptors.

In regards to exposure estimation, an additional source of uncertainty may lie with the assessment for the NN AEU and MK AEU, which was based on a limited data set. The DQA determined that data in the NN AEU were adequate for assessing risks, given that no sources of contamination are likely present in the RC AEU and SE AEU. However, the limited data set does introduce some uncertainty into the exposure analysis. This uncertainty may underestimate or overestimate exposure.

Finally, the relative bioavailability of ECOPCs in surface water and sediment can create significant uncertainty in the risk characterization process. Such uncertainty can affect the EPCs used to estimate bioavailable forms (for example, dissolved metal in solution) as well as the toxicity endpoints used to derive AT values (ATs). Surface water ATs for divalent metals, for example, are generally based on toxicity associated with the bioavailable forms, which is assumed to be represented by the chemical in dissolved soluble form. ECOIs associated with the site, however, are in forms that may not be as readily absorbed by ecological receptors.

Bioavailability and ecotoxicity of environmental contaminants are integrally linked to their environmental concentrations and chemical forms (EPA 1999). The toxicity of a contaminant is controlled by:

- Its environmental concentration;
- Its site-specific chemistry (especially its ionic solubility and speciation if a metal or metalloid);
- The physical matrix in which the contaminant is found; and
- The uptake pathway(s) into a target organism from its physical matrix.

Organic carbon (OC) in sediments binds nonpolar (non-ionic) organic contaminants to render them non-bioavailable (Mahony et al. 1996). If the total organic carbon (TOC) in NN AEU sediments is higher than the 1 percent TOC assumed in the ESLs, then these ESLs will be more conservative than necessary to protect benthic organisms. TOC at RFETS waterbodies ranged from 0.05 to 5.4 percent (1.1 ± 0.9 percent; n=176). Higher OC in sediments is derived from decomposition of leaves and organic matter, producing a dark spongy soil. Site investigations indicate that pond sediment, averaging 1.4 ± 1.1 percent TOC (n=58), is generally darker and richer in OC than the assumed 1 percent. Sediment accumulation areas in the ponds, streams (backwaters and pools), and marshy areas with emergent vegetation can produce TOC-rich sediment (greater than 5 percent) and electrochemically-reduced sediments that will produce sulfide. Acid volatile sulfides (AVS) bind metals when the sediments are anaerobic (Ankley et al. 1996). Therefore, sulfide and TOC likely to be present in the soft sediments of low-energy microhabitats, including pond bottoms, will serve to detoxify metals and certain organic contaminants.

All of these factors helped determine the exposure matrix for organisms in the field. Because the interplay of these factors determines the site-specific bioavailability and, thus, the potential expression of ecologically relevant effects, predictions of toxicity based solely on total concentrations in various environmental media have questionable scientific validity (EPA 1999). Therefore, assessment of ecological risks and the potential adverse effects of a contaminant required an understanding of the exposure matrix that may lead to actual uptake by a receptor species. The overall effect of the uncertainties related to unknown bioavailability may overestimate or underestimate the calculated risk.

6.2.3 Uncertainties Associated with Development of 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 (Calabrese and Baldwin 1993) when extrapolations are made from:

- Acute to chronic endpoints;
- One life stage to an entire life cycle;
- 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 overestimation or underestimation of risk, depending on RFETS-specific conditions, the types of receptors included in the evaluation, and the particular ECOIs.

The CRA Methodology 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

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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.

6.3 Uncertainties Associated with ECOPCs with Elevated Reporting Limits

For certain organic chemicals, the analytical reporting limits can vary significantly, especially for solid media analysis where the media may cause interference with the analytical method. At times, the reported limit can be greater than the ESL and introduce an uncertainty into the risk characterization process. For this assessment, the organic sediment ECOPCs were evaluated to determine if reported limits do occur at levels greater than the ESL and the AT benchmarks. HQ distributions for these ECOPCs are presented in Section 5 tables and differentiate between ESL exceedances by detected and nondetected concentrations.

6.4 Uncertainties Associated with the Lack of Toxicity Data for Ecological Contaminants of Interest

Several ECOIs detected in the AEUs did not have adequate toxicity data available in the published literature for the derivation of ESLs (CRA Methodology). The ECOPC identification process identified ECOIs of uncertain toxicity for each AEU (Tables 6.1 and 6.2).

Several of these surface water ECOIs are not expected to pose a risk to aquatic organisms. Calcium, iron, magnesium, potassium, and sodium are macronutrients or rock-forming elements, and are not generally considered toxic to aquatic life. Radionuclide ESLs are available for all detected individual radionuclides and, therefore, the lack of ESLs for gross alpha and gross beta activities is not expected to affect the ERA. The potential for risk from these ECOPCs is uncertain.

Benthic macroinvertebrate sediment ESLs were not available for 19 inorganic ECOIs (beryllium, boron, calcium, cesium, cobalt, lithium, magnesium, molybdenum, nitrate/nitrite, potassium, silica, silicon, sodium, strontium, thallium, tin, titanium, uranium, and vanadium), 6 organics (2,4-dinitro-2-methylphenol, 4-nitrophenol, acetone, benzo[b]fluoranthene, benzoic acid, and methylene chloride), and 3 radionuclides (cesium-134, gross alpha, and gross beta). Several of these sediment ECOIs are not expected to pose a risk to benthic organisms. Calcium, magnesium, nitrate/nitrite, potassium, silica, and sodium are considered macronutrients or rock-forming elements, and are not generally considered toxic to aquatic life. Radionuclide ESLs are available for all detected individual radionuclides and, therefore, the lack of ESLs for gross alpha and gross beta activities is not expected to affect the ERA. The potential for risk from these ECOPCs is uncertain.

This evaluation focused upon the assessment of ECOPCs within surface water and sediment exposure media to aquatic receptors. ECOPCs associated with one media can transport to the other through various biological and physico-chemical processes. It is possible that one media can act as a source of contamination to another. Of particular interest and concern to aquatic receptors is the possible dissolution of sediment associated ECOPCs to surface water. Because there was a lack of available ESLs for certain sediment chemicals for which there were surface water ESLs, it is possible that potentially toxic sediment-related chemicals could have been overlooked, despite being identified as surface water ECOPCs. In order to address this potential data gap, an evaluation of sediment ECOIs that lack ESLs, but not surface water ESLs, was completed.

Tables 6.3 through 6.6 present the sediment ECOIs for each AEU that lacked ESLs and were identified as uncertainties. Within these tables, the AEU-specific surface water information is presented. For many of these chemicals, there was also a lack of surface water ESL information; therefore, these will remain chemicals of uncertain toxicity. Others had low frequencies of detection (less than 10 percent) in either surface water or sediment, occurred below background levels, were common elements with low toxicity and considered non-toxic, or were not identified as surface water ECOPCs as part of the screening process. The results for each AEU are as follows:

- For the NN AEU, there were inorganic, organic, and radionuclide sediment ECOIs of uncertain toxicity (Table 6.3). Several inorganic and organic sediment ECOIs had surface water ESLs available to evaluate risks to aquatic organisms from the same ECOI in surface water (beryllium, boron, cobalt, lithium, molybdenum, strontium, thallium, tin, vanadium, acetone, and methylene chloride). These ECOIs, for which there were surface water ESLs, were not identified as surface water ECOPCs.

- For the RC AEU, there were inorganic, organic, and radionuclide sediment ECOIs of uncertain toxicity (Table 6.4). Several inorganic and organic sediment ECOIs had surface water ESLs available to evaluate risks to aquatic organisms from the same ECOI in surface water (beryllium, boron, cobalt, lithium, molybdenum, strontium, thallium, tin, uranium, vanadium, acetone, benzoic acid, and methylene chloride). These ECOIs, for which there were surface water ESLs, were not identified as surface water ECOPCs.

- For the MK AEU, there were inorganic, organic, and radionuclide sediment ECOIs of uncertain toxicity (Table 6.5). Several inorganic and organic sediment ECOIs had surface water ESLs available to evaluate risks to aquatic organisms from the same ECOI in surface water (beryllium, boron, cobalt, lithium, molybdenum, strontium, thallium, tin, uranium, and vanadium). These ECOIs, for which there were surface water ESLs, were not identified as surface water ECOPCs.

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- For the SE AEU, there were inorganic sediment ECOIs of uncertain toxicity (Table 6.6). Several ECOIs of uncertain toxicity in sediment had surface water ESLs available to evaluate risks to aquatic organisms from the same ECOI in surface water (beryllium, boron, cobalt, lithium, molybdenum, strontium, thallium, uranium, and vanadium). These ECOIs, for which there were surface water ESLs, were not identified as surface water ECOPCs.

Because the surface water data set from which this evaluation was completed is comprehensive and represents surface water conditions since 1991, there is confidence in the conclusion that the sediment ECOIs of uncertain toxicity do not pose a potential for risk to surface water organisms.

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

ECOPCs in the RC AEU (cadmium and lead in surface water; aluminum, arsenic, barium, cadmium, iron, lead, selenium, silver, zinc, and pentachlorophenol in sediment) and in the SE AEU (silver in surface water; aluminum, barium, iron, and selenium in sediment) were eliminated as ECOPCs based on professional judgment (Attachment 3). No sources of contaminants or patterns of release were identified in the AEUs, and the slightly elevated concentrations of these ECOPCs in the AEUs were most likely due to natural variation. The weight of evidence supports the conclusion that concentrations of these ECOPCs are naturally occurring and not due to site activities. Uncertainty associated with the exclusion of risk from these chemicals is low.

7.0 SUMMARY AND CONCLUSIONS

This section provides a summary of conclusions relating to risk to aquatic life, as well as a summary of risk conclusions for waterfowl and wading bird receptors as identified from the DOE (1996) report.

7.1 Aquatic Life Receptors

Multiple LOEs were gathered to evaluate the aquatic risk conditions to water column organisms and benthic macroinvertebrates within the NN AEU, RC AEU, MK AEU, and SE AEU. An evaluation of the potential for risk from contaminants in sediment and surface water was conducted using a standard HQ approach as well as other contaminant risk lines of evidence. Additional LOEs gathered from other/drainage studies were also compiled with the contaminant risk evaluation in order to formulate a risk conclusion.

Conservative values representing EPCs of the data (e.g., MDC, 95 UTL, and 95 UCL) were compared to conservative ESL benchmark values in the chemical risk evaluation. Refined ESLs and more realistic exposure considerations were integrated as final lines of evidence in order to provide a more accurate and realistic representation of risk. An AT benchmark indicating the concentrations where the potential for adverse effects are probable was also compared to the EPCs to evaluate the likelihood and magnitude of risk. In addition to these EPCs, data were evaluated on a point-by-point basis and mapped to identify the extent of potential risk.

Following an initial screen of contaminants and professional judgment evaluation, the potential for risk was excluded for all contaminants in RC AEU and SE AEU. ECOPCs identified in NN AEU and MK AEU could not be excluded from posing a potential risk in this conservative screening assessment, but upon further risk characterization they were all determined to pose no significant risk potential. A low frequency and magnitude of sample concentrations exceeding the ESL and AT benchmarks was found for ECOPCs. There were also few locations where observed concentrations exceeded ESL benchmarks.

The aquatic conditions within the AEUs, evaluated by other studies that are summarized here, indicate that these drainages are limited by flow conditions and habitat. The aquatic life within the system is highly susceptible to changes in flow and, in turn, is represented as an opportunistic assemblage of aquatic invertebrates. No studies have indicated water or sediment quality is a controlling factor to the ecology, and species assemblages are comparable to reference areas.

In summary, the multiple LOEs support a weight-of-evidence conclusion that there is no significant risk to aquatic life within NN AEU, RC AEU, MK AEU, and SE AEU attributable to ECOPCs. Past conditions in these watersheds, determined through several habitat and risk evaluations, supports the conclusion that aquatic life is not significantly affected by residual chemical exposure from activities at the RFETS.

7.2 Waterfowl and Wading Bird Receptors

The results of this assessment provide conclusions regarding NN AEU, RC AEU, MK AEU, and SE AEU risk settings for aquatic life species of fish, invertebrates, and aquatic plants. Waterfowl and wading birds are also important receptors with regard to AEU exposure; however, the purpose of this assessment did not encompass these receptors. The risk to waterfowl and wading birds had been previously evaluated by DOE (1996). The ECOPC process identified a small set of surface water ECOPCs requiring further evaluation. The risk characterization provided LOEs that found the surface water ECOPCs pose insignificant risk to aquatic life. The results of the DOE (1996) waterfowl and wading bird evaluations were included as a LOE within the risk characterization, supporting this conclusion of no significant risk.

DOE completed an evaluation of sediment-related ECOCs in order to determine the potential exposure and risk to the great blue heron and mallard avian wildlife receptors (DOE 1996). Avian exposures to manganese and strontium exceeded screening levels by a low magnitude, and these metals were identified as ECOCs. However, the exposure pathway for avian piscivores and avian invertivores in NN AEU was considered incomplete due to the lack of food (few macroinvertebrate communities and no fish). No other surface water or sediment contaminants were determined to pose risk to avian

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piscivores or avian invertivores residing or feeding in the East Landfill Pond of NN AEU. Therefore, the risk to waterfowl and wading birds in NN AEU is not considered significant.

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TABLES

Table ES.1
Surface Water ECOPCs by AEU

ECOPC	No Name	Rock Creek	McKay Ditch	Southeast
Inorganics				
Aluminum (T)			x	
Ammonia (T)				
Antimony (T)				
Barium (T)	x			
Beryllium (T)				
Cadmium (D)			x	
Chromium (D)				
Cobalt (D)				
Copper (D)				
Cyanide (T)				
Fluoride (T)				
Iron (D)				
Lead (D)	x			
Lithium (T)				
Manganese (D)				
Mercury (D)				
Nickel (D)				
Nitrite				
Selenium (T)			x	
Silver (D)	x			
Strontium (T)				
Tin (T)				
Vanadium (T)				
Zinc (D)	x		x	
Organics				
Pentachlorophenol	x			
Phenanthrene	x			
Total ECOPCs	**6**	**0**	**4**	**0**

T = Total metal.
D = Dissolved metal.
The ECOPC selection was conducted on the MDC, either dissolved or total.
x - Indicates analyte is an ECOPC.

Table ES.2

Sediment ECOPCs by AEU

ECOPC	No Name	Rock Creek	McKay Ditch	Southeast
Inorganics				
Aluminum	x		x	
Antimony				
Arsenic				
Barium	x			
Cadmium				
Chromium			x	
Copper				
Fluoride			x	
Iron	x			
Lead	x			
Manganese				
Mercury				
Nickel			x	
Selenium			x	
Silver				
Zinc				
Organics				
Benzo(a)anthracene	x			
Benzo(a)pyrene	x			
Benzo(g,h,i)perylene	x			
Chrysene	x			
Indeno(123-cd)pyrene	x			
Pentachlorophenol				
Phenanthrene	x			
Pyrene	x			
Total PCBs				
Dioxin -TEQ				
Total ECOPCs	**11**	**0**	**5**	**0**

x - Indicates analyte is an ECOPC.

Table 1.1
AEU IHSSs

IHSS	PAC/UBC	Name	OU	EU	AEU
166.1	NE-166.1	Trench A	BZ	NNEU	NN AEU
166.2	NE-166.2	Trench B	BZ	NNEU	NN AEU
166.3	NE-166.3	Trench C	BZ	NNEU	NN AEU
167.1	NE-167.1	Landfill North Area Spray Field	BZ	NNEU	NN AEU
167.2	NE-167.2	Pond Area Spray Field (Center Area)	BZ	NNEU	NN AEU
167.3	NE-167.3	South Area Spray Field	BZ	NNEU	NN AEU
168	000-168	West Spray Field	BZ	IDEU	MK AEU
170	NW-170	PU&D Storage Yard - Waste Spills	BZ	NNEU	NN AEU
195	NW-195	Nickel Carbonyl Disposal	BZ	IDEU	RC AEU
203	NW-203	Inactive Hazardous Waste Storage Area	BZ	NNEU	NN AEU
174A	NW-174A	PU&D Yard Container Storage Area (drum)	BZ	NNEU	NN AEU
174B	NW-174B	PU&D Container Storage Facilities (dumpster)	BZ	NNEU	NN AEU
N/A	000-501	Roadway Spraying (originally identified as 000-501 in HRR Qtly Update 4; reassigned as 100-613 in the HRR Qtly Update 7)	IA, BZ	IAEU, IDEU, LWOEU, UWOEU, SEEU, NNEU, UWNEU, SWEU, WBEU	NW AEU, RC AEU, MK AEU, WC AEU, SE AEU
N/A	100-604	T130 Complex Sewer Line Leaks	IA	IAEU	MK AEU
N/A	NE-1400	Tear Gas Powder Release	BZ	NNEU, IDEU	MK AEU
N/A	NW-1500	Diesel Spill at PU&D Yard (originally identifed as NW-175 in HRR Quarterly Update No. 3; reassigned as NW-1500 in HRR Quarterly Update No. 7)	BZ	NNEU	NN AEU
N/A	NW-1501	Asbestos Release at PU&D Yard (originally identified as NW-176 in HRR Quarterly Update No. 3; reassigned as NW-1501 in HRR Quarterly Update No. 7)	BZ	NNEU	NN AEU
N/A	NW-1502	Improper Disposal of Diesel-Contaminated Material at Landfill (originally identifed as NW-177 in HRR Quarterly Update No. 2; reassigned as NW-1502 in HRR Quarterly Update No. 7)	BZ	NNEU	NN AEU
N/A	NW-1503	Improper Disposal of Fuel-Contaminated Material at Landfill	BZ	NNEU	NN AEU
N/A	NW-1504	Improper Disposal of Thorosilane-Contaminated Material at Landfill	BZ	NNEU	NN AEU
N/A	NW-1505	North Firing Range	BZ	NNEU	NN AEU

N/A = Not available or not applicable.

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Table 1.2
Number of Samples Collected in Each AEU by Medium and Analyte Suite

AEU	Analyte Suite	Total Number of Results for Surface Water		Total Number of Results for Sediment
		Total	Dissolved	
NN AEU	Inorganics	87	32	20
	Organics	148	N/A	16
	Radionuclides	86	14	23
RC AEU	Inorganics	110	42	22
	Organics	43	N/A	22
	Radionuclides	43	5	20
MK AEU	Inorganics	40	27	12
	Organics	14	N/A	8
	Radionuclides	38	1	13
SE AEU	Inorganics	14	7	7
	Organics	7	N/A	N/A
	Radionuclides	11	2	9

N/A = Not applicable.

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Table 1.3
Summary of Surface Water ECOI Data in the NN AEU

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Inorganics (mg/L) Total							
Aluminum	0.00025 - 0.2	70	81.4	0.017	55.4	2.537	8.48
Ammonia[1]	0.015 - 0.1	3	33.3	1.50	1.50	0.522	0.847
Antimony	0.00005 - 0.06	72	15.2	5.90E-04	0.015	0.006	0.007
Arsenic	0.00035 - 0.01	69	40.6	7.00E-04	0.015	0.002	2.23E-03
Barium	0.00002 - 0.2	72	100	0.003	0.820	0.334	0.241
Beryllium	0.00001 - 0.005	71	28.2	3.00E-05	0.003	3.43E-04	4.14E-04
Cadmium	0.00003 - 0.005	73	12.3	9.00E-05	0.001	7.37E-04	7.78E-04
Calcium	0.0016 - 5	71	100	1.56	166	79.4	47.6
Chloride	0.2 - 50	29	96.6	5.60	286	112	81.7
Chromium	0.0001 - 0.0275	72	50.0	1.70E-04	0.044	0.004	0.007
Cobalt	0.00001 - 0.05	72	41.6	1.60E-04	0.012	0.002	0.002
Copper	0.00004 - 0.025	72	55.5	4.50E-04	0.044	0.004	0.006
Fluoride	0.05 - 0.5	28	96.4	0.290	0.950	0.578	0.202
Iron	0.0021 - 0.1	71	100	0.016	117	21.3	30.8
Lead	0.00001 - 0.0058	71	53.5	5.40E-04	0.051	0.003	0.008
Lithium	0.00002 - 0.1	63	96.8	0.006	0.098	0.030	0.024
Magnesium	0.00008 - 5	71	100	0.354	54.6	25.4	14.4
Manganese	0.00001 - 0.015	71	90.1	0.002	1.52	0.470	0.603
Mercury	0.000014 - 0.0002	69	10.1	1.10E-04	0.001	1.16E-04	1.72E-04
Molybdenum	0.00003 - 0.2	67	40.3	1.60E-04	0.021	0.003	0.004
Nickel	0.00005 - 0.04	72	62.5	1.00E-03	0.036	0.007	0.007
Nitrate / Nitrite	0.05 - 0.5	36	36.1	0.070	1.90	0.183	0.402
Nitrite	0.02 - 0.05	17	5.9	0.031	0.031	0.013	0.007
Phosphorus	0.05 - 0.05	16	43.8	0.057	0.150	0.062	0.047
Potassium	0.0021 - 5	71	95.7	1.23	19.0	5.77	3.37
Selenium	0.0002 - 0.005	72	18.0	0.001	0.038	0.002	0.005
Silicon	0.0073 - 0.1	26	100	0.076	18.3	5.67	4.23
Silver	0.00002 - 0.01	72	9.7	3.20E-04	0.004	0.001	0.001
Sodium	0.00038 - 5	71	100	0.316	195	74.5	58.6
Strontium	0.00002 - 0.2	67	100	0.005	1.23	0.613	0.346
Sulfate	0.5 - 25	31	83.8	0.460	143	21.3	28.7
Thallium	0.00001 - 0.012	72	9.7	0.001	0.007	0.001	0.001
Tin	0.00004 - 0.2	62	12.9	6.80E-04	0.057	0.007	0.011
Uranium	0.002 - 0.039	26	03.8	2.70E-03	0.003	0.003	0.005
Vanadium	0.00002 - 0.05	72	54.2	0.00054	0.10	0.007	0.014
Zinc	0.00009 - 0.02	72	77.7	0.003	2.22	0.251	0.569
Inorganics (mg/L) Dissolved							
Aluminum	0.005 - 0.2	29	34.5	0.008	0.155	0.027	0.030

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Table 1.3
Summary of Surface Water ECOI Data in the NN AEU

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Antimony	0.00048 - 0.06	31	12.9	0.022	0.032	0.013	0.009
Arsenic	0.00058 - 0.01	30	36.7	6.50E-04	0.002	0.001	4.81E-04
Barium	0.00005 - 0.2	31	100	0.004	0.640	0.305	0.194
Beryllium	0.00002 - 0.005	30	13.3	5.10E-04	0.001	4.18E-04	2.68E-04
Cadmium	0.00008 - 0.005	32	3.13	0.003	0.003	0.001	7.77E-04
Calcium	0.0041 - 5	30	100	1.88	168	79.3	47.9
Cesium	0.5 - 1	24	16.7	0.050	0.100	0.201	0.087
Chromium	0.00015 - 0.0275	31	6.5	0.004	0.004	0.002	0.002
Cobalt	0.00018 - 0.05	31	29.0	0.001	0.009	0.003	0.002
Copper	0.00025 - 0.025	31	41.9	0.002	0.012	0.004	0.003
Iron	0.0034 - 0.1	30	90.0	0.008	95.8	24.1	35.9
Lead	0.00072 - 0.003	32	15.6	1.00E-03	0.005	8.69E-04	8.71E-04
Lithium	0.00005 - 0.1	28	85.7	0.004	0.090	0.037	0.029
Magnesium	0.0007 - 5	30	100	0.320	51.0	30.7	13.3
Manganese	0.00005 - 0.015	29	82.8	0.001	1.50	0.514	0.655
Molybdenum	0.0003 - 0.2	28	10.7	8.80E-04	0.004	0.003	0.001
Nickel	0.0003 - 0.04	31	25.8	0.004	0.025	0.007	0.005
Potassium	0.007 - 5	30	100	0.598	13.4	5.78	3.29
Selenium	0.001 - 0.0065	32	9.4	0.011	0.043	0.003	0.008
Silicon	0.0073 - 0.1	24	100	0.104	10.8	5.58	3.45
Silver	0.00026 - 0.01	32	15.6	0.004	0.013	0.003	0.002
Sodium	0.0105 - 5	30	100	0.270	185	94.2	60.4
Strontium	0.00002 - 0.2	28	100	0.007	1.20	0.669	0.307
Tin	0.00068 - 0.2	28	7.1	0.022	0.032	0.012	0.010
Vanadium	0.0002 - 0.05	31	22.6	0.003	0.016	0.003	0.003
Zinc	0.00012 - 0.02	31	74.2	0.002	1.50	0.259	0.466
Organics (ug/L) Total							
1,1,1-Trichloroethane	0.01 - 5	138	0.7	1.00	1.00	0.953	0.857
1,1-Dichloroethane	0.03 - 5	138	58.0	0.390	10.0	2.63	2.13
1,1-Dichloroethene	0.04 - 5	138	1.4	0.520	1.70	0.958	0.859
1,2,3-Trichlorobenzene	0.05 - 1	97	6.2	0.100	1.30	0.503	0.259
1,2,3-Trichloropropane	0.02 - 10	98	1.02	0.700	0.700	0.583	0.645
1,2,4-Trichlorobenzene	0.06 - 12	116	12.1	0.100	3.00	1.22	1.69
1,2,4-Trimethylbenzene	0.02 - 1	97	41.2	0.190	2.20	0.688	0.481
1,2-Dichlorobenzene	0.03 - 12	116	32.8	0.240	0.900	1.19	1.68
1,2-Dichloroethene	1 - 5	37	5.4	4.00	4.00	2.26	0.855
1,2-Dichloropropane	0.03 - 5	138	5.1	0.100	0.960	0.938	0.868
1,3,5-Trimethylbenzene	0.03 - 1	97	16.5	0.100	0.900	0.478	0.242
1,3-Dichlorobenzene	0.02 - 12	116	12.9	0.100	0.600	1.20	1.68
1,4-Dichlorobenzene	0.03 - 12	116	31.0	0.200	0.660	1.20	1.68

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Table 1.3
Summary of Surface Water ECOI Data in the NN AEU

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
2,4-Dimethylphenol	2.9 - 330	72	8.3	0.600	3.00	6.78	18.9
2-Butanone	0.42 - 10	101	6.9	2.00	17.0	4.23	1.99
2-Methylnaphthalene	1.5 - 330	73	31.5	1.00	23.0	7.43	19.0
2-Nitrophenol	1.8 - 330	72	1.4	2.00	2.00	7.05	18.9
4-Bromophenyl-phenylether	0.029 - 330	71	1.4	3.00	3.00	7.14	19.0
4-Chlorotoluene	0.02 - 1	98	1.0	0.300	0.300	0.501	0.218
4-Isopropyltoluene	0.02 - 2.5	96	17.7	0.100	3.00	0.484	0.279
4-Methylphenol	2.1 - 330	65	4.6	1.00	3.00	7.17	19.9
Acenaphthene	1 - 330	73	43.8	1.00	4.90	6.06	18.9
Acenaphthylene	1 - 330	71	1.4	2.00	2.00	7.13	19.0
Acetone	1 - 10	114	39.5	0.670	43.0	6.52	6.40
alpha-BHC	0.05 - 0.056	7	28.6	0	0.360	0.070	0.128
Anthracene	1.6 - 330	72	5.6	0.600	0.600	6.80	19.0
Benzene	0.01 - 5	139	42.4	0.240	2.50	1.28	0.832
Benzo(a)pyrene	1.4 - 330	71	1.4	1.00	1.00	7.08	19.0
Benzo(b)fluoranthene	2.2 - 12	56	1.8	0.700	0.700	4.78	0.956
Benzo(g,h,i)perylene	1.7 - 330	71	1.4	2.00	2.00	7.10	19.0
Benzo(k)fluoranthene	2 - 12	52	1.9	0.900	0.900	4.76	0.975
Benzoic Acid	9 - 1700	68	20.6	0.600	15.0	31.6	101
beta-BHC	0.05 - 0.056	7	28.6	0	0	0.018	0.012
bis(2-ethylhexyl)phthalate	3.1 - 330	72	47.2	0.400	140	7.82	17.9
Bromoform	0.09 - 5	139	1.4	0.100	0.700	0.947	0.855
Butylbenzylphthalate	1.6 - 330	71	8.5	0.700	4.00	6.91	19.1
Carbazole	10 - 10	4	25.0	3.00	3.00	4.50	1.00
Chlorobenzene	0.02 - 5	139	23.7	0.240	0.950	0.931	0.867
Chlorodifluoromethane	N/A	3	100	4.00	68.0	25.3	37.0
Chloroethane	0.13 - 10	139	57.6	2.60	62.0	11.3	10.8
Chloroform	0.01 - 5	139	0.7	0.590	0.590	0.946	0.856
Chloromethane	0.1 - 10	139	3.6	0.100	7.00	1.61	1.92
cis-1,2-Dichloroethene	0.03 - 1	97	19.6	0.100	0.600	0.477	0.237
delta-BHC	0.05 - 0.056	7	28.6	0	0.180	0.044	0.061
Dibenz(a,h)anthracene	1.3 - 330	71	1.4	2.00	2.00	7.10	19.0
Dibenzofuran	4.2 - 330	73	32.9	0.600	2.00	5.86	19.0
Dichlorodifluoromethane	0.22 - 20	96	16.7	0.200	24.0	1.38	3.64
Dichlorofluoromethane	N/A	1	100	16.0	16.0	16.0	N/A
Diethylphthalate	1.1 - 330	72	23.6	0.700	10.0	6.31	19.1
Di-n-butylphthalate	1.1 - 330	72	23.6	0.400	48.0	4.83	5.40
Di-n-octylphthalate	1.5 - 330	71	1.4	2.00	2.00	7.10	19.0
Ethylbenzene	0.04 - 5	138	37.7	0.100	17.0	2.73	3.93
Fluorene	1.3 - 330	73	41.1	1.00	3.00	5.88	18.9

Table 1.3
Summary of Surface Water ECOI Data in the NN AEU

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
gamma-BHC (Lindane)	0.05 - 0.056	7	28.6	0	0	0.018	0.012
Heptachlor	0.05 - 0.056	7	28.6	0	0	0.018	0.012
Hexachlorobutadiene	0.05 - 12	116	2.6	0.100	0.690	1.22	1.67
Hexachloroethane	2.2 - 330	71	1.4	10.0	10.0	7.21	19.0
Indeno(1,2,3-cd)pyrene	1.2 - 330	71	1.4	2.00	2.00	7.10	19.0
Isophorone	2.3 - 330	71	1.4	0.200	0.200	7.24	19.0
Isopropylbenzene	0.02 - 1	96	44.8	0.320	2.00	0.673	0.344
Methylene Chloride	0.01 - 10	138	38.4	0.090	37.0	1.69	3.53
Naphthalene	0.02 - 20	117	58.1	0.760	41.0	7.68	9.13
n-Butylbenzene	0.03 - 1	98	5.1	0.100	0.700	0.495	0.225
n-Propylbenzene	0.03 - 1	97	33.0	0.180	1.00	0.491	0.249
Pentachlorophenol	2.7 - 1700	72	5.6	1.00	10.0	33.2	97.8
Phenanthrene	1.3 - 330	73	39.7	2.80	6.00	6.59	18.8
Phenol	0.78 - 330	76	9.2	0.500	5,000	138	694
Pyrene	2 - 330	71	1.41	2.00	2.00	7.13	19.0
sec-Butylbenzene	0.03 - 1	98	11.2	0.100	0.400	0.473	0.235
Styrene	0.1 - 5	138	0.7	3.00	3.00	0.967	0.875
Tetrachloroethene	0.02 - 5	138	1.4	0.200	0.200	0.945	0.861
Toluene	0.02 - 5	138	38.4	0.180	47.0	2.58	7.59
trans-1,2-Dichloroethene	0.03 - 1	97	5.15	0.100	0.100	0.414	0.258
Trichloroethene	0.03 - 5	138	17.4	0.100	2.00	0.944	0.850
Trichlorofluoromethane	0.24 - 10	98	3.06	0.370	0.770	0.553	0.502
Vinyl Chloride	0.01 - 10	138	34.8	0.330	11.0	2.02	2.03
Xylene	0.41 - 5	132	43.2	0.250	24.0	2.76	4.27
Radionuclides (pCi/L) (Total)							
Americium-241	0 - 0.185	77	100.0	-0.015	0.033	0.003	0.009
Cesium-137	0.43 - 1.16	20	100.0	-0.607	1.20	0.220	0.462
Gross Alpha	1.4002 - 8.68	27	100.0	-1.20	8.20	2.55	2.38
Gross Beta	1.46199 - 12	28	100.0	0.560	20.0	9.44	3.50
Plutonium-238	0.005791 - 0.02939	5	100.0	-0.002	0.019	0.006	0.010
Plutonium-239/240	0 - 0.081	76	100.0	-0.006	0.056	0.005	0.010
Radium-226	0.13 - 0.211	2	100.0	0.130	0.230	0.180	0.071
Strontium-89/90	0.2 - 1	15	100.0	0.600	4.06	1.33	0.869
Tritium	205.0143 - 460	42	100.0	-130.80	1,500	189	252
Uranium-233/234	0 - 0.5356	61	100.0	-0.024	4.07	1.09	0.900
Uranium-235	0 - 0.263	61	100.0	-0.012	0.338	0.058	0.066
Uranium-238	0.01216 - 0.4183	61	100.0	-0.010	3.65	0.938	0.808

N/A = Not available.

[1] total ammonia reported

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Table 1.4
Summary of Sediment ECOI Data in the NN AEU

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Inorganics (mg/kg)							
Aluminum	4.4 - 40	20	100	6,000	24,000	14,689	5,247
Arsenic	0.14 - 2	20	100	3.60	7.10	5.41	1.08
Barium	0.15 - 40	20	100	92.6	390	192	80.3
Beryllium	0.025 - 1	20	95.0	0.600	1.20	0.918	0.188
Boron	1.5 - 2	10	100	4.80	10.0	7.06	1.79
Cadmium	0.056 - 1.2	20	10.0	0.110	0.160	0.251	0.215
Calcium	2.7 - 1000	20	100	2,280	74,000	11,400	15,253
Cesium	95.2 - 200	8	12.5	3.90	3.90	36.8	25.4
Chromium	0.06 - 2	20	95.0	3.70	25.0	13.8	6.26
Cobalt	0.12 - 10	20	100	4.30	11.8	7.84	1.79
Copper	0.074 - 5	20	100	5.70	19.1	15.8	2.92
Iron	1.2 - 20	20	100	9,050	21,500	15,513	3,194
Lead	0.36 - 1.3	20	100	12.0	37.6	20.4	5.99
Lithium	0.29 - 20	18	94.4	4.30	15.0	9.40	3.03
Magnesium	5.8 - 1000	20	100	1,200	4,200	3,003	756
Manganese	0.15 - 3	20	100	78.0	1,100	254	226
Mercury	0.0054 - 0.13	20	55.0	0.017	0.090	0.051	0.015
Molybdenum	0.2 - 40	18	61.1	0.260	5.20	0.947	1.10
Nickel	0.2 - 8	20	100	7.00	17.0	12.8	2.10
Nitrate / Nitrite	0.2 - 1.1	10	70.0	0.638	3.20	1.32	0.978
Potassium	36 - 1000	20	95.0	989	2,810	1,640	618
Selenium	0.22 - 1	19	31.6	0.410	0.880	0.459	0.203
Silica	1.5 - 2	10	100	1,400	2,000	1,720	230
Silicon	0 - 4.4	6	100	153	417	267	95.6
Silver	0.072 - 2	20	5.00	0.340	0.340	0.321	0.288
Sodium	8.6 - 1000	20	85.0	38.1	600	148	128
Strontium	0.092 - 40	18	100	33.4	320	70.3	64.8
Thallium	0.29 - 2	20	45.0	0.310	2.30	0.443	0.497
Tin	0.56 - 40	18	27.8	7.70	16.6	5.57	6.53
Titanium	0.22 - 0.29	10	100	59.0	150	93.8	27.6
Vanadium	0.35 - 10	20	100	18.7	59.0	35.9	11.7
Zinc	0.49 - 4	20	100	29.1	110	64.1	17.3
Organics (ug/kg)							
1,2,4-Trimethylbenzene	1.1 - 1.5	10	60.0	1.40	4.60	2.87	0.994
2-Butanone	5.4 - 12	16	6.25	13.0	13.0	10.3	3.54
Acetone	5.3 - 12	16	62.5	6.10	99.0	22.9	23.2
Anthracene	26 - 400	16	12.5	37.0	51.0	187	60.6

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Table 1.4
Summary of Sediment ECOI Data in the NN AEU

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Benzo(a)anthracene	28 - 400	16	37.5	42.0	150	220	146
Benzo(a)pyrene	45 - 400	16	12.5	98.0	160	316	131
Benzo(b)fluoranthene	32 - 400	16	25.0	56.0	190	278	145
Benzo(g,h,i)perylene	30 - 400	16	12.5	71.0	89.0	310	140
Benzo(k)fluoranthene	36 - 400	16	6.25	110	110	333	125
bis(2-ethylhexyl)phthalate	81 - 400	16	31.3	36.0	220	280	146
Chrysene	31 - 400	16	25.0	44.0	190	273	150
Di-n-butylphthalate	23 - 400	16	6.25	34.0	34.0	330	133
Fluoranthene	25 - 400	16	37.5	79.0	340	248	133
Indeno(1,2,3-cd)pyrene	25 - 400	16	12.5	57.0	86.0	309	142
Methylene Chloride	0.92 - 6.1	16	62.5	2.60	3.30	5.57	6.52
Naphthalene	0.99 - 400	16	18.8	1.70	2.50	76.4	99.8
Phenanthrene	39 - 400	16	37.5	57.0	280	237	138
Pyrene	150 - 400	16	12.5	210	320	333	113
Toluene	0.9 - 6	16	12.5	8.00	190	15.1	46.7
Radionuclides (pCi/g)							
Americium-241	0 - 0.196	21	100	-0.037	0.130	0.027	0.034
Cesium-134	0.0409 - 0.097	5	100	1.28E-04	0.167	0.081	0.061
Cesium-137	0.03 - 0.12	9	100	0.064	1.21	0.293	0.356
Gross Alpha	1.7 - 56	9	100	4.82	37.0	19.1	9.97
Gross Beta	2.08071 - 21	9	100	6.45	32.0	22.4	8.82
Plutonium-239/240	0 - 0.17	23	100	-0.014	0.447	0.042	0.092
Radium-226	0.14 - 0.51	5	100	0.910	1.53	1.22	0.234
Radium-228	0.06 - 0.89	7	100	1.10	1.62	1.30	0.174
Strontium-89/90	0.04 - 1.02	9	100	0.036	1.04	0.265	0.310
Uranium-233/234	0.022 - 0.385	21	100	0.480	1.51	0.974	0.229
Uranium-235	0 - 0.385	21	100	0	0.143	0.062	0.035
Uranium-238	0 - 0.281	21	100	0.500	1.58	0.982	0.228

N/A = Not applicable.

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Table 1.5
Summary of Surface Water ECOI Data in the RC AEU

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Inorganics (mg/L) (Total)							
Aluminum	0.00025 - 0.2	109	89.9	0.018	129	5.11	15.2
Antimony	0.00005 - 0.06	110	11.8	4.10E-04	0.006	0.006	0.007
Arsenic	0.00032 - 0.01	108	35.2	6.40E-04	0.017	0.002	0.003
Barium	0.00002 - 0.2	109	99.0	0.003	0.630	0.092	0.076
Beryllium	0 - 0.005	109	24.7	3.00E-05	0.004	4.26E-04	5.97E-04
Cadmium	0.00003 - 0.005	108	6.5	6.00E-05	0.004	7.46E-04	8.63E-04
Calcium	0.0016 - 5	109	100	1.53	152	28.5	16.81
Cesium	0.0001 - 1	44	9.1	0.006	0.060	0.124	0.117
Chloride	0.1 - 5	98	93.9	0.990	76.0	13.0	10.8
Chromium	0.00005 - 0.01	110	49.1	1.90E-04	0.247	0.009	0.030
Cobalt	0.00001 - 0.05	109	31.2	0.00026	0.019	0.002	0.003
Copper	0.00004 - 0.025	106	62.3	4.70E-04	0.048	0.005	0.009
Cyanide	0.005 - 0.02	34	5.9	0.002	0.026	0.006	0.005
Fluoride	0.03 - 0.5	98	95.9	0.100	1.00	0.374	0.162
Iron	0.0021 - 0.1	109	98	0.014	88.6	3.54	10.4
Lead	0.00003 - 0.005	106	55.6	1.20E-04	0.051	0.004	0.009
Lithium	0.00002 - 0.1	102	77.4	0.001	0.154	0.011	0.019
Magnesium	0.00008 - 5	109	99.0	0.355	18.2	6.59	2.90
Manganese	0.00001 - 0.015	109	94.5	0.001	0.492	0.046	0.077
Mercury	0.000013 - 0.0002	104	9.6	3.50E-05	4.77E-03	8.61E-05	5.74E-05
Molybdenum	0.00003 - 0.2	102	40.1	4.80E-04	0.008	0.002	0.002
Nickel	0.00005 - 0.04	109	50.4	8.20E-04	0.120	0.008	0.016
Nitrate / Nitrite	0.02 - 1	40	65	0.060	2.07	0.489	0.519
Nitrite	0.02 - 0.1	32	3.1	0.058	0.058	0.019	0.012
Ortho-phosphate	0.02 - 0.05	20	5	0.110	0.110	0.029	0.019
Phosphate	0.01 - 0.05	16	68.8	0.020	0.060	0.025	0.013
Phosphorus	0.01 - 0.05	27	33.3	0.050	0.180	0.048	0.040
Potassium	0.00035 - 5	109	93.6	0.370	15.4	2.42	2.09
Selenium	0.0002 - 0.0067	105	27.6	4.10E-04	0.019	0.0014	0.002
Silica	0.023 - 0.023	3	100	19.0	21.0	20.3	1.15
Silicon	0.0105 - 0.5556	46	100	0.064	177	13.6	26.9
Silver	0.00003 - 0.01	110	2.7	6.00E-05	2.40E-04	7.47E-04	7.68E-04
Sodium	0.00038 - 5	109	100	0.309	35.0	16.5	6.82
Strontium	0.00038 - 0.2	102	99.0	0.005	0.703	0.167	0.086
Sulfate	0.1 - 50	98	99	1.32	258	29.1	26.1
Sulfide	1 - 1	33	6.1	6.00	16.0	1.14	2.83
Thallium	0.00005 - 0.01	110	9.1	2.40E-04	0.008	9.73E-04	0.001

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Table 1.5
Summary of Surface Water ECOI Data in the RC AEU

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Tin	0.00016 - 0.2	99	10.1	9.90E-04	0.019	0.006	0.011
Titanium	0.0026 - 0.0026	3	33.3	0.011	0.011	0.005	0.006
Uranium	0.0021 - 0.028	26	7.7	0.003	0.004	0.004	0.004
Vanadium	0.00002 - 0.05	109	60.5	3.80E-04	0.132	0.010	0.023
Zinc	0.00008 - 0.02	108	75.0	7.20E-04	0.480	0.022	0.050
Inorganics (mg/L) (Dissolved)							
Aluminum	0.0187 - 0.2	42	54.8	0.019	1.05	0.129	0.223
Antimony	0.0002 - 0.06	42	16.7	0.005	0.029	0.014	0.007
Arsenic	0.0007 - 0.01	41	7.3	0.002	0.004	0.001	0.001
Barium	0.0002 - 0.2	42	100	0.00	0	00.1	00.0
Cadmium	0.0002 - 0.005	42	14	1.40E-03	0.003	0.001	0.001
Calcium	0.0174 - 5	42	100	1.53E+00	137.000	24.498	2.14E+01
Cesium	0.0001 - 1	41	24.4	0.001	0.14	0.128	0.108
Chromium	0.0002 - 0.01	41	7.3	0.002	0.015	0.002	0.002
Cobalt	0.0001 - 0.05	42	7	0.000	00.0	0.00	0.00
Copper	0.001 - 0.025	42	5.00E+01	0.001	0.022	4.10E-03	4.93E-03
Iron	0.0047 - 0.1	40	92.5	0.009	3.190	0.240	0.511
Lead	0.0001 - 0.005	41	29	0.000	0.01	0.00	0.00
Lithium	0.001 - 0.1	42	47.6	0.001	00.0	0.00	0.01
Magnesium	0.0296 - 5	42	100	0.266	14.7	05.2	2.87
Manganese	0.0004 - 0.015	42	92.9	0.001	0.486	0.027	0.077
Mercury	0.0002 - 0.0002	41	2	0.00477	0.00477	0.000	7.30E-04
Molybdenum	0.0001 - 0.2	42	21.4	0.002304	0.0058	0.003	0.001
Nickel	0.0006 - 0.04	42	7.1	1.41E-03	0.007	0.005	0.003
Potassium	0.3 - 5	42	92.9	5.14E-01	9.200	1.954	1.545
Selenium	0.001 - 0.0067	42	7.1	1.50E-03	0.004	0.001	0.001
Silicon	0.0152 - 0.1	42	100	5.96E-02	14.500	6.381	3.658
Silver	0.0001 - 0.01	42	2.4	2.00E-03	0.002	0.001	0.001
Sodium	0.0283 - 5	42	100	2.74E-01	33.400	14.662	6.939
Strontium	0.0001 - 0.2	42	100	5.40E-03	0.620	0.139	0.100
Thallium	0.0001 - 0.01	40	2.5	4.30E-04	0.000	0.001	0.000
Vanadium	0.0003 - 0.05	41	19.5	4.08E-04	0.028	0.003	0.004
Zinc	0.0017 - 0.02	42	54.8	2.40E-03	0.024	0.007	0.006
Organics (ug/L)							
Acetone	6.3 - 10	29	6.9	13.0	28.0	6.62	4.62
Chlorobenzene	0.27 - 5	43	2.3	0.400	0.400	2.04	0.909
Chlorodifluoromethane	N/A	3	100	2.00	3.00	2.33	0.577
Chloroform	0.17 - 5	43	4.7	0.200	0.200	2.03	0.920

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Table 1.5
Summary of Surface Water ECOI Data in the RC AEU

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Methylene Chloride	0.28 - 5	43	7	0.300	2.00	3.46	5.23
Tetrachloroethene	0.18 - 5	43	2.3	10.0	10.0	2.21	1.52
Radionuclides (pCi/L) (Total)							
Americium-241	0 - 0.0289	37	100	-0.004	0.127	0.006	0.021
Cesium-137	0.2 - 1.03	23	100	-0.558	0.890	0.164	0.370
Curium-244	0.02 - 0.02	1	100	0.002	0.002	0.002	N/A
Gross Alpha	0.41 - 6	24	100	0.008	45.0	5.34	12.4
Gross Beta	0.828 - 8	24	100	1.02	35.0	6.07	8.98
Neptunium-237	0.051 - 0.072	2	100	-0.006	0.009	0.0015	0.011
Plutonium-239/240	0 - 0.029	35	100	-0.003	1.69	0.054	0.285
Radium-226	0.16 - 0.5	3	100	-0.100	4.90	2.30	2.50
Strontium-89/90	0.14 - 0.958	17	100	0.140	1.80	0.597	0.465
Thorium-230	0.18 - 0.18	1	100	0.220	0.220	0.220	N/A
Thorium-232	0.31 - 0.31	1	100	-0.029	-0.029	-0.029	N/A
Tritium	200 - 470	27	100	-63.0	320	101	110
Uranium-233/234	0 - 0.3	29	100	-0.056	5.10	1.02	1.36
Uranium-235	0 - 0.32	29	100	-0.00962	0.290	0.061	0.069
Uranium-238	0.02 - 0.297	29	100	0.042	4.90	0.891	1.30

N/A = Not applicable.

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Table 1.6
Summary of Sediment ECOI Data in the RC AEU

Analyte	Range of Reported Detection limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Inorganics (mg/kg)							
Aluminum	5.1 - 50	22	100	2,380	19,500	11,300	4,784
Antimony	0.69 - 50	19	5.3	11.1	11.1	3.77	3.73
Arsenic	0.14 - 3	22	95.5	1.70	15.0	4.32	3.12
Barium	0.18 - 40	22	100	34.5	360	153	79.7
Beryllium	0.03 - 5	19	73.7	0.320	2.10	0.787	0.463
Boron	1.8 - 5	5	100	3.40	17.0	10.4	5.68
Cadmium	0.066 - 5	19	36.8	0.210	1.30	0.691	0.413
Calcium	3.7 - 1,000	22	100	1,970	61,000	9,089	12,198
Cesium	93.2 - 749	15	6.7	2.90	2.90	82.4	92.8
Chromium	0.07 - 10	22	95.5	4.20	28.2	12.3	6.17
Cobalt	0.14 - 10	21	95.2	2.60	18.0	7.67	4.29
Copper	0.087 - 10	22	90.9	5.80	29.9	14.3	6.50
Iron	1.3 - 20	22	100	2,520	39,000	15,529	8,352
Lead	0.42 - 4.7	22	100	5.90	79.1	22.9	16.0
Lithium	0.34 - 20	21	100	1.80	20.3	8.37	3.90
Magnesium	6.8 - 1,000	22	100	444	4,100	2,388	937
Manganese	0.18 - 10	22	100	35.8	2,500	357	517
Mercury	0.0064 - 0.62	19	26.3	0.013	0.066	0.088	0.060
Molybdenum	0.23 - 40	20	20	0.310	9.60	1.89	2.50
Nickel	0.23 - 20	21	95.2	1.40	23.0	10.9	4.41
Nitrate / Nitrite	0.02 - 5.5	15	66.7	0.700	76.0	12.6	20.2
Potassium	42 - 1,170	21	100	342	2,900	1,499	616
Selenium	0.21 - 2.4	22	31.8	0.380	3.20	0.748	0.761
Silica	1.8 - 5	5	100	760	2,600	1,792	752
Silicon	3.5 - 100	11	100	128	1,480	486	438
Silver	0.085 - 10	19	21.1	1.20	3.40	0.918	0.914
Sodium	8.9 - 1,000	22	72.7	70.1	413	174	96.6
Strontium	0.11 - 400	22	100	9.50	179	49.7	36.1
Thallium	0.14 - 2.8	19	10.5	0.200	0.410	0.371	0.276
Tin	0.66 - 100	19	31.6	7.40	37.1	6.98	8.55
Titanium	0.26 - 0.73	5	100	48.0	170	108	45.6
Uranium	1.2 - 3.5	5	40	5.10	7.80	3.05	3.25
Vanadium	0.41 - 10	22	100	6.40	57.1	28.1	11.4
Zinc	0.58 - 10	22	95.5	11.3	720	124	191
Organics (ug/kg)							
1,1,1-Trichloroethane	5 - 14	11	9.1	9.00	9.00	5.05	1.88
2-Butanone	10 - 79	13	15.4	20.0	190	24.7	49.8

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Table 1.6
Summary of Sediment ECOI Data in the RC AEU

Analyte	Range of Reported Detection limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
4,6-Dinitro-2-methylphenol	220 - 4,800	17	5.9	1,100	1,100	2,444	1,399
4-Methylphenol	72 - 950	20	15	640	1,500	587	362
4-Nitrophenol	340 - 4,800	17	5.9	1,300	1,300	2,182	1,380
Acetone	10 - 79	11	36.4	46.0	520	110	161
Benzo(a)anthracene	32 - 950	19	5.3	62.0	62.0	503	312
Benzo(a)pyrene	53 - 950	18	5.6	130	130	521	309
Benzoic Acid	380 - 4,800	20	35	230	2,000	1,789	1,046
bis(2-ethylhexyl)phthalate	95 - 950	18	38.9	80.0	350	418	323
Chrysene	37 - 950	19	5.3	74.0	74.0	504	311
Di-n-butylphthalate	27 - 2,000	20	30	66.0	250	409	340
Fluoranthene	30 - 950	19	5.3	89.0	89.0	504	310
Methylene Chloride	5 - 40	15	6.7	300	300	31.4	74.8
Pentachlorophenol	150 - 4,800	19	5.3	1,500	1,500	2,329	1,368
Phenanthrene	46 - 950	19	5.3	59.0	59.0	503	312
Phenol	46 - 950	19	5.3	120	120	506	307
Pyrene	180 - 950	19	5.3	130	130	507	307
Tetrachloroethene	5 - 14	10	10	38.0	38.0	8.00	10.6
Toluene	5 - 14	10	10	39.0	39.0	8.10	10.9
Trichloroethene	5 - 14	11	9.1	48.0	48.0	8.59	13.1
Xylene	5 - 14	10	10	14.0	14.0	5.60	3.27
Radionuclides (pCi/g)							
Americium-241	0 - 0.167	18	100	-0.003	0.038	0.009	0.010
Cesium-134	0.075 - 0.33	6	100	0.002	0.260	0.094	0.087
Cesium-137	0.03 - 0.5	15	100	0.103	1.49	0.444	0.407
Gross Alpha	1.8 - 23.96	15	100	1.20	62.0	27.8	18.2
Gross Beta	2.4 - 5.9	15	100	5.58	54.0	30.7	13.3
Plutonium-239/240	0 - 0.184	20	100	0	0.081	0.024	0.025
Radium-226	0.16 - 1.1	9	100	0.750	1.80	1.18	0.359
Radium-228	0.07 - 2.5	9	100	0.810	4.10	1.98	1.02
Strontium-89/90	0.04 - 0.4	14	100	-0.010	0.560	0.217	0.150
Uranium-233/234	0 - 0.274	18	100	0.425	2.30	1.37	0.568
Uranium-235	0 - 0.29	18	100	0.019	0.269	0.082	0.076
Uranium-238	0 - 0.159	18	100	0.731	2.30	1.24	0.466

N/A = Not applicable.

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Table 1.7
Summary of Surface Water ECOI Data in the MK AEU

Analyte	Range of Reported Detection Limits	Total Number of Results	Total Detection Frequency (%)	Total Minimum Detected Concentration	Total Maximum Detected Concentration	Total Arithmetic Mean Concentration	Total Standard Deviation
Inorganics (mg/L) (Total)							
Aluminum	0.017 - 0.2	39	100.0	0.088	46.0	4.17	7.75
Antimony	0.0002 - 0.06	39	2.56	0.005	0.005	0.010	0.009
Arsenic	0.0007 - 0.2	38	21.1	8.00E-04	0.014	0.009	0.018
Barium	0.0002 - 0.2	39	89.7	0.006	0.340	0.093	0.092
Boron	0.013 - 0.013	2	100	0.019	0.020	0.020	7.07E-04
Cadmium	0.0002 - 0.005	39	2.6	0.005	0.005	0.001	0.001
Calcium	0.0174 - 5	39	100.0	2.70	110	20.9	23.1
Cerium	0.0002 - 0.0011	4	100.0	0.002	0.030	0.018	0.013
Cesium	0.0001 - 1	26	23.1	3.30E-04	0.050	0.092	0.118
Chloride	0.2 - 5	24	100	4.10	67.0	15.3	12.8
Chromium	0.0002 - 0.01	39	51.3	7.40E-04	0.044	0.006	0.009
Cobalt	0.0001 - 0.05	39	35.9	7.10E-04	0.010	0.002	0.002
Copper	0.001 - 0.025	39	71.8	0.002	0.033	0.007	0.006
Fluoride	0.1 - 0.1	22	90.9	0.100	0.360	0.190	0.083
Iron	0.0047 - 0.1	38	100.0	0.087	42.0	3.85	6.92
Lead	0.0001 - 0.15	38	76.3	4.80E-04	0.100	0.014	0.022
Lithium	0.002 - 0.1	30	43.3	0.001	0.021	0.004	0.004
Magnesium	0.017 - 5	39	100.0	0.715	23.0	4.79	4.60
Manganese	0.0004 - 0.015	39	100.0	0.009	0.510	0.135	0.129
Mercury	0.000044 - 0.0002	33	3.0	2.00E-04	2.00E-04	9.08E-05	3.13E-05
Molybdenum	0.0001 - 0.2	34	2.9	6.00E-04	6.00E-04	0.002	0.002
Nickel	0.0006 - 0.04	37	32.4	0.001	0.020	0.006	0.004
Nitrate / Nitrite	0.02 - 0.5	27	85.2	0.120	2.20	0.684	0.561
Nitrite	0.02 - 0.05	10	10.0	0.037	0.037	0.020	0.010
Ortho-phosphate	0.05 - 0.05	6	16.7	0.580	0.580	0.118	0.227
Phosphate	0.01 - 0.02	5	100	0.020	0.060	0.034	0.017
Phosphorus	0.02 - 0.5	14	71.4	0.030	0.180	0.056	0.043
Potassium	0.25 - 5	39	100.0	1.15	18.0	4.13	2.96
Selenium	0.0008 - 0.15	39	7.7	8.00E-04	0.005	0.005	0.007
Silica	0.023 - 0.4	3	100	1.60	17.0	10.5	7.99
Silicon	0.009 - 0.1111	31	100.0	2.60	60.0	9.30	10.7
Silver	0.0001 - 0.01	39	5.1	2.00E-04	0.003	0.001	0.001
Sodium	0.023 - 5	39	100.0	1.77	490	39.2	89.1
Strontium	0.0001 - 0.2	32	96.9	0.019	0.590	0.140	0.143
Sulfate	2 - 10	24	87.5	4.32	34.5	13.9	9.29
Thallium	0.0001 - 0.35	39	2.56	0.001	0.001	0.007	0.017

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Table 1.7
Summary of Surface Water ECOI Data in the MK AEU

Analyte	Range of Reported Detection Limits	Total Number of Results	Total Detection Frequency (%)	Total Minimum Detected Concentration	Total Maximum Detected Concentration	Total Arithmetic Mean Concentration	Total Standard Deviation
Tin	0.001 - 0.2	34	2.94	0.028	0.028	0.007	0.007
Titanium	0.0026 - 0.0026	2	100	0.003	0.035	0.019	0.023
Uranium	0.0078 - 0.0078	2	50.0	0.035	0.035	0.022	0.018
Vanadium	0.0003 - 0.05	39	51.3	6.80E-04	0.082	0.008	0.014
Zinc	0.0017 - 0.02	39	89.7	0.007	0.380	0.086	0.090
Inorganics (mg/L) (Dissolved)							
Aluminum	0.0187 - 0.2	26	65.4	0.019	1.08	0.194	0.290
Antimony	0.0002 - 0.06	26	23.1	3.40E-04	0.017	0.009	0.006
Arsenic	0.0007 - 0.2	24	12.5	0.001	0.003	0.008	0.018
Barium	0.0002 - 0.2	26	100.0	0.010	0.087	0.037	0.018
Beryllium	0.0001 - 0.005	26	3.85	6.00E-04	6.00E-04	2.84E-04	1.93E-04
Cadmium	0.0002 - 0.005	26	19.2	2.10E-04	0.003	9.40E-04	8.10E-04
Calcium	0.0174 - 5	26	100.0	3.86	38.2	12.8	7.48
Cerium	0.0001 - 0.0001	4	100.0	1.40E-04	2.40E-04	1.95E-04	4.20E-05
Cesium	0.0001 - 1	22	18.2	1.68E-04	0.060	0.097	0.119
Chromium	0.0001 - 0.01	26	38.5	8.30E-04	0.024	0.003	0.005
Cobalt	0.0001 - 0.05	26	30.8	1.20E-04	0.004	0.002	9.68E-04
Copper	0.0005 - 0.025	24	70.8	0.003	0.025	0.005	0.005
Iron	0.0047 - 0.1	27	96.3	0.034	0.715	0.221	0.189
Lead	0.0001 - 0.15	25	56.0	3.90E-04	0.071	0.007	0.016
Lithium	0.001 - 0.1	25	8.0	0.002	0.007	0.001	0.001
Magnesium	0.0296 - 5	26	100.0	0.630	6.20	2.54	1.16
Manganese	0.0002 - 0.015	27	100.0	0.001	0.316	0.087	0.101
Molybdenum	0.0001 - 0.2	26	7.7	3.30E-04	0.004	0.002	0.002
Nickel	0.0005 - 0.04	26	38.5	0.001	0.013	0.005	0.003
Potassium	0.3 - 5	26	100	0.830	5.97	2.47	1.18
Selenium	0.0008 - 0.15	26	15.38	1.00E-03	0.004	0.004	0.007
Silicon	0.0152 - 0.1	24	100	0.273	8.70	3.30	2.19
Silver	0.0001 - 0.01	26	3.85	0.002	0.002	0.001	0.001
Sodium	0.0283 - 5	26	100	4.50	33.4	13.8	6.53
Strontium	0.0001 - 0.2	26	100	0.032	0.194	0.073	0.034
Thallium	0.0001 - 0.35	26	7.7	2.40E-04	0.007	0.007	0.018
Tin	0.001 - 0.2	26	3.8	0.011	0.011	0.006	0.005
Vanadium	0.0002 - 0.05	26	23.1	5.54E-04	0.022	0.002	0.004
Zinc	0.001 - 0.02	26	84.6	0.003	0.245	0.037	0.053
Organics (ug/L) (Total)							
2-Butanone	10 - 10	12	8.3	3.00	3.00	4.83	0.577

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Table 1.7
Summary of Surface Water ECOI Data in the MK AEU

Analyte	Range of Reported Detection Limits	Total Number of Results	Total Detection Frequency (%)	Total Minimum Detected Concentration	Total Maximum Detected Concentration	Total Arithmetic Mean Concentration	Total Standard Deviation
bis(2-ethylhexyl)phthalate	10 - 11	2	50.0	1.00	1.00	3.00	2.83
Methylene Chloride	5 - 10	13	7.7	16.0	16.0	3.73	3.75
Tetrachloroethene	5 - 10	13	7.7	5.00	5.00	2.88	0.939
Trichloroethene	5 - 10	13	7.7	5.00	5.00	2.88	0.939
Radionuclides (pCi/L) (Total)							
Americium-241	0 - 0.109	36	100	-0.001	0.032	0.008	0.009
Cesium-137	0.2 - 0.814	7	100	-0.160	0.740	0.185	0.328
Gross Alpha	0.37 - 13	27	100	0.129	33.0	6.53	7.88
Gross Beta	1 - 4	29	100	1.68	60.0	13.0	12.2
Plutonium-238	0.01 - 0.3777	8	100	-0.002	0.013	0.005	0.006
Plutonium-239/240	0 - 0.2569	35	100	-0.009	0.500	0.026	0.090
Radium-226	0.6 - 0.6	1	100	0.540	0.540	0.540	N/A
Strontium-89/90	0.07 - 0.835	6	100	0.300	2.10	0.978	0.679
Tritium	200 - 470	8	100	-120	751	87.6	276
Uranium-233/234	0.004 - 0.6	34	100	-0.044	5.93	0.454	1.01
Uranium-235	0 - 0.6	34	100	-0.039	0.190	0.019	0.040
Uranium-238	0.004 - 0.6	34	100	0	3.39	0.354	0.596

N/A = Not applicable.

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Table 1.8
Summary of Sediment ECOI Data in the MK AEU

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Inorganics (mg/kg)							
Aluminum	4 - 40	12	100	2,390	30,300	11,016	8,591
Antimony	0.54 - 12	12	8.3	12.4	12.4	3.04	3.76
Arsenic	0.14 - 2	12	100	1.40	8.40	3.47	2.29
Barium	0.14 - 40	12	100	18.0	170	77.2	54.5
Beryllium	0.023 - 1	12	83.3	0.260	1.50	0.571	0.415
Boron	1.4 - 1.7	4	100	1.40	6.40	3.38	2.40
Cadmium	0.052 - 1.46	12	41.7	0.067	0.490	0.349	0.204
Calcium	3.6 - 2,000	12	100	470	130,000	15,173	37,063
Cesium	10.7 - 200	8	12.5	4.90	4.90	17.3	21.2
Chromium	0.055 - 2	12	100	2.10	44.3	12.0	12.1
Chromium VI	0.005 - 0.005	1	100	0.013	0.013	0.013	N/A
Cobalt	0.11 - 10	12	91.7	1.90	9.30	4.68	2.18
Copper	0.068 - 5	12	91.7	3.10	33.2	11.5	10.1
Fluoride	2.5 - 2.5	1	100	8.47	8.47	8.47	N/A
Iron	1.2 - 20	12	100	4,200	27,500	11,686	7,438
Lead	0.33 - 1.1	12	100	2.00	73.6	14.8	20.0
Lithium	0.26 - 20	12	100	2.30	19.2	8.28	6.01
Magnesium	5.3 - 2,000	12	100	560	4,700	2,314	1,633
Manganese	0.14 - 3	12	100	67.0	326	165	86.4
Mercury	0.005 - 0.243	12	33.3	0.016	0.160	0.069	0.049
Molybdenum	0.18 - 40	12	58.3	0.190	2.40	1.24	1.06
Nickel	0.18 - 8	12	91.7	3.10	28.3	10.9	8.06
Nitrate / Nitrite	0.02 - 1.3	7	57.1	0.300	64.0	9.73	23.9
Potassium	33 - 2,000	12	100	423	2,940	1,356	891
Selenium	0.24 - 1.46	12	8.3	2.70	2.70	0.456	0.716
Silica	1.4 - 1.7	4	100	500	970	698	228
Silicon	4.1 - 5	3	100	252	854	463	339
Sodium	8.8 - 2,000	12	100	65.1	2,090	381	557
Strontium	0.085 - 400	12	100	4.10	180	34.1	48.0
Thallium	0.29 - 2	12	8.3	0.400	0.400	0.245	0.177
Tin	0.52 - 40	12	25.0	3.60	9.30	4.99	6.40
Titanium	0.2 - 0.25	4	100	62.0	150	97.0	41.5
Uranium	0.96 - 1.2	4	25.0	1.10	1.10	0.668	0.293
Vanadium	0.32 - 10	12	100	7.40	67.7	25.5	18.4
Zinc	0.45 - 4	12	100	19.0	347	80.1	96.7
Organics (ug/kg)							
2-Butanone	10 - 27	8	12.5	3.00	3.00	7.06	3.05
4-Methylphenol	330 - 890	8	12.5	95.0	95.0	303	173

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Table 1.8
Summary of Sediment ECOI Data in the MK AEU

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Benzoic Acid	1,600 - 2,200	7	14.3	480	480	1,369	814
bis(2-ethylhexyl)phthalate	330 - 890	8	37.5	52.0	120	315	232
Chrysene	330 - 890	8	12.5	150	150	310	164
Di-n-butylphthalate	330 - 890	8	37.5	38.0	280	289	197
Fluoranthene	330 - 890	8	25.0	88.0	170	291	180
Phenanthrene	330 - 890	8	12.5	96.0	96.0	303	172
Pyrene	330 - 890	8	25.0	61.0	170	288	184
Toluene	5 - 27	8	25.0	2.00	6.00	5.00	3.63
Radionuclides (pCi/g)							
Americium-241	0 - 0.166	12	100	-0.0242	0.087	0.015	0.028
Cesium-134	0.087 - 0.2	3	100	0.087	0.110	0.132	0.060
Cesium-137	0.04 - 0.104	7	100	0.002	0.391	0.154	0.133
Gross Alpha	1.8 - 27.17	9	100	-2.40	79.0	35.3	27.5
Gross Beta	2.4 - 6	9	100	8.45	69.0	44.1	16.9
Plutonium-239/240	0 - 0.132	12	100	0.002	0.054	0.024	0.017
Radium-226	0.18 - 0.71	5	100	0.390	1.90	0.918	0.597
Radium-228	0.07 - 0.64	3	100	0.930	1.70	1.19	0.442
Strontium-89/90	0.04 - 0.4	7	100	0.030	0.316	0.178	0.113
Uranium-233/234	0.014 - 0.322	12	100	0.303	15.0	2.25	4.11
Uranium-235	0 - 0.322	12	100	-0.040	0.460	0.090	0.128
Uranium-238	0.01 - 0.287	12	100	0.310	13.0	2.03	3.55

N/A = Not applicable.

Table 1.9
Summary of Surface Water ECOI Data in the SE AEU

Analyte	Range of Reported Detection Limits	Total Number of Results	Total Detection Frequency (%)	Total Minimum Detected Concentration	Total Maximum Detected Concentration	Total Arithmetic Mean Concentration	Total Standard Deviation
Inorganics (mg/L) (Total)							
Aluminum	0.017 - 0.2	11	72.7	0.038	0.274	0.095	0.094
Ammonia[1]	0.1 - 0.1	1	100	0.280	0.280	0.280	N/A
Antimony	0.0032 - 0.06	12	16.7	0.027	0.029	0.012	0.010
Arsenic	0.0007 - 0.01	10	10.0	1.00E-03	1.00E-03	0.001	5.51E-04
Barium	0.0021 - 0.2	12	91.7	0.031	0.120	0.063	0.029
Boron	0.013 - 0.013	4	75.0	0.014	0.130	0.049	0.057
Calcium	0.0183 - 5	12	100	25.4	110	50.3	24.9
Cesium	0.5 - 1	8	12.5	0.050	0.050	0.175	0.122
Chloride	1 - 5	7	100	19.0	44.0	32.7	7.79
Copper	0.0016 - 0.025	11	27.3	0.002	0.004	0.002	0.001
Fluoride	0.1 - 0.2	7	100	0.200	0.720	0.379	0.162
Iron	0.0052 - 0.1	12	91.7	0.049	0.546	0.217	0.173
Lead	0.0008 - 0.005	12	33.3	0.001	0.021	0.003	0.006
Lithium	0.002 - 0.1	12	50.0	0.002	0.065	0.010	0.018
Magnesium	0.017 - 5	12	100	3.80	69.0	13.0	18.1
Manganese	0.0014 - 0.015	12	75.0	0.006	0.460	0.088	0.130
Molybdenum	0.0019 - 0.2	12	25.0	0.003	0.005	0.003	0.002
Nickel	0.002 - 0.04	12	16.7	0.003	0.004	0.004	0.002
Nitrate / Nitrite	0.02 - 0.1	8	37.5	0.040	1.50	0.238	0.511
Phosphate	0.01 - 0.05	6	66.7	0.020	0.060	0.036	0.020
Phosphorus	0.05 - 0.05	7	14.3	0.061	0.061	0.030	0.014
Potassium	0.25 - 5	12	100	0.800	15.0	4.45	4.23
Selenium	0.0008 - 0.005	12	8.3	0.001	0.001	0.001	5.58E-04
Silica	0.023 - 0.023	4	100	0.730	13.0	7.18	5.42
Silicon	0.0208 - 0.1	8	100	2.41	6.06	3.14	1.24
Silver	0.00037 - 0.01	12	8.3	0.005	0.005	0.002	0.001
Sodium	0.0344 - 5	12	100	11.0	160	34.3	41.7
Strontium	0.0013 - 0.2	12	100	0.090	1.20	0.297	0.311
Sulfate	0.5 - 25	7	100	9.30	114	28.6	38.4
Sulfide	1 - 1	7	14.3	2.00	2.00	0.714	0.567
Tin	0.0047 - 0.2	12	8.3	0.013	0.013	0.006	0.005
Titanium	0.0026 - 0.0026	4	25.0	0.003	0.003	0.002	7.50E-04
Zinc	0.0017 - 0.02	12	25.0	0.003	0.012	0.004	0.004
Inorganics (mg/L) (Dissolved)							
Aluminum	0.017 - 0.2	7	57.1	0.023	0.058	0.031	0.020
Antimony	0.0188 - 0.06	7	28.6	0.026	0.030	0.016	0.009
Barium	0.0038 - 0.2	7	100	0.030	0.078	0.045	0.017
Beryllium	0.0006 - 0.005	7	28.6	6.00E-04	0.002	5.79E-04	4.69E-04
Calcium	0.0183 - 5	7	100	24.7	43.4	33.0	6.25
Cesium	0.5 - 1	7	42.9	0.030	0.060	0.163	0.109
Chloride	0.2 - 0.2	1	100	33.0	33.0	33.0	N/A
Cobalt	0.0022 - 0.05	7	14.3	0.002	0.002	0.002	9.33E-04
Copper	0.0021 - 0.025	7	57.1	0.002	0.004	0.002	9.25E-04
Fluoride	0.1 - 0.1	1	100	0.200	0.200	0.200	N/A
Iron	0.0052 - 0.1	5	60.0	0.023	0.121	0.051	0.052
Lead	0.0008 - 0.003	6	16.7	0.002	0.002	7.67E-04	7.55E-04
Lithium	0.002 - 0.1	7	42.9	0.002	0.018	0.005	0.006
Magnesium	0.0206 - 5	7	100	3.74	15.8	5.95	4.37
Manganese	0.0014 - 0.015	7	71.4	0.010	0.164	0.035	0.058
Molybdenum	0.0035 - 0.2	7	28.6	0.005	0.005	0.004	0.002
Nickel	0.0099 - 0.04	7	14.3	0.013	0.013	0.005	0.004
Potassium	0.674 - 5	7	85.7	1.10	6.80	2.69	2.21

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Table 1.9
Summary of Surface Water ECOI Data in the SE AEU

Analyte	Range of Reported Detection Limits	Total Number of Results	Total Detection Frequency (%)	Total Minimum Detected Concentration	Total Maximum Detected Concentration	Total Arithmetic Mean Concentration	Total Standard Deviation
Selenium	0.0008 - 0.005	6	16.7	9.00E-04	9.00E-04	0.001	6.57E-04
Silicon	0.0208 - 0.1	7	100	2.27	3.67	2.67	0.502
Silver	0.002 - 0.01	7	28.6	0.003	0.003	0.002	8.76E-04
Sodium	0.0344 - 5	7	100	15.0	59.7	22.1	16.6
Strontium	0.0033 - 0.2	7	100	0.088	0.373	0.143	0.102
Sulfate	2 - 2	1	100	10.0	10.0	10.0	N/A
Tin	0.0094 - 0.2	7	14.3	0.016	0.016	0.009	0.006
Zinc	0.0017 - 0.02	7	28.6	0.006	0.011	0.004	0.004
Organics (ug/L) (Total)							
Methylene Chloride	0.01 - 5	7	14.3	10.0	10.0	4.00	2.97
Radionuclides (pCi/L) (Total)							
Americium-241	0 - 0.0788	10	100	0.003	0.014	0.007	0.004
Cesium-137	0.3 - 1.07	6	100	-0.186	1.60	0.340	0.660
Gross Alpha	0.5 - 4.02	6	100	-0.100	1.30	0.517	0.549
Gross Beta	1.7 - 3.81	6	100	2.52	9.20	5.96	2.37
Plutonium-239/240	0 - 0.153	11	100	-0.003	0.0604	0.009	0.019
Strontium-89/90	0.25 - 1.41	4	100	0.680	3.20	1.33	1.25
Tritium	200 - 650	5	100	-53.8	150	42.2	86.9
Uranium-233/234	0 - 0.524	8	100	0.053	1.86	0.821	0.723
Uranium-235	0 - 0.569	8	100	0	0.117	0.048	0.042
Uranium-238	0.0616 - 0.387	8	100	0	2.58	0.771	0.873

N/A = Not applicable.

[1] total ammonia reported

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Table 1.10
Summary of Sediment ECOI Data in the SE AEU

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Inorganics (mg/kg)							
Aluminum	5.2 - 12	7	100	7,600	26,000	18,229	6,295
Arsenic	0.69 - 1.6	7	100	3.30	9.30	5.99	2.20
Barium	0.18 - 0.42	7	100	77.0	240	158	51.6
Beryllium	0.03 - 0.071	7	100	0.520	1.30	1.03	0.262
Boron	1.8 - 4.2	7	100	5.40	19.0	9.66	4.63
Cadmium	0.067 - 0.16	7	100	0.190	0.710	0.511	0.163
Calcium	12 - 28	7	100	4,900	55,000	15,700	17,954
Chromium	0.071 - 0.17	7	100	8.70	26.0	18.7	6.02
Cobalt	0.14 - 0.32	7	100	5.40	8.60	7.14	1.42
Copper	0.088 - 0.21	7	100	9.30	27.0	18.6	5.60
Iron	1.5 - 3.6	7	100	11,000	34,000	18,857	8,315
Lead	0.43 - 1	7	100	9.50	27.0	18.9	5.31
Lithium	0.34 - 0.81	7	100	6.00	23.0	14.4	5.97
Magnesium	6.9 - 16	7	100	1,700	7,100	3,700	1,850
Manganese	0.18 - 0.42	7	100	82.0	480	228	172
Mercury	0.0065 - 0.015	7	100	0.021	0.080	0.038	0.021
Molybdenum	0.23 - 0.55	7	85.7	0.260	1.00	0.643	0.342
Nickel	0.23 - 0.55	7	100	9.60	21.0	16.4	3.89
Potassium	43 - 100	7	100	1,200	5,200	2,757	1,372
Selenium	0.85 - 2	7	14.3	1.70	1.70	0.729	0.471
Silica	1.8 - 4.2	7	100	980	2,900	1,854	604
Sodium	110 - 260	7	42.9	150	510	175	176
Strontium	0.11 - 0.26	7	100	38.0	290	87.4	91.0
Thallium	0.37 - 0.87	7	57.1	0.550	2.60	1.07	1.00
Titanium	0.26 - 0.62	7	100	64.0	260	168	77.1
Uranium	1.3 - 2.9	7	28.6	2.30	2.80	1.34	0.881
Vanadium	0.41 - 0.97	7	100	22.0	62.0	45.4	15.0
Zinc	0.59 - 1.4	7	100	36.0	81.0	65.6	15.3
Radionuclides (pCi/g)							
Americium-241	0.084 - 0.193	9	100	-0.013	0.0997	0.041	0.037
Plutonium-239/240	0.0875 - 0.219	9	100	0.00205	0.216	0.109	0.082
Uranium-233/234	0.077 - 0.324	9	100	0.958	3.18	1.69	0.650
Uranium-235	0.095 - 0.352	9	100	0.0351	0.188	0.110	0.044
Uranium-238	0.077 - 0.319	9	100	0.860	3.39	1.53	0.754

Table 2.1
Summary of ECOPC Screening Steps for Surface Water ECOPCs in the NN AEU

Analyte	MDC	Surface Water ESL	MDC > ESL?	Number of Samples	Number of Detects	Detects (%)	Detection Frequency > 5%	> BKG?	AEU UTL	95th UTL > ESL?	Professional Judgment	ECOPC
Inorganics (mg/L) (Total)												
Aluminum	55.4	0.087	Yes	70	57	81.4	Yes	No	-	-	-	No
Ammonia[1]	0.0035	0.020	No	3	1	33.3	-	-	-	-	-	No
Antimony	0.015	0.240	No	72	11	15.2	-	-	-	-	-	No
Barium	**0.820**	**0.438**	Yes	72	72	100	Yes	Yes	0.744	Yes	Yes	Yes
Beryllium	0.003	0.002	Yes	71	20	28.2	Yes	N/A	0.001	No	-	No
Chloride	286	230,000	No	29	28	96.6	-	-	-	-	-	No
Cobalt	0.012	0.100	No	72	30	41.6	-	-	-	-	-	No
Fluoride	0.950	2.12	No	28	27	96.4	-	-	-	-	-	No
Lithium	0.098	0.096	Yes	63	61	96.8	Yes	Yes	0.083	No	-	No
Molybdenum	0.021	0.800	No	67	27	40.3	-	-	-	-	-	No
Nitrite	0.031	4.47	No	17	1	5.88	-	-	-	-	-	No
Selenium	0.038	0.005	Yes	72	13	18.0	Yes	N/A	0.004	No	-	No
Strontium	1.23	8.30	No	67	67	100	-	-	-	-	-	No
Thallium	0.007	0.015	No	72	7	9.70	-	-	-	-	-	No
Tin	0.057	0.073	No	62	8	12.9	-	-	-	-	-	No
Vanadium	0.095	0.012	Yes	72	39	54.1	Yes	No	-	-	-	No
Inorganics (mg/L) (Dissolved)												
Arsenic	0.002	0.150	No	30	11	36.7	-	-	-	-	-	No
Cadmium	0.003	2.50E-04	Yes	32	1	3.13	No	-	-	-	-	No
Chromium	0.004	0.074	No	31	2	6.45	-	-	-	-	-	No
Copper	0.012	0.009	Yes	31	13	41.9	Yes	No	-	-	-	No
Iron	95.8	1.00	Yes	30	27	90.0	Yes	No	-	-	-	No
Lead	**0.0047**	**0.0025**	Yes	32	5	15.6	Yes	N/A	0.003	Yes	Yes	Yes
Manganese	1.50	1.65	No	29	24	82.7	-	-	-	-	-	No
Nickel	0.025	0.052	No	31	8	25.8	-	-	-	-	-	No
Silver	**0.013**	**3.20E-04**	Yes	32	5	15.6	Yes	N/A	0.006	Yes	Yes	Yes
Zinc	**1.50**	**0.118**	Yes	31	23	74.2	Yes	Yes	1.5	Yes	Yes	Yes
Organics (µg/L)												
1,1,1-Trichloroethane	1.00	89.0	No	138	1	0.725	-	-	-	-	-	No
1,1-Dichloroethane	10.0	740	No	138	80	58.0	-	-	-	-	-	No
1,1-Dichloroethene	1.70	65.0	No	138	2	1.45	-	-	-	-	-	No
1,2,3-Trichlorobenzene	1.30	8.00	No	97	6	6.19	-	-	-	-	-	No
1,2,4-Trichlorobenzene	3.00	50.0	No	116	14	12.1	-	-	-	-	-	No
1,2,4-Trimethylbenzene	2.20	17.0	No	97	40	41.2	-	-	-	-	-	No
1,2-Dichlorobenzene	0.900	13.0	No	116	38	32.8	-	-	-	-	-	No
1,2-Dichloroethene	4.00	1,100	No	37	2	5.41	-	-	-	-	-	No
1,2-Dichloropropane	0.960	5,700	No	138	7	5.07	-	-	-	-	-	No
1,3,5-Trimethylbenzene	0.900	45.0	No	97	16	16.5	-	-	-	-	-	No
1,3-Dichlorobenzene	0.600	28.0	No	116	15	12.9	-	-	-	-	-	No
1,4-Dichlorobenzene	0.660	16.0	No	116	36	31.0	-	-	-	-	-	No
2,4-Dimethylphenol	3.00	212	No	72	6	8.33	-	-	-	-	-	No
2-Butanone	17.0	2,200	No	101	7	6.93	-	-	-	-	-	No
4-Methylphenol	3.00	25.0	No	65	3	4.62	-	-	-	-	-	No
Acenaphthene	4.90	520	No	73	32	43.8	-	-	-	-	-	No
Acetone	43.0	1,500	No	114	45	39.5	-	-	-	-	-	No
alpha-BHC	0.360	2.20	No	7	2	28.6	-	-	-	-	-	No
Anthracene	0.600	0.730	No	72	4	5.56	-	-	-	-	-	No
Benzene	2.50	530	No	139	59	42.4	-	-	-	-	-	No
Benzo(a)pyrene	1.00	0.014	Yes	71	1	1.41	No	-	-	-	-	No
Benzoic Acid	15.0	42.0	No	68	14	20.6	-	-	-	-	-	No
beta-BHC	0	2.20	No	7	2	28.6	-	-	-	-	-	No
bis(2-ethylhexyl)phthalate	140	28.5	Yes	72	34	47.2	Yes	N/A	23	No	-	No
Bromoform	0.700	320	No	139	2	1.44	-	-	-	-	-	No
Butylbenzylphthalate	4.00	67.0	No	71	6	8.45	-	-	-	-	-	No
Carbazole	3.00	4.00	No	4	1	25.0	-	-	-	-	-	No
Chlorobenzene	0.950	47.0	No	139	33	23.7	-	-	-	-	-	No
Chloroform	0.590	1,240	No	139	1	0.719	-	-	-	-	-	No
cis-1,2-Dichloroethene	0.600	620	No	97	19	19.6	-	-	-	-	-	No
delta-BHC	0.180	2.20	No	7	2	28.6	-	-	-	-	-	No
Dibenzofuran	2.00	4.00	No	73	24	32.9	-	-	-	-	-	No
Dichlorofluoromethane	16.0	150	No	1	1	100	-	-	-	-	-	No
Diethylphthalate	10.0	110	No	72	17	23.6	-	-	-	-	-	No
Di-n-butylphthalate	48.0	9.70	Yes	72	17	23.6	Yes	N/A	5.5	No	-	No
Ethylbenzene	17.0	3,200	No	138	52	37.7	-	-	-	-	-	No
Fluorene	3.00	12.0	No	73	30	41.1	-	-	-	-	-	No
gamma-BHC (Lindane)	0	0.080	No	7	2	28.6	-	-	-	-	-	No
Heptachlor	0	0.004	No	7	2	28.6	-	-	-	-	-	No
Hexachlorobutadiene	0.690	9.30	No	116	3	2.59	-	-	-	-	-	No
Hexachloroethane	10.0	540	No	71	1	1.41	-	-	-	-	-	No
Isophorone	0.200	1,300	No	71	1	1.41	-	-	-	-	-	No
Methylene Chloride	37.0	940	No	138	53	38.4	-	-	-	-	-	No
Naphthalene	41.0	620	No	117	68	58.1	-	-	-	-	-	No
Pentachlorophenol	**10.0**	**8.1**	Yes	72	4	5.56	Yes	N/A	27	Yes	Yes	Yes
Phenanthrene	**6.00**	**2.40**	Yes	73	29	39.7	Yes	N/A	5.5	Yes	Yes	Yes
Phenol	5,000	2,560	Yes	76	7	9.21	Yes	N/A	5.5	No	-	No
Pyrene	2.00	0.025	Yes	71	1	1.41	No	-	-	-	-	No

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Table 2.1
Summary of ECOPC Screening Steps for Surface Water ECOPCs in the NN AEU

Analyte	MDC	Surface Water ESL	MDC > ESL?	Number of Samples	Number of Detects	Detects (%)	Detection Frequency > 5%	> BKG[2]	AEU UTL	95th UTL > ESL?	Professional Judgment	ECOPC
Styrene	3.00	160	No	138	1	0.725	-	-	-	-	-	No
Tetrachloroethene	0.200	840	No	138	2	1.45	-	-	-	-	-	No
Toluene	47.0	1,750	No	138	53	38.4	-	-	-	-	-	No
trans-1,2-Dichloroethene	0.100	1,500	No	97	5	5.15	-	-	-	-	-	No
Trichloroethene	2.00	21,900	No	138	24	17.4	-	-	-	-	-	No
Vinyl Chloride	11.0	930	No	138	48	34.8	-	-	-	-	-	No
Xylene	24.0	35.0	No	132	57	43.2	-	-	-	-	-	No
Radionuclides (pCi/L) (Total)												
Americium-241	0.033	43.8	No	77	77	100	-	-	-	-	-	No
Cesium-137	1.20	42.6	No	20	20	100	-	-	-	-	-	No
Plutonium-239/240	0.056	18.7	No	76	76	100	-	-	-	-	-	No
Radium-226	0.230	1.02	No	2	2	100	-	-	-	-	-	No
Strontium-89/90	4.06	278	No	15	15	100	-	-	-	-	-	No
Uranium-233/234	4.07	20.1	No	61	61	100	-	-	-	-	-	No
Uranium-235	0.338	21.7	No	61	61	100	-	-	-	-	-	No
Uranium-238	3.65	22.3	No	61	61	100	-	-	-	-	-	No

Note: Data set includes both AEU-specific data and data that are part of the background data set.
- = Screen not performed because ECOI was eliminated from further consideration in previous step.
[1] The un-ionized fraction was calculated from the total recoverable concentration by multiplying by a factor of 0.396%.
[2] Data set used for background comparison does not include data from background locations.
N/A = not available or not applicable.
Bold = Indicates analyte is an ECOPC.

Table 2.2
Summary of ECOPC Screening Steps for Sediment ECOPCs in NN AEU

Analyte	MDC	Sediment ESL	MDC > ESL?	Number of Detects	Number of Samples	Detects (%)	Detection Frequency > 5%	> BKG[1]	AEU UTL	95th UTL > ESL?	Professional Judgment	Sediment ECOPC
Inorganics (mg/kg)												
Aluminum	**24,000**	**15,900**	**Yes**	**20**	**20**	**100**	**Yes**	**Yes**	**24,795**	**Yes**	**Yes**	**Yes**
Arsenic	7.1	9.79	No	20	20	100	-	-	-	-	-	No
Barium	**390**	**189**	**Yes**	**20**	**20**	**100**	**Yes**	**Yes**	**390**	**Yes**	**Yes**	**Yes**
Cadmium	0.160	0.990	No	2	20	10.0	-	-	-	-	-	No
Chromium	25.0	43.4	No	19	20	95.0	-	-	-	-	-	No
Copper	19.1	31.6	No	20	20	100	-	-	-	-	-	No
Iron	**21,500**	**20,000**	**Yes**	**20**	**20**	**100**	**Yes**	**Yes**	**21,664**	**Yes**	**Yes**	**Yes**
Lead	**37.6**	**35.8**	**Yes**	**20**	**20**	**100**	**Yes**	**Yes**	**37.6**	**Yes**	**Yes**	**Yes**
Manganese	1,100	630	Yes	20	20	100	Yes	No	-	-	-	No
Mercury	0.090	0.180	No	11	20	55.0	-	-	-	-	-	No
Nickel	17.0	22.7	No	20	20	100	-	-	-	-	-	No
Selenium	0.880	0.950	No	6	19	31.6	-	-	-	-	-	No
Silver	0.340	1.00	No	1	20	5.00	-	-	-	-	-	No
Zinc	110	121	No	20	20	100	-	-	-	-	-	No
Organics (µg/kg)												
1,2,4-Trimethylbenzene	4.60	122	No	6	10	60.0	-	-	-	-	-	No
2-Butanone	13.0	84.2	No	1	16	6.25	-	-	-	-	-	No
Anthracene	51.0	57.2	No	2	16	12.5	-	-	-	-	-	No
Benzo(a)anthracene	**150**	**108**	**Yes**	**6**	**16**	**37.5**	**Yes**	**N/A**	**435**	**Yes**	**Yes**	**Yes**
Benzo(a)pyrene	**160**	**150**	**Yes**	**2**	**16**	**12.5**	**Yes**	**N/A**	**500**	**Yes**	**Yes**	**Yes**
Benzo(g,h,i)perylene	**89.0**	**13.0**	**Yes**	**2**	**16**	**12.5**	**Yes**	**N/A**	**500**	**Yes**	**Yes**	**Yes**
Benzo(k)fluoranthene	110	240	No	1	16	6.25	-	-	-	-	-	No
bis(2-ethylhexyl)phthalate	220	24,900	No	5	16	31.3	-	-	-	-	-	No
Chrysene	**190**	**166**	**Yes**	**4**	**16**	**25.0**	**Yes**	**N/A**	**579**	**Yes**	**Yes**	**Yes**
Di-n-butylphthalate	34.0	612	No	1	16	6.25	-	-	-	-	-	No
Fluoranthene	340	423	No	6	16	37.5	-	-	-	-	-	No
Indeno(1,2,3-cd)pyrene	**86.0**	**17.0**	**Yes**	**2**	**16**	**12.5**	**Yes**	**N/A**	**500**	**Yes**	**Yes**	**Yes**
Naphthalene	2.50	176	No	3	16	18.8	-	-	-	-	-	No
Phenanthrene	**280**	**204**	**Yes**	**6**	**16**	**37.5**	**Yes**	**N/A**	**517**	**Yes**	**Yes**	**Yes**
Pyrene	**320**	**195**	**Yes**	**2**	**16**	**12.5**	**Yes**	**N/A**	**500**	**Yes**	**Yes**	**Yes**
Toluene	190	1,660	No	2	16	12.5	-	-	-	-	-	No
Radionuclides (pCi/g)												
Americium-241	0.130	5,150	No	21	21	100	-	-	-	-	-	No
Cesium-137	1.21	3,120	No	9	9	100	-	-	-	-	-	No
Plutonium-239/240	0.447	5,860	No	23	23	100	-	-	-	-	-	No
Radium-226	1.53	101	No	5	5	100	-	-	-	-	-	No
Radium-228	1.62	87.8	No	7	7	100	-	-	-	-	-	No
Strontium-89/90	1.04	582	No	9	9	100	-	-	-	-	-	No
Uranium-233/234	1.51	5,280	No	21	21	100	-	-	-	-	-	No
Uranium-235	0.143	3,730	No	21	21	100	-	-	-	-	-	No
Uranium-238	1.58	2,490	No	21	21	100	-	-	-	-	-	No

Note: Data set includes both AEU-specific data and data that are part of the background data set.
- = Screen not performed because ECOI was eliminated from further consideration in previous step.
[1] Data set used for background comparison does not include data from background locations.
N/A = not available or not applicable.
Bold = Indicates analyte is an ECOPC.

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Table 2.3
Summary of ECOPC Screening Steps for Surface Water ECOPCs in the RC AEU

Analyte	MDC	Surface Water ESL	MDC > ESL?	Total Number of Samples	Total Number of Detects	Detects (%)	Detection Frequency > 5%	> BKG[1]	AEU UTL	95th UTL > ESL?	Professional Judgment	ECOPC
Inorganic (mg/L) (Total)												
Aluminum	129	0.087	Yes	109	98	89.9	Yes	No	-	-	-	No
Antimony	0.0063	0.240	No	110	13	11.8	-	-	-	-	-	No
Barium	0.630	0.438	Yes	109	108	99.0	Yes	Yes	0.137	No	-	No
Beryllium	0.004	0.002	Yes	109	27	24.8	Yes	N/A	8.50E-04	No	-	No
Chloride	76.0	230,000	No	98	92	93.9	-	-	-	-	-	No
Cobalt	0.019	0.100	No	109	34	36.2	-	-	-	-	-	No
Cyanide	0.026	5.00E-04	Yes	34	2	5.88	Yes	N/A*	-	-	-	No
Fluoride	1.00	2.12	No	98	94	95.9	-	-	-	-	-	No
Lithium	0.154	0.096	Yes	102	79	77.4	Yes	Yes	0.028	No	-	No
Molybdenum	0.008	0.800	No	102	41	40.2	-	-	-	-	-	No
Nitrite	0.058	4.47	No	32	1	3.13	-	-	-	-	-	No
Selenium	0.019	0.005	Yes	105	29	27.6	Yes	N/A	0.004	No	-	No
Strontium	0.703	8.30	No	102	101	99.0	-	-	-	-	-	No
Thallium	0.008	0.015	No	110	10	9.10	-	-	-	-	-	No
Tin	0.019	0.073	No	99	10	10.1	-	-	-	-	-	No
Vanadium	0.132	0.012	Yes	109	66	61.0	Yes	No	-	-	-	No
Inorganic (mg/L) (Dissolved)												
Arsenic	0.004	0.150	No	41	3	7.32	-	-	-	-	-	No
Cadmium	0.003	2.50E-04	Yes	42	6	14.3	Yes	N/A	0.003	Yes	No	No
Chromium	0.015	0.074	No	41	3	7.32	-	-	-	-	-	No
Copper	0.022	0.009	Yes	42	21	50.0	Yes	No	-	-	-	No
Iron	3.19	1.00	Yes	40	37	92.5	Yes	No	-	-	-	No
Lead	0.012	0.003	Yes	41	12	29.3	Yes	N/A	0.009	Yes	No	No
Manganese	0.486	1.65	No	42	39	92.9	-	-	-	-	-	No
Mercury	0.005	7.70E-04	Yes	41	1	2.44	No	-	-	-	-	No
Nickel	0.007	0.052	No	42	3	7.14	-	-	-	-	-	No
Silver	0.002	3.20E-04	Yes	42	1	2.38	No	-	-	-	-	No
Zinc	0.024	0.118	No	42	23	54.8	-	-	-	-	-	No
Organic (µg/L)												
Acetone	28.0	1,500	No	29	2	6.90	-	-	-	-	-	No
Chlorobenzene	0.400	47.0	No	43	1	2.33	-	-	-	-	-	No
Chloroform	0.200	1,240	No	43	2	4.65	-	-	-	-	-	No
Methylene Chloride	2.00	940	No	43	3	6.98	-	-	-	-	-	No
Tetrachloroethene	10.0	840	No	43	1	2.33	-	-	-	-	-	No
Radionuclides (pCi/L)												
Americium-241	0.127	43.8	No	37	37	100	-	-	-	-	-	No
Cesium-137	0.890	42.6	No	23	23	100	-	-	-	-	-	No
Plutonium-239/240	1.69	18.7	No	35	35	100	-	-	-	-	-	No
Radium-226	4.90	1.02	Yes	3	3	100	Yes	N/A*	-	-	-	No
Strontium-89/90	1.80	278	No	17	17	100	-	-	-	-	-	No
Tritium	320	2.65E+08	No	27	27	100	-	-	-	-	-	No
Uranium-233/234	5.10	20.1	No	29	29	100	-	-	-	-	-	No
Uranium-235	0.290	21.7	No	29	29	100	-	-	-	-	-	No
Uranium-238	4.90	22.3	No	29	29	100	-	-	-	-	-	No

Note: Data set includes both AEU-specific data and data that are part of the background data set.

\- = Screen not performed because ECOI was eliminated from further consideration in previous step.

[1] Data set used for background comparison does not include data from background locations.

N/A = Not available or not applicable.

* Background comparison not valid, only background samples had detected concentrations greater than the ESL and ECOI does not pose a risk.

Table 2.4
Summary of ECOPC Screening Steps for Sediment ECOPCs in the RC AEU

Analyte	MDC	Sediment ESL	MDC > ESL?	Number of Samples	Number of Detects	Detects (%)	Detection Frequency > 5%	> BKG[1]	AEU UTL	95th UTL > ESL?	Professional Judgment	Sediment ECOPC
Inorganics (mg/kg)												
Aluminum	19,500	15,900	Yes	22	22	100	Yes	Yes	20,325	Yes	No	No
Antimony	11.1	2.00	Yes	19	1	5.26	Yes	N/A*	-	-	-	No
Arsenic	15.0	9.79	Yes	22	21	95.5	Yes	Yes	15.0	Yes	No	No
Barium	360	189	Yes	22	22	100	Yes	Yes	303	Yes	No	No
Cadmium	1.30	0.990	Yes	19	7	36.8	Yes	N/A	2.00	Yes	No	No
Chromium	28.2	43.4	No	22	21	95.5	-	-	-	-	-	No
Copper	29.9	31.6	No	22	20	90.9	-	-	-	-	-	No
Iron	39,000	20,000	Yes	22	22	100	Yes	Yes	39,000	Yes	No	No
Lead	79.1	35.8	Yes	22	22	100	Yes	Yes	79.1	Yes	No	No
Manganese	2,500	630	Yes	22	22	100	Yes	No	-	-	-	No
Mercury	0.066	0.180	No	19	5	26.3	-	-	-	-	-	No
Nickel	23.0	22.7	Yes	21	20	95.2	Yes	Yes	19.3	No	-	No
Selenium	3.20	0.950	Yes	22	7	31.8	Yes	Yes	3.20	Yes	No	No
Silver	3.40	1.00	Yes	19	4	21.1	Yes	N/A	3.40	Yes	No	No
Zinc	720	121	Yes	22	21	95.5	Yes	Yes	720	Yes	No	No
Organics (ug/kg)												
1,1,1-Trichloroethane	9.00	159	No	11	1	9.09	-	-	-	-	-	No
2-Butanone	190	84.2	Yes	13	2	15.4	Yes	N/A*	-	-	-	No
4-Methylphenol	1,500	12.3	Yes	20	3	15.0	Yes	N/A*	-	-	-	No
Benzo(a)anthracene	62.0	108	No	19	1	5.26	-	-	-	-	-	No
Benzo(a)pyrene	130	150	No	18	1	5.56	-	-	-	-	-	No
bis(2-ethylhexyl)phthalate	350	24,900	No	18	7	38.9	-	-	-	-	-	No
Chrysene	74.0	166	No	19	1	5.26	-	-	-	-	-	No
Di-n-butylphthalate	250	612	No	20	6	30.0	-	-	-	-	-	No
Fluoranthene	89.0	423	No	19	1	5.26	-	-	-	-	-	No
Pentachlorophenol	1,500	255	Yes	19	1	5.26	Yes	N/A	6,500	Yes	No	No
Phenanthrene	59.0	204	No	19	1	5.26	-	-	-	-	-	No
Phenol	120	773	No	19	1	5.26	-	-	-	-	-	No
Pyrene	130	195	No	19	1	5.26	-	-	-	-	-	No
Tetrachloroethene	38.0	3,050	No	10	1	10.0	-	-	-	-	-	No
Toluene	39.0	1,660	No	10	1	10.0	-	-	-	-	-	No
Trichloroethene	48.0	22,800	No	11	1	9.09	-	-	-	-	-	No
Xylene	14.0	91.0	No	10	1	10.0	-	-	-	-	-	No
Radionuclides (pCi/g)												
Americium-241	0.038	5,150	No	18	18	100	-	-	-	-	-	No
Cesium-137	1.50	3,120	No	15	15	100	-	-	-	-	-	No
Plutonium-239/240	0.081	5,860	No	20	20	100	-	-	-	-	-	No
Radium-226	1.80	101	No	9	9	100	-	-	-	-	-	No
Radium-228	4.10	87.8	No	9	9	100	-	-	-	-	-	No
Strontium-89/90	0.560	582	No	14	14	100	-	-	-	-	-	No
Uranium-233/234	2.30	5,280	No	18	18	100	-	-	-	-	-	No
Uranium-235	0.269	3,730	No	18	18	100	-	-	-	-	-	No
Uranium-238	2.30	2,490	No	18	18	100	-	-	-	-	-	No

Note: Data set includes both AEU-specific data and data that are part of the background data set.

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

N/A = Not available or not applicable.

[1] Data set used for background comparison does not include data from background locations.

* Background comparison not valid, only background samples had detected concentrations greater than the ESL and ECOI does not pose a risk.

Table 2.5
Summary of ECOPC Screening Steps for Surface Water ECOPCs in the MK AEU

Analyte	MDC	Surface Water ESL	MDC > ESL?	Number of Samples	Number of Detections	Detects (%)	Detection Frequency > 5%	> BKG[1]	95th UTL > ESL?	AEU UTL	Professional Judgment	ECOPC
Inorganics (mg/L) (Total)												
Aluminum	**46.0**	**0.087**	**Yes**	**39**	**39**	**100**	**Yes**	**Yes**	**Yes**	**17.7**	**Yes**	**Yes**
Antimony	0.0051	0.240	No	39	1	2.56	-	-	-	-	-	No
Barium	0.340	0.438	No	39	35	89.7	-	-	-	-	-	No
Boron	0.020	1.90	No	2	2	100	-	-	-	-	-	No
Chloride	67.0	230,000	No	24	24	100	-	-	-	-	-	No
Cobalt	0.010	0.100	No	39	14	35.9	-	-	-	-	-	No
Fluoride	0.360	2.12	No	22	20	90.9	-	-	-	-	-	No
Lithium	0.021	0.096	No	30	13	43.3	-	-	-	-	-	No
Molybdenum	6.00E-04	0.800	No	34	1	2.94	-	-	-	-	-	No
Nitrite	0.037	4.47	No	10	1	10.0	-	-	-	-	-	No
Selenium	**0.005**	**0.005**	**Yes**	**39**	**3**	**7.69**	**Yes**	**N/A**	**Yes**	**0.022**	**Yes**	**Yes**
Strontium	0.590	8.30	No	32	31	96.9	-	-	-	-	-	No
Thallium	0.001	0.015	No	39	1	2.56	-	-	-	-	-	No
Tin	0.028	0.073	No	34	1	2.94	-	-	-	-	-	No
Vanadium	0.082	0.012	Yes	39	20	51.3	Yes	No	-	-	-	No
Inorganics (mg/L) (Dissolved)												
Arsenic	0.003	0.150	No	24	3	12.5	-	-	-	-	-	No
Cadmium	**0.003**	**2.50E-04**	**Yes**	**26**	**5**	**19.2**	**Yes**	**N/A**	**Yes**	**0.003**	**Yes**	**Yes**
Chromium	0.024	0.074	No	26	10	38.5	-	-	-	-	-	No
Copper	0.025	0.009	Yes	24	17	70.8	Yes	No	-	-	-	No
Iron	0.715	1.00	No	27	26	96.3	-	-	-	-	-	No
Lead	0.071	0.003	Yes	25	14	56.0	Yes	No	-	-	-	No
Manganese	0.316	1.65	No	27	27	100	-	-	-	-	-	No
Nickel	0.013	0.052	No	26	10	38.5	-	-	-	-	-	No
Silver	0.002	3.20E-04	Yes	26	1	3.85	No	-	-	-	-	No
Zinc	**0.245**	**0.118**	**Yes**	**26**	**22**	**84.6**	**Yes**	**Yes**	**Yes**	**0.245**	**Yes**	**Yes**
Organics (µg/L)												
2-Butanone	3.00	2,200	No	12	1	8.33	-	-	-	-	-	No
bis(2-ethylhexyl)phthalate	1.00	28.5	No	2	1	50.0	-	-	-	-	-	No
Methylene Chloride	16.0	940	No	13	1	7.69	-	-	-	-	-	No
Tetrachloroethene	5.00	840	No	13	1	7.69	-	-	-	-	-	No
Trichloroethene	5.00	21,900	No	13	1	7.69	-	-	-	-	-	No
Radionuclides (pCi/L)												
Americium-241	0.032	43.8	No	36	36	100	-	-	-	-	-	No
Cesium-137	0.740	42.6	No	4	4	100	-	-	-	-	-	No
Plutonium-239/240	0.500	18.7	No	35	35	100	-	-	-	-	-	No
Radium-226	0.540	1.02	No	1	1	100	-	-	-	-	-	No
Strontium-89/90	2.10	278	No	6	6	100	-	-	-	-	-	No
Tritium	751	2.65E+08	No	8	8	100	-	-	-	-	-	No
Uranium-233/234	5.93	20.1	No	34	34	100	-	-	-	-	-	No
Uranium-235	0.190	21.7	No	34	34	100	-	-	-	-	-	No
Uranium-238	3.39	22.3	No	34	34	100	-	-	-	-	-	No

Note: Data set includes both AEU-specific data and data that are part of the background data set.

\- = Screen not performed because ECOI was eliminated from further consideration in previous step.

N/A = not available or not applicable.

[1] Data set used for background comparison does not include data from background locations.

Bold = Indicates analyte is an ECOPC.

Table 2.6
Summary of ECOPC Screening Steps for Sediment ECOPCs in the MK AEU

Analyte	MDC	Sediment ESL	MDC > ESL?	Number of Samples	Number of Detections	Detects (%)	Detection Frequency > 5%	> BKG[1]	95th UTL > ESL?	AEU UTL	Professional Judgment	Sediment ECOPC?
Inorganics (mg/kg)												
Aluminum	**30,300**	**15,900**	**Yes**	**12**	**12**	**100**	**Yes**	**Yes**	**Yes**	**30,003**	**Yes**	**Yes**
Antimony	12.40	2.00	Yes	12	1	8.33	Yes	N/A*	-	-	-	No
Arsenic	8.40	9.79	No	12	12	100	-	-	-	-	-	No
Barium	170	189	No	12	12	100	-	-	-	-	-	No
Cadmium	0.490	0.990	No	12	5	41.7	-	-	-	-	-	No
Chromium	**44.3**	**43.4**	**Yes**	**12**	**12**	**100**	**Yes**	**Yes**	**Yes**	**44.3**	**Yes**	**Yes**
Chromium VI	0.013	43.4	No	1	1	100	-	-	-	-	-	No
Copper	33.2	31.6	Yes	12	11	91.7	Yes	No	-	-	-	No
Fluoride	**8.47**	**0.010**	**Yes**	**1**	**1**	**100**	**Yes**	**N/A**	**N/A**	**N/A**	**Yes**	**Yes**
Iron	27,500	20,000	Yes	12	12	100	Yes	No	-	-	-	No
Lead	73.6	35.8	Yes	12	12	100	Yes	No	-	-	-	No
Manganese	326	630	No	12	12	100	-	-	-	-	-	No
Mercury	0.160	0.180	No	12	4	33.3	-	-	-	-	-	No
Nickel	**28.3**	**22.7**	**Yes**	**12**	**11**	**91.7**	**Yes**	**Yes**	**Yes**	**28.7**	**Yes**	**Yes**
Selenium	**2.70**	**0.950**	**Yes**	**12**	**1**	**8.33**	**Yes**	**N/A**	**Yes**	**2.70**	**Yes**	**Yes**
Zinc	347	121	Yes	12	12	100	Yes	No	-	-	-	No
Organics (µg/kg)												
2-Butanone	3.00	84.2	No	8	1	12.5	-	-	-	-	-	No
4-Methylphenol	95.0	12.3	Yes	8	1	12.5	Yes	N/A*	-	-	-	No
bis(2-ethylhexyl)phthalate	120	24,900	No	8	3	37.5	-	-	-	-	-	No
Chrysene	150	166	No	8	1	12.5	-	-	-	-	-	No
Di-n-butylphthalate	280	612	No	8	3	37.5	-	-	-	-	-	No
Fluoranthene	170	423	No	8	2	25.0	-	-	-	-	-	No
Phenanthrene	96.0	204	No	8	1	12.5	-	-	-	-	-	No
Pyrene	170	195	No	8	2	25.0	-	-	-	-	-	No
Toluene	6.00	1,660	No	8	2	25.0	-	-	-	-	-	No
Radionuclides (pCi/g)												
Americium-241	0.087	5,150	No	12	12	100	-	-	-	-	-	No
Cesium-137	0.391	3,120	No	7	7	100	-	-	-	-	-	No
Plutonium-239/240	0.054	5,860	No	12	12	100	-	-	-	-	-	No
Radium-226	1.90	101	No	5	5	100	-	-	-	-	-	No
Radium-228	1.70	87.8	No	3	3	100	-	-	-	-	-	No
Strontium-89/90	0.316	582	No	7	7	100	-	-	-	-	-	No
Uranium-233/234	15.0	5,280	No	12	12	100	-	-	-	-	-	No
Uranium-235	0.460	3,730	No	12	12	100	-	-	-	-	-	No
Uranium-238	13.0	2,490	No	12	12	100	-	-	-	-	-	No

Note: Data set includes both AEU-specific data and data that are part of the background data set.

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

N/A = not available or not applicable.

Bold = Indicates analyte is an ECOPC.

[1] Data set used for background comparison does not include data from background locations.

* Background comparison not valid, only background samples had detected concentrations greater than the ESL and ECOI does not pose a risk.

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Table 2.7

Summary of ECOPC Screening Steps for Surface Water ECOPCs in the SE AEU

Analyte	MDC	Surface Water ESL	MDC > ESL?	Number of Samples	Number of Detections	Detects (%)	Detection Frequency > 5%	> BKG[2]	95th UTL > ESL?	AEU UTL	Professional Judgment	ECOPC
Inorganics (mg/L) (Total)												
Aluminum	0.274	0.087	Yes	11	8	72.7	Yes	No	-	-	-	No
Ammonia[1]	0.0035	0.020	No	1	1	100	-	-	-	-	-	No
Antimony	0.029	0.240	No	12	2	16.7	-	-	-	-	-	No
Barium	0.120	0.438	No	12	11	91.7	-	-	-	-	-	No
Boron	0.130	1.90	No	4	3	75.0	-	-	-	-	-	No
Chloride	44.0	230,000	No	7	7	100	-	-	-	-	-	No
Fluoride	0.720	2.12	No	7	7	100	-	-	-	-	-	No
Lithium	0.065	0.096	No	12	6	50.0	-	-	-	-	-	No
Molybdenum	0.005	0.800	No	12	3	25.0	-	-	-	-	-	No
Selenium	0.001	0.005	No	12	1	8.33	-	-	-	-	-	No
Strontium	1.20	8.30	No	12	12	100	-	-	-	-	-	No
Tin	0.013	0.073	No	12	1	8.33	-	-	-	-	-	No
Inorganics (mg/L) (Dissolved)												
Copper	0.004	0.009	No	7	4	57.1	-	-	-	-	-	No
Iron	0.121	1.00	No	5	3	60.0	-	-	-	-	-	No
Lead	0.002	0.003	No	6	1	16.7	-	-	-	-	-	No
Manganese	0.164	1.65	No	7	5	71.4	-	-	-	-	-	No
Nickel	0.013	0.052	No	7	1	14.3	-	-	-	-	-	No
Silver	0.003	3.20E-04	Yes	7	2	28.6	Yes	N/A	Yes	0.003	No	No
Zinc	0.011	0.118	No	7	2	28.6	-	-	-	-	-	No
Organics (µg/L)												
Methylene Chloride	10.0	940	No	7	1	14.3	-	-	-	-	-	No
Radionuclides (pCi/L)												
Americium-241	0.014	43.8	No	10	10	100	-	-	-	-	-	No
Cesium-137	1.60	42.6	No	6	6	100	-	-	-	-	-	No
Plutonium-239/240	0.060	18.7	No	11	11	100	-	-	-	-	-	No
Strontium-89/90	3.20	278	No	4	4	100	-	-	-	-	-	No
Tritium	150	2.65E+08	No	6	6	100	-	-	-	-	-	No
Uranium-233/234	1.86	20.1	No	8	8	100	-	-	-	-	-	No
Uranium-235	0.117	21.7	No	8	8	100	-	-	-	-	-	No
Uranium-238	2.58	22.3	No	8	8	100	-	-	-	-	-	No

Note: Data set includes both AEU-specific data and data that are part of the background data set.

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

[1] The un-ionoized fraction was calculated from the total recoverable concentration by muliplying by a factor of 1.24%.

[2] Data set used for background comparison does not include data from background locations.

N/A = Not available or not applicable.

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Table 2.8
Summary of ECOPC Screening Steps for Sediment ECOPCs in the SE AEU

Analyte	MDC	Sediment ESL	MDC > ESL?	Number of Samples	Number of Detections	Detects (%)	Detection Frequency > 5%	> BKG[1]	95th UTL > ESL?	AEU UTL	Professional Judgment	Sediment ECOPC
Inorganics (mg/kg)												
Aluminum	26,000	15,900	Yes	7	7	100	Yes	Yes	Yes	35,575	No	No
Arsenic	9.3000	9.79	No	7	7	100	-	-	-	-	-	No
Barium	240	189	Yes	7	7	100	Yes	Yes	Yes	300	No	No
Cadmium	0.710	0.990	No	7	7	100	-	-	-	-	-	No
Chromium	26.0	43.4	No	7	7	100	-	-	-	-	-	No
Copper	27.0	31.6	No	7	7	100	-	-	-	-	-	No
Iron	34,000	20,000	Yes	7	7	100	Yes	Yes	Yes	41,769	No	No
Lead	27.0	35.8	No	7	7	100	-	-	-	-	-	No
Manganese	480	630	No	7	7	100	-	-	-	-	-	No
Mercury	0.080	0.180	No	7	7	100	-	-	-	-	-	No
Nickel	21.0	22.7	No	7	7	100	-	-	-	-	-	No
Selenium	1.70	0.950	Yes	7	1	14.3	Yes	N/A	Yes	1.70	No	No
Zinc	81.0	121	No	7	7	100	-	-	-	-	-	No
Radionuclides (pCi/g)												
Americium-241	0.0997	5,150	No	9	9	100	-	-	-	-	-	No
Plutonium-239/240	0.216	5,860	No	9	9	100	-	-	-	-	-	No
Uranium-233/234	3.18	5,280	No	9	9	100	-	-	-	-	-	No
Uranium-235	0.188	3,730	No	9	9	100	-	-	-	-	-	No
Uranium-238	3.39	2,490	No	9	9	100	-	-	-	-	-	No

Note: Data set includes both AEU-specific data and data that are part of the background data set.
\- = Screen not performed because ECOI was eliminated from further consideration in previous step.
[1] Data set used for background comparison does not include data from background locations.
N/A = Not available or not applicable.

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Table 5.1
Hazard Quotient Evaluation of Surface Water ECOPCs in NN AEU

ECOPC	ESL		Alternative Toxicity Value		Units	n	MDC EPC Hazard Quotients			95 UTL EPC Hazard Quotients			95UCL Hazard Quotients		
							EPC-Max	ESL-HQ	Alternative Toxicity-HQ	EPC-95UTL	ESL-HQ	Alternative Toxcity-HQ	EPC-95UCL	ESL-HQ	Alternative Toxicity-HQ
Inorganics															
Barium (Total)	0.856	(1)	4.89	(1)	mg/L	72	0.820	<1	<1	0.744	<1	<1	0.456	<1	<1
Lead (Dissolved)	0.005	(1)	0.127	(1)	mg/L	32	0.0047	<1	<1	0.003	<1	<1	0.002	<1	<1
Silver (Dissolved)	0.0009	(1)	0.006	(1)	mg/L	32	0.013	**15**	**2**	0.006	**7**	**1**	0.003	**3**	<1
Zinc (Dissolved)	0.202	(1)	0.2	(1)	mg/L	31	1.500	**7**	**8**	1.5	**7**	**8**	1.090	**5**	**5**
Organics															
Pentachlorophenol	8.10	(1)	21.1	(1)	ug/L	72	10	**1**	<1	27 (10)	**1**	<1	83.4 (10)	**1**	<1
Phenanthrene	2.40		43.0		ug/L	73	6	**3**	<1	5.5	**2**	<1	16.2 (6)	**3**	<1

95UCLs based on proxy values which include NDs at 1/2 DL.
Values in parenthesis represent the MDC, used as the EPC when the MDC < the 95 UTL and/or 95 UCL.
HQ = Hazard Quotient, rounded to nearest whole number.
Values in bold indicate HQs > 1.
(1) A site-specific ESL was developed using site-specific water quality considerations of hardness (Attachment 5).

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Table 5.2
Hazard Quotient Evaluation of Surface Water ECOPCs Using a Post-1999 Data in NN AEU

ECOPC	ESL		Alternative Toxicity Value		Units	n	MDC EPC Hazard Quotients			95 UTL EPC Hazard Quotients			95UCL Hazard Quotients		
							MDC	ESL-HQ	AT-HQ	EPC-95 UTL	ESL-HQ	AT-HQ	EPC-95 UCL	ESL-HQ	AT-HQ
Inorganics															
Barium (Total)	0.856	(1)	4.8	(1)	mg/L	26	0.82	<1	<1	0.82	<1	<1	0.389	<1	<1
Lead (Dissolved)	0.005	(1)	0.127	(1)	mg/L	1	N/A	--	--	N/A	--	--	N/A	--	--
Silver (Dissolved)	0.0009	(1)	0.006	(1)	mg/L	1	N/A	--	--	N/A	--	--	N/A	--	--
Zinc (Dissolved)	0.202	(1)	0.2	(1)	mg/L	1	N/A	--	--	N/A	--	--	N/A	--	--
Organics															
Pentachlorophenol	8.10	(1)	21.1	(1)	ug/L	4	N/A	--	--	N/A	--	--	N/A	--	--
Phenanthrene	2.40		43.0		ug/L	4	3.5	**1**	<1	8.87 (3.5)	**1**	<1	5.52 (3.5)	**1**	<1

95UCLs based on proxy values which include NDs at 1/2 DL.

Values in parenthesis represent the MDC, used as the EPC when the MDC < the 95 UTL and/or 95 UCL.

HQ = Hazard Quotient, rounded to nearest whole number.

Values in bold indicate HQs > 1.

(1) A site-specific ESL was developed using site-specific water quality considerations of hardness (Attachment 5).

-- = Could not be calculated due to lack of EPC.

N/A = Not available.

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Table 5.3
Hazard Quotient Evaluation of Sediment ECOPCs in NN AEU

ECOPC	ESL	Alternative Toxicity Value	Units	n	MDC EPC Hazard Quotients			95 UTL EPC Hazard Quotients			95UCL Hazard Quotients		
					EPC-Max	ESL-HQ	Alternative Toxicity-HQ	EPC-95UTL	ESL-HQ	Alternative Toxicity-HQ	EPC-95UCL	ESL-HQ	Alternative Toxicity-HQ
Inorganics													
Aluminum	15,900	58,000	mg/kg	20	24,000	**2**	<1	24,795	**2**	<1	16,718	**1**	<1
Barium	189	287	mg/kg	20	390	**2**	**1**	390	**2**	**1**	225	**1**	<1
Iron	20,000	280,000	mg/kg	20	21,500	**1**	<1	21,664	**1**	<1	16,747	<1	<1
Lead	35.8	128	mg/kg	20	37.6	**1**	<1	37.6	**1**	<1	22.8	<1	<1
Organics													
Benzo(a)anthracene	108	1,050	µg/kg	16	150	**1**	<1	435 (150)	**1**	<1	312 (150)	**1**	<1
Benzo(a)pyrene	150	1,450	µg/kg	16	160	**1**	<1	500 (160)	**1**	<1	373 (160)	**1**	<1
Benzo(g,h,i)perylene	13.0	280	µg/kg	16	89	**7**	<1	500 (89)	**7**	<1	463 (89)	**7**	<1
Chrysene	166	1,290	µg/kg	16	190	**1**	<1	579 (190)	**1**	<1	339 (190)	**1**	<1
Indeno(1,2,3-cd)pyrene	17.0	250	µg/kg	16	86	**5**	<1	500 (86)	**5**	<1	464 (86)	**5**	<1
Phenanthrene	204	1,170	µg/kg	16	280	**1**	<1	517 (280)	**1**	<1	297 (280)	**1**	<1
Pyrene	195	1520	µg/kg	16	320	**2**	<1	500 (320)	**2**	<1	382 (320)	**2**	<1
Total PAHs	1,610	22,800	µg/kg	16	5,448	**3**	<1	5,448	**3**	<1	4,408	**3**	<1
Total (detected) PAHs	1,610	22,800	µg/kg	7	1,762	**1**	<1	1,762	**1**	<1	2,112 (1,762)	**1**	<1

95UCLs based on proxy values which include NDs at 1/2 DL.
Values in parenthesis represent the MDC, used as the EPC when the MDC < the 95 UTL and/or 95 UCL.
HQ = Hazard Quotient, rounded to nearest whole number.
Values in bold indicate HQs > 1.
-- = Could not be calculated due to lack of EPC.

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Table 5.4
Hazard Quotient Evaluation of Surface Sediment ECOPCs in NN AEU

ECOPC	ESL	Alternative Toxicity Value	Units	n	MDC EPC Hazard Quotients			95 UTL EPC Hazard Quotients			95UCL Hazard Quotients		
					MDC	ESL-HQ	AT-HQ	EPC-95UTL	ESL-HQ	AT-HQ	EPC-95UCL	ESL-HQ	AT-HQ
Inorganics													
Aluminum	15,900	58,000	mg/kg	17	24,000	**2**	<1	24,795 (24,000)	**2**	<1	17,731	1	<1
Barium	189	287	mg/kg	17	390	**2**	1	390	1	1	239	1	<1
Iron	20,000	280,000	mg/kg	17	21,500	1	<1	21,580 (21,500)	1	<1	16,958	<1	<1
Lead	35.8	128	mg/kg	17	38	1	<1	38	1	<1	23	<1	<1
Organics													
Benzo(a)anthracene	108	1,050	ug/kg	15	150	1	<1	435 (150)	1	<1	321 (150)	1	<1
Benzo(a)pyrene	150	1,450	ug/kg	15	160	1	<1	500 (160)	1	<1	472 (160)	1	<1
Benzo(g,h,i)perylene	13	280	ug/kg	15	89	**7**	<1	500 (89)	**7**	<1	477 (89)	**7**	<1
Chrysene	166	1,290	ug/kg	15	190	1	<1	597 (190)	1	<1	347 (190)	1	<1
Indeno(1,2,3-cd)pyrene	17	250	ug/kg	15	86	**5**	<1	500 (86)	**5**	<1	478 (86)	**5**	<1
Phenanthrene	204	1,170	ug/kg	15	280	1	<1	532 (280)	1	<1	302 (280)	1	<1
Pyrene	195	1,520	ug/kg	15	320	**2**	<1	500 (320)	**2**	<1	392 (320)	**2**	<1
Total PAHs	1,610	22,800	ug/kg	15	5,002	**3**	<1	5,448 (5,002)	**3**	<1	4,490	**3**	<1

95UCLs based on proxy values which include NDs at 1/2 DL.

Values in parenthesis represent the MDC, used as the EPC when the MDC < the 95 UTL and/or 95 UCL.

HQ = Hazard Quotient, rounded to nearest whole number.

Values in bold indicate HQs > 1.

-- = Could not be calculated due to lack of EPC.

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Table 5.5
Frequency and Magnitude of Aquatic Receptor HQs for NN AEU Surface Water and Sediment ECOPCs

ECOPC and Media	Number of Samples	HQs <= 1	HQs > 1 - 5	HQs > 5 - 10	HQs > 10	Frequency of Detected Exceedances	LOE Risk Conclusion
Surface Water ECOPCs							
Inorganic							
Barium (Total)	72	72	0	0	0	0%	Low
Lead (Dissolved)	32	32	0	0	0	0%	Low
Silver (Dissolved)	32	4	2 (23)	2	1	16%	Low
Zinc (Dissolved)	31	22	5	4	0	29%	Retained
Organic							
Pentachlorphenol	72	3	1 (67)	0	(1)	1%	Low
Phenanthrene	73	1	29 (42)	0	(1)	40%	Low
Sediment ECOPCs							
Inorganic							
Aluminum	20	11	9	0	0	45%	Low
Barium	20	12	8	0	0	40%	Low
Iron	20	18	2	0	0	10%	Low
Lead	20	19	1	0	0	5%	Low
Organic							
Benzo(a)anthracene	16	4	2 (10)	0	0	13%	Low
Benzo(a)pyrene	16	1	1 (14)	0	0	6%	Low
Benzo(g,h,i)perylene	16	0	0	2	(14)	13%	Low
Chrysene	16	3	1 (12)	0	0	6%	Low
Indeno(1,2,3-cd)pyrene	16	0	1	1 (1)	(13)	13%	Low
Phenanthrene	16	8	1 (7)	0	0	6%	Low
Pyrene	16	3	2 (11)	0	0	13%	Low
Total PAHs	16	0	16	0	0	100%	Low
Total (detected) PAHs	7	6	1	0	0	14%	Low

Samples below detection limits are in parentheses.

Counts based on proxy values include NDs at 1/2 DL.

Risk Conclusions for this LOE:

None = Sample concentrations do not exceed the ESL.

Low = Low potential for Risk. Detected concentrations only exceed the ESL by low magnitude (HQs < 5) or exceedances <20%.

Retained = Potential for risk could not be excluded and further evaluation is required; Detected HQs > 5 and exceedances >20%.

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Table 5.6
Summary of Other/Drainage Lines of Evidence for the NN AEU

Line of Evidence Category and Source	Summary of Results (from the cited report)	Uncertainties	Conclusions and Relevance to RFETS CRA
Tissues Analysis			
N/A			
Aquatic Population Studies			
Ebasco, 1992	The East Landfill Pond supports no fish and only a depauperate benthic macroinvertebrate community. Macrobenthic sampling conducted in 1991 documented only eight taxa of macrobenthic organisms present in the pond, including organisms in the groups: Gastropoda, Pelecypoda, Oligochaeta, Hydracarina, Amphipoda, and Diptera. Many aquatic organisms present are adapted to low stream flow conditions. These organisms are often classified as "tolerant" considering general water quality.	The time period from which this study was completed represents an historic condition associated with RFETS. The flow of water into and out of certain ponds has been altered. Therefore, the results of current conditions are likely different from those described within the study.	Aquatic habitats at RFETS had a high density of benthic macroinvertebrates. Fish species diversity was naturally low, due to harsh environmental conditions (e.g., intermittent streams). Most species were found in pools that offer refuge from drought conditions. The most disruptive factor to aquatic communities was the ephemeral stream flows due to natural semiarid conditions. All streams have sections that are intermittent while others are fed by groundwater seeps that keep sections perennial and aquatic communities at RFETS thrive despite the environmental limitations.
DOE, 1996	A total of 81 taxa were identified in the pond benthos samples. The highly variable environmental (physicochemical) conditions at RFETS may account for the dominance of colonizing species resistant to stressors.	The time period from which this study was completed represents an historic condition associated with RFETS.	These evaluations occurred prior to accelerated actions when sediment chemical concentrations were potentially high. Accelerated actions have occurred which would affect overland flows and potential releases to NN AEU that would likely improve the current sediment quality, it is anticipated that the benthic macroinvertebrate populations is now less limited by chemical contamination than when this evaluation occurred.
Exponent, 1998	Aquatic life in Walnut Creek is limited by stream flow, which has been modified from natural flow conditions. However the assessment presented findings of good habitat and a relatively healthy macroinvertebrate community, which typically equates to good water quality. There are no indications that pollution is limiting aquatic life. The observed species are controlled/affected by the intermittent flows in the Creek.	The aquatic condition within the lower portions of the Walnut Creek watershed are described. They do not reflect conditions within RFETS, but rather the conditions just inside the boundary, to off-site downgradient areas. In addition, findings reflect one sampling event in the spring of 1998 representing a snapshot of conditions.	This study provides additional evidence that RFETS aquatic communities in lower Walnut Creek are limited by physical conditions of the streams and ponds due to very limited or manipulated flows. Water management onsite and the arid conditions found in the region limits the diversity and abundance of aquatic communities in the RFETS.
Kaiser-Hill, 1999, 2000, and 2001	Fish sampling conducted in 1999 at the pond captured no fish; however, a few frogs were captured. The No Name Gulch drainage, below the landfill pond is dry most of the time and surface water is present only during rain/snow events; therefore, very limited aquatic habitat exists and no aquatic sampling has been conducted in the No Name Gulch drainage.	This survey was essentially conducted during drought conditions. 1998 through 2000 were very dry years in terms of precipitation. No analysis is presented on the abundance of fish over time. A declining trend in fish abundance can not distinguish between chemical stressors and declining habitat conditions. Trends in relative abundance are unknown for RFETS streams and ponds.	With the exception of the bass observations, all fish species observed during the baseline study (Ebasco 1992) were observed again over this three year survey and found in the same general locations as they were in 1992. These studies indicate that all the RFETS streams are intermittent, and illustrate the points that perennial flows and better aquatic habitats occur in the upper reaches of these streams. It is unrealistic to expect that vibrant aquatic communities, especially fish communities, can occur in the lower reaches. Overall, fish species richness is very low.
Bioassay Analysis			
N/A			

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Table 5.6
Summary of Other/Drainage Lines of Evidence for the NN AEU

Line of Evidence Category and Source	Summary of Results (from the cited report)	Uncertainties	Conclusions and Relevance to RFETS CRA
Waterfowl/Wading Bird Evaluations			
DOE, 1996	Initial exposure screens for aquatic (receptor) species and source areas revealed ECOCs for barium in surface water from the OU7 Downgradient Source Area. However, there was no aquatic-life-based surface water standard available for barium. Therefore, Barium was not carried through in the risk characterization. Manganese and strontium were also revealed to have low hazard quotients. No other surface water or sediment contaminants of significant toxicity to aquatic life were known from the Present Landfill in aquatic environments. Due to the depauperate conditions of macroinvertebrate communities and the absence of fish in the landfill pond, exposure to aquatic feeding birds was considered an incomplete pathway for Great Blue Heron and Mallard.	The co-located sediment, surface water and biota analysis completed for this study represent a set of historic conditions. It is unlikely that current conditions would be comparable. This study likely represents worst-case conditions given that the analysis were completed prior to accelerated action.	The results of this study provide a screening measure of potential chemicals of concern to wading birds and waterfowl. The results were compared to this CRA risk characterization process for ECOPCs.

N/A = Not available.

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Table 5.7
Hazard Quotient Evaluation of Surface Water ECOPCs in MK AEU

ECOPC	ESL	Alternative Toxicity Value	Units	n	MDC EPC Hazard Quotients			95 UTL EPC Hazard Quotients			95UCL Hazard Quotients		
					EPC-Max	ESL-HQ	Alternative Toxicity-HQ	EPC-95UTL	ESL-HQ	Alternative Toxcity-HQ	EPC-95UCL	ESL-HQ	Alternative Toxicity-HQ
Inorganics													
Aluminum (Total)	0.750 (1)	N/A	mg/L	39	46	**61**	--	17.7	**24**	--	8.23	**11**	--
Cadmium (Dissolved)	0.00374 (1)	0.00897 (1)	mg/L	26	0.003	<1	<1	0.003	<1	<1	0.001	<1	<1
Selenium (Total)	0.0046	0.0184	mg/L	39	0.005	1	<1	0.022 (0.005)	1	<1	0.016 (0.005)	1	<1
Zinc (Dissolved)	0.211 (1)	0.21 (1)	mg/L	26	0.245	1	1	0.245	1	1	0.113	<1	<1

Samples below detection limits are in parentheses.
95UCLs based on proxy values which include NDs at 1/2 DL.
Values in parenthesis represent the MDC, used as the EPC when the MDC < the 95 UTL and/or 95 UCL.
HQ = Hazard Quotient, rounded to nearest whole number.
Values in bold indicate HQs > 1.
(1) A site-specific ESL was developed using site-specific water quality considerations of hardness (Attachment 5).
-- = Could not be calculated due to lack of EPC.
N/A = Not available.

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Table 5.8
Hazard Quotient Evaluation of Surface Water ECOPCs Using a Post-1999 Data in MK AEU

ECOPC	ESL		Alternative Toxicity Value		Units	n	MDC EPC Hazard Quotients			95 UTL EPC Hazard Quotients			95UCL Hazard Quotients		
							MDC	ESL-HQ	AT-HQ	EPC-95 UTL	ESL-HQ	AT-HQ	EPC-95 UCL	ESL-HQ	AT-HQ
Inorganics															
Aluminum (Total)	0.75	(1)	N/A		mg/L	2	1.7	**2**	--	1.7	**2**	--	N/A	--	--
Cadmium (Dissolved)	0.00374	(1)	0.00897	(1)	mg/L	0	N/A	--	--	N/A	--	--	N/A	--	--
Selenium (Total)	0.0046		0.0184		mg/L	2	N/A	--	--	N/A	--	--	N/A	--	--
Zinc (Dissolved)	0.211	(1)	0.21	(1)	mg/L	0	N/A	--	--	N/A	--	--	N/A	--	--

Samples below detection limits are in parentheses.
95UCLs based on proxy values which include NDs at 1/2 DL.
Values denoted in parenthesis represent the MDC, used as the EPC when the MDC < the 95 UTL and/or 95 UCL.
HQ = Hazard Quotient, rounded to nearest whole number.
Values in bold indicate HQs > 1.
(1) A site-specific ESL was developed using site-specific water quality considerations of hardness (Attachment 5).
-- = Could not be calculated due to lack of EPC.
N/A = Not available.

Table 5.9
Hazard Quotient Evaluation of Sediment ECOPCs in MK AEU

ECOPC	ESL	Alternative Toxicity Value	Units	n	MDC EPC Hazard Quotients			95 UTL EPC Hazard Quotients			95UCL Hazard Quotients		
					EPC-Max	ESL-HQ	Alternative Toxicity-HQ	EPC-95UTL	ESL-HQ	Alternative Toxicity-HQ	EPC-95UCL	ESL-HQ	Alternative Toxicity-HQ
Inorganics													
Aluminum	15,900	58,000	mg/kg	12	30,300	**2**	<1	30,003	**2**	<1	15,470	<1	<1
Chromium	43.4	111	mg/kg	12	44.3	**1**	<1	44.3	**1**	<1	20.1	<1	<1
Fluoride	0.010	7	mg/kg	1	8.47	**847**	**1**	N/A	--	--	N/A	--	--
Nickel	22.7	48.6	mg/kg	12	28.3	**1**	<1	28.7 (28.3)	**1**	<1	15.1	<1	<1
Selenium	1.0	1.73	mg/kg	12	2.7	**3**	**2**	2.7	**3**	**2**	1.36	**1**	<1

95UCLs based on proxy values which include NDs at 1/2 DL.

Values denoted in parenthesis represent the MDC, used as the EPC when the MDC < the 95 UTL and/or 95 UCL.

N/A = 95UCL and 95UTL could not be calculated due to low sample size (n=1 for fluoride).

HQ = Hazard Quotient, rounded to nearest whole number.

Values in bold indicate HQs > 1.

-- = Could not be calculated due to lack of EPC.

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Table 5.10
Hazard Quotient Evaluation of Surface Sediment ECOPCs in MK AEU

ECOPC	ESL	Alternative Toxicity Value	Units	n	MDC EPC Hazard Quotients			95 UTL EPC Hazard Quotients			95UCL Hazard Quotients		
					MDC	ESL-HQ	AT-HQ	EPC-95UTL	ESL-HQ	AT-HQ	EPC-95UCL	ESL-HQ	AT-HQ
Inorganics													
Aluminum	15,900	58,000	mg/kg	10	30,300	**2**	<1	31,403 (30,300)	**2**	<1	15,804	<1	<1
Chromium	43.4	111	mg/kg	10	44.3	1	<1	44	1	<1	23	<1	<1
Fluoride	0.01	7	mg/kg	1	8.47	**847**	1	N/A	--	--	N/A	--	--
Nickel	23	49	mg/kg	10	28.3	1	<1	30 (28.3)	1	<1	16	<1	<1
Selenium	0.959	1.73	mg/kg	10	2.7	**3**	**2**	2.7	**3**	**2**	1.56	**2**	<1

Samples below detection limits are in parentheses.

95UCLs based on proxy values which include NDs at 1/2 DL.

Values in parenthesis represent the MDC, used as the EPC when the MDC < the 95 UTL and/or 95 UCL.

HQ = Hazard Quotient, rounded to nearest whole number.

Values in bold indicate HQs > 1.

-- = Could not be calculated due to lack of EPC.

N/A = Not available.

Table 5.11
Frequency and Magnitude of Aquatic Receptor HQs for MK AEU Sediment ECOPCs

ECOPC and Media	Number of Samples	HQs <= 1	HQs > 1 - 5	HQs > 5 - 10	HQs > 10	Frequency of Detected Exceedances (percent)	LOE Risk Conclusion
Surface Water ECOPCs							
Inorganic							
Aluminum (Total)	39	10	19	4	6	74%	Retained
Cadmium (Dissolved)	26	26	0	0	0	0%	Low
Selenium (Total)	39	31	1 (7)	0	0	3%	Low
Zinc (Dissolved)	26	25	1	0	0	4%	Low
Sediment ECOPCs							
Inorganic							
Aluminum	12	9	3	0	0	25%	Retained
Chromium	12	11	1	0	0	8%	Low
Fluoride	1	0	0	1	0	100%	Retained
Nickel	12	11	1	0	0	8%	Low
Selenium	12	11	1	0	0	8%	Low

Counts based on proxy values include NDs at 1/2 DL.

Risk Conclusions for this LOE:

None = Sample concentrations do not exceed the ESL.

Low = Low potential for Risk. Detected concentrations only exceed the ESL by low magnitude (HQs < 5) or exceedances <20 percent.

Retained = Potential for risk could not be excluded and further evaluation is required; Detected HQs > 5 and exceedances >20 percent.

Table 5.12
Summary of Other/Drainage Lines of Evidence for the MK AEU

Line of Evidence Category and Source	Summary of Results (from the cited report)	Uncertainties	Conclusions and Relevance to RFETS CRA
Tissues Analysis			
N/A			
Aquatic Population Studies			
Kaiser-Hill, 1999; 2000, and 2001	Fish surveys of streams and ponds over three consecutive years determined whether previously recorded fish species (Ebasco 1992) were still present within RFETS streams. Fathead minnow (*Pimephales promelas*) were captured in all major drainages at RFETS. This included locations in Rock Creek. Pond and impoundment surveys in 1999 revealed fathead minnows in all locations. With the exception of bass, all fish species observed during the baseline study were observed again and found in the same general locations as they were in 1992. Notably, McKay ditch had no fish present and Walnut Creek above the A-Series Ponds had no fish.	This survey was conducted during drought conditions. 1998 through 2000 were very dry years in terms of precipitation. No analysis is presented on the abundance of fish over time. A declining trend in fish abundance could not distinguish between chemical stressors and declining habitat conditions. Trends in relative abundance are unknown for RFETS streams and ponds.	With the exception of the bass observations, all fish species observed during the baseline study (Ebasco 1992) were observed again over this three year survey and found in the same general locations as they were in 1992. These studies reiterate that all the RFETS streams are intermittent and that better aquatic habitats occur in the upper reaches where flows are more perennial. It is unrealistic to expect that vibrant aquatic communities, especially fish communities, can occur in the lower reaches that are often dry. Overall, fish species richness is very low.
Bioassay Analysis			
N/A			
Waterfowl/Wading Bird Evaluations			
N/A			

N/A = Not available.

Table 6.1
Summary of Surface Water ECOIs Without ESLs

ECOI	NN AEU	RC AEU	MK AEU	SE AEU
Cations/Anions and Inorganics				
Calcium	X	X	X	X
Magnesium	X	X	X	X
Nitrate/Nitrite	X	X	X	X
Orthophosphate	N/A	X	X	N/A
Phosphate	N/A	X	X	X
Phosphorous	X	X	X	X
Potassium	X	X	X	X
Silica	N/A	X	X	X
Silicon	X	X	X	X
Sodium	X	X	X	X
Sulfate	X	X	X	X
Sulfide	N/A	X	N/A	X
Titanium	N/A	X	X	X
Uranium	X	X	X	N/A
Organics				
1,2,3-Trichloropropane	X	N/A	N/A	N/A
2-Methylnaphthalene	X	N/A	N/A	N/A
2-Nitrophenol	X	N/A	N/A	N/A
4-Bromophenyl-phenylether	X	N/A	N/A	N/A
4-Chlorotoluene	X	N/A	N/A	N/A
4-Isopropyltoluene	X	N/A	N/A	N/A
Acenaphthylene	X	N/A	N/A	N/A
Benzo(b)fluoranthene	X	N/A	N/A	N/A
Benzo(g,h,i)perylene	X	N/A	N/A	N/A
Benzo(k)fluoranthene	X	N/A	N/A	N/A
Chlorodifluoromethane	X	X	N/A	N/A
Chloroethane	X	N/A	N/A	N/A
Chloromethane	X	N/A	N/A	N/A
Dibenz(a,h)anthracene	X	N/A	N/A	N/A
Dichlorodifluoromethane	X	N/A	N/A	N/A
Di-n-octylphthalate	X	N/A	N/A	N/A
Indeno(1,2,3-cd)pyrene	X	N/A	N/A	N/A
Isopropylbenzene	X	N/A	N/A	N/A
n-Butylbenzene	X	N/A	N/A	N/A
n-Propylbenzene	X	N/A	N/A	N/A
sec-Butylbenzene	X	N/A	N/A	N/A
Trichlorofluoromethane	X	N/A	N/A	N/A
Radionuclides[1]				
Curium-244	N/A	X	N/A	N/A
Gross Alpha	X	X	X	X
Gross Beta	X	X	X	X
Neptunium-237	N/A	X	N/A	N/A
Thorium-230	N/A	X	N/A	N/A
Thorium-232	N/A	X	N/A	N/A
Plutonium-238	X	N/A	X	N/A

X = Indicates ESL is unavailable.
N/A indicates that the ECOI was not analyzed in the AEU
[1] curium-241, neptunium-237, thorium-230, thorium-232, plutonium-238, and tritium were below detection limits in all samples

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Table 6.2
Summary of Sediment ECOIs Without ESLs

ECOI	NN AEU	RC AEU	MK AEU	SE AEU
Cations/Anions and Inorganics				
Beryllium	X	X	X	X
Boron	X	X	X	X
Calcium	X	X	X	X
Cobalt	X	X	X	X
Lithium	X	X	X	X
Magnesium	X	X	X	X
Molybdenum	X	X	X	X
Nitrate/Nitrite	X	X	X	N/A
Potassium	X	X	X	X
Silica	X	X	X	X
Silicon	X	X	X	N/A
Sodium	X	X	X	X
Strontium	X	X	X	X
Thallium	X	X	X	X
Tin	X	X	X	N/A
Titanium	X	X	X	X
Uranium	N/A	X	X	X
Vanadium	X	X	X	X
Organics				
Acetone	X	X	N/A	N/A
Benzo(b)fluoranthene	X	N/A	N/A	N/A
Benzoic acid	N/A	X	X	N/A
2-Hexanone	N/A	N/A	N/A	N/A
4,6-Dinitro-2-methylphenol	N/A	X	N/A	N/A
4-Nitrophenol	N/A	X	N/A	N/A
Methylene chloride	X	X	N/A	N/A
Radionuclides[1]				
Cesium-134	X	X	X	N/A
Gross Alpha	X	X	X	N/A
Gross Beta	X	X	X	N/A

X = Indicates ESL is unavailable.
N/A indicates that the ECOI was not analyzed in the AEU
[1] cesium-134 was below detection in all samples

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Table 6.3
Summary of Uncertain Sediment ECOIs as Compared to Surface Water ECOPCs for NN AEU

Analyte	MDC	% Detect in Sediment	> Background in Sediment	SW ESL Available?	% Detect in Surface Water	> Background in Surface Water	SW ECOPC?	Risk Concern?	Rationale
Inorganics (mg/kg)									
Beryllium	1.2	95	Yes	Yes	23	N/A	No	No	BB, Not a SW ECOPC
Boron	10	100	N/A	Yes	ND	N/A	No	No	ND
Calcium	74,000	100	Yes	No	100	Yes	N/A	No	CE
Cesium	3.9	13	N/A	No	8	N/A	N/A	No	FD
Cobalt	11.8	100	Yes	Yes	37	N/A	No	No	Not a SW ECOPC
Lithium	15	94	Yes	Yes	93	Yes	No	No	Not a SW ECOPC
Magnesium	4,200	100	Yes	No	100	Yes	N/A	No	CE
Molybdenum	5.2	61	No	Yes	31	No	No	No	BB, Not a SW ECOPC
Nitrate / Nitrite	3.2	70	N/A	No	36	N/A	N/A	No	UC
Potassium	2,810	95	Yes	No	97	Yes	N/A	No	CE
Silicon	417	100	N/A	No	100	N/A	N/A	No	CE
Sodium	600	85	No	No	100	Yes	N/A	No	BB, Not a SW ECOPC
Strontium	320	100	Yes	Yes	100	Yes	No	No	Not a SW ECOPC
Thallium	2.3	45	N/A	Yes	8	N/A	No	No	FD, Not a SW ECOPC
Tin	16.6	28	No	Yes	11	N/A	No	No	BB, Not a SW ECOPC
Vanadium	59	100	Yes	Yes	44	No	No	No	BB, Not a SW ECOPC
Organics (µg/kg)									
Acetone	99	62	N/A	Yes	39	N/A	No	No	Not a SW ECOPC
Benzo(b)fluoranthene	190	25	N/A	No	2	N/A	N/A	No	FD, Not a SW ECOPC
Methylene Chloride	3.3	62	N/A	Yes	38	N/A	No	No	Not a SW ECOPC
Radionuclides (pCi/g)									
Cesium-134	0.1673	100	No	No	ND	N/A	N/A	No	ND
Gross Alpha	37	100	No	No	100	Yes	N/A	No	BB
Gross Beta	32	100	No	No	100	Yes	N/A	No	BB

BB = Observed sediment or surface water MDC was less than the appropriate background level.
CE = Common element that is associated with low toxicity.
FD = was detected in less than 10% of the surface water or sediment samples.
ND = was not detected in the surface water samples.
Not a SW ECOPC = was not identified as an ECOPC for surface water as per the selection process.
UC = Uncertain toxicity due to a lack of both surface water and sediment ESLs.

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Table 6.4
Summary of Uncertain Sediment ECOIs as Compared to Surface Water ECOPCs for RC AEU

Analyte	MDC	% Detect in Sediment	> Background in Sediment	SW ESL Available?	% Detect in Surface Water	> Background in Surface Water	SW ECOPC?	Risk Concern?	Rationale
Inorganics (mg/kg)									
Beryllium	2.1	74	Yes	Yes	18	N/A	No	No	Not a SW ECOPC
Boron	17	100	N/A	Yes	ND	N/A	No	No	ND
Calcium	61,000	100	Yes	No	100	Yes	N/A	No	CE
Cesium	2.9	7	N/A	No	16	N/A	N/A	No	FD
Cobalt	18	95	Yes	Yes	24	N/A	No	No	FD, Not a SW ECOPC
Lithium	20.3	100	Yes	Yes	68	Yes	No	No	Not a SW ECOPC
Magnesium	4,100	100	Yes	No	99	Yes	N/A	No	CE
Molybdenum	9.6	20	No	Yes	34	No	No	No	BB, Not a SW ECOPC
Nitrate / Nitrite	76	67	N/A	No	65	N/A	N/A	No	UC
Potassium	2,900	100	Yes	No	94	No	N/A	No	BB
Silica	2,600	100	Yes	No	100	Yes	N/A	No	CE
Silicon	1,480	100	N/A	No	100	N/A	N/A	No	CE
Sodium	413	73	No	No	100	Yes	N/A	No	BB, CE
Strontium	179	100	Yes	Yes	99	Yes	No	No	Not a SW ECOPC
Thallium	0.41	11	N/A	Yes	8	N/A	No	No	FD, Not a SW ECOPC
Tin	37.1	32	No	Yes	7	N/A	No	No	FD
Titanium	170	100	N/A	No	33	N/A	N/A	No	UC
Uranium	7.8	40	N/A	Yes	9	N/A	No	No	FD
Vanadium	57.1	100	Yes	Yes	49	No	No	No	BB
Organics (µg/kg)									
4,6-Dinitro-2-methylphenol	1,100	6	N/A	No	ND	N/A	N/A	No	ND
4-nitrophenol	1,300	6	N/A	No	ND	N/A	N/A	No	ND
Acetone	520	36	N/A	Yes	7	N/A	No	No	FD, Not a SW ECOPC
Benzoic Acid	2,000	35	N/A	Yes	ND	N/A	No	No	ND
Methylene Chloride	300	7	N/A	Yes	7	N/A	No	No	FD, Not a SW ECOPC
Radionuclides (pCi/g)									
Cesium-134	0.26	100	No	No	ND	N/A	N/A	No	ND
Gross Alpha	62	100	No	No	100	No	N/A	No	BB
Gross Beta	54	100	No	No	100	No	N/A	No	BB

BB = Observed sediment or surface water MDC was less than the appropriate background level.
CE = Common element that is associated with low toxicity.
FD = was detected in less than 10% of the surface water or sediment samples.
ND = was not detected in the surface water samples.
Not a SW ECOPC = was not identified as an ECOPC for surface water as per the selection process.
UC = Uncertain toxicity due to a lack of both surface water and sediment ESLs.

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Table 6.5
Summary of Uncertain Sediment ECOIs as Compared to Surface Water ECOPCs for MK AEU

Analyte	MDC	% Detect in Sediment	> Background in Sediment	SW ESL Available?	% Detect in Surface Water	> Background in Surface Water	SW ECOPC?	Risk Concern?	Rationale
Inorganics (mg/kg)									
Beryllium	1.5	83	Yes	Yes	NA	N/A	NA	No	FD
Boron	6.4	100	N/A	Yes	100	N/A	No	No	Not a SW ECOPC
Calcium	130,000	100	No	No	100	No	N/A	No	BB, CE
Cesium	4.9	12	N/A	No	23.1	N/A	N/A	UC	UC
Cobalt	9.3	92	No	Yes	35.9	N/A	No	No	BB, Not a SW ECOPC
Lithium	19.2	100	No	Yes	43.3	No	No	No	BB, Not a SW ECOPC
Magnesium	4,700	100	No	No	100	No	N/A	No	BB, CE
Molybdenum	2.4	58	No	Yes	2.9	N/A	No	No	BB, Not a SW ECOPC
Nitrate / Nitrite	64	57	N/A	No	85	N/A	N/A	UC	UC
Potassium	2940	100	Yes	No	100	Yes	N/A	No	CE
Silica	970	100	Yes	No	100	No	N/A	No	BB
Silicon	854	100	N/A	No	100	N/A	N/A	No	CE
Sodium	2,090	100	No	No	100	No	N/A	No	BB
Strontium	180	100	No	Yes	96.9	No	No	No	BB, Not a SW ECOPC
Thallium	0.4	8	N/A	Yes	3	N/A	No	No	FD, Not a SW ECOPC
Tin	9.3	25	N/A	Yes	3	N/A	No	No	FD, Not a SW ECOPC
Titanium	150	100	N/A	No	100	N/A	N/A	UC	UC
Uranium	1.1	25	N/A	Yes	50	N/A	No	No	Not a SW ECOPC
Vanadium	67.7	100	No	Yes	51.3	No	No	No	BB, Not a SW ECOPC
Organics (µg/kg)									
Benzoic Acid	480	14.0	N/A	No	ND	N/A	No	No	ND, Not a SW ECOPC
Radionuclides (pCi/g)									
Cesium-134	0.11	100	Yes	No	ND	N/A	N/A	No	ND
Gross Alpha	79	100	No	No	100	Yes	N/A	No	BB
Gross Beta	69	100	No	No	100	Yes	N/A	No	BB

BB = Observed sediment or surface water MDC was less than the appropriate background level.
CE = Common element that is associated with low toxicity.
FD = was detected in less than 10% of the surface water or sediment samples.
ND = was not detected in the surface water samples.
Not a SW ECOPC = was not identified as an ECOPC for surface water as per the selection process.
UC = Uncertain toxicity due to a lack of both surface water and sediment ESLs.

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Table 6.6
Summary of Uncertain Sediment ECOIs as Compared to Surface Water ECOPCs for SE AEU

Analyte	MDC	% Detect in Sediment	> Background in Sediment	SW ESL Available?	% Detect in Surface Water	> Background in Surface Water	SW ECOPC?	Risk Concern?	Rationale
Inorganics (mg/kg)									
Beryllium	1.3	100	Yes	Yes	11	N/A	No	No	ND
Boron	19	100	N/A	Yes	75	N/A	No	No	Not a SW ECOPC
Calcium	55,000	100	Yes	No	100	Yes	N/A	No	CE
Cobalt	8.6	100	No	Yes	5	N/A	No	No	FD, Not a SW ECOPC
Lithium	23	100	Yes	Yes	50	No	No	No	BB
Magnesium	7,100	100	Yes	No	100	Yes	N/A	No	CE
Molybdenum	1	86	No	Yes	25	No	No	No	BB, Not a SW ECOPC
Potassium	5,200	100	Yes	No	100	Yes	N/A	No	CE
Silica	2,900	100	Yes	No	100	No	N/A	No	BB, CE
Sodium	510	43	No	No	100	Yes	N/A	No	BB, CE
Strontium	290	100	Yes	Yes	100	Yes	No	No	Not a SW ECOPC
Thallium	2.6	57	N/A	Yes	ND	N/A	N/A	No	ND
Titanium	260	100	N/A	No	25	N/A	N/A	UC	UC
Uranium	2.8	29	N/A	Yes	ND	N/A	N/A	No	ND
Vanadium	62	100	Yes	Yes	ND	N/A	N/A	No	ND

BB = Observed sediment or surface water MDC was less than the appropriate background level.
CE = Common element that is associated with low toxicity.
FD = was detected in less than 10% of the surface water or sediment samples.
ND = was not detected in the surface water samples.
Not a SW ECOPC = was not identified as an ECOPC for surface water as per the selection process.
UC = Uncertain toxicity due to a lack of both surface water and sediment ESLs.

FIGURES

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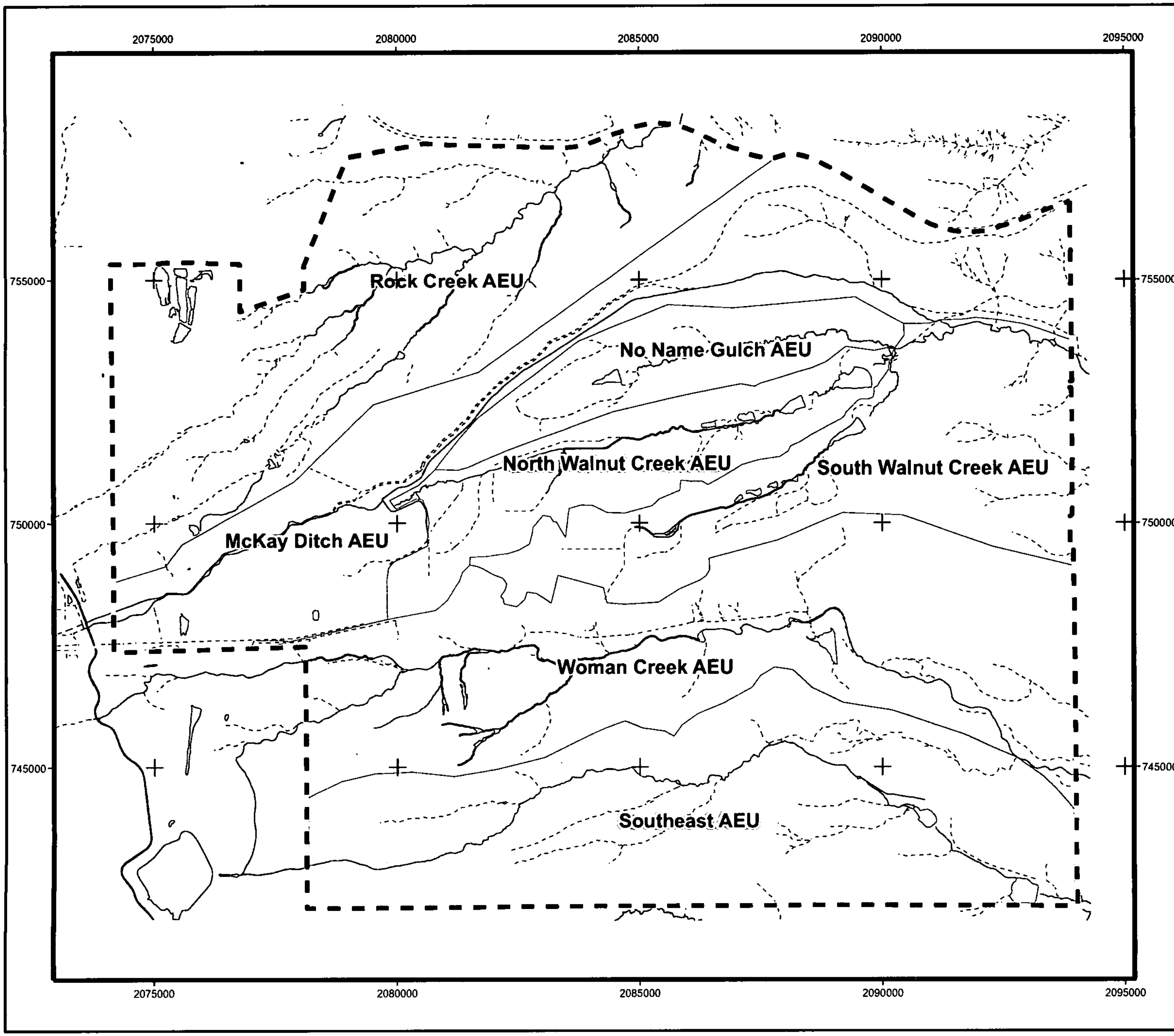

Figure 1.1
Rocky Flats Environmental Technology Site
Aquatic Exposure Units

KEY

- Aquatic exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N W E S

0 1,500 3,000 Feet

Scale 1:36,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

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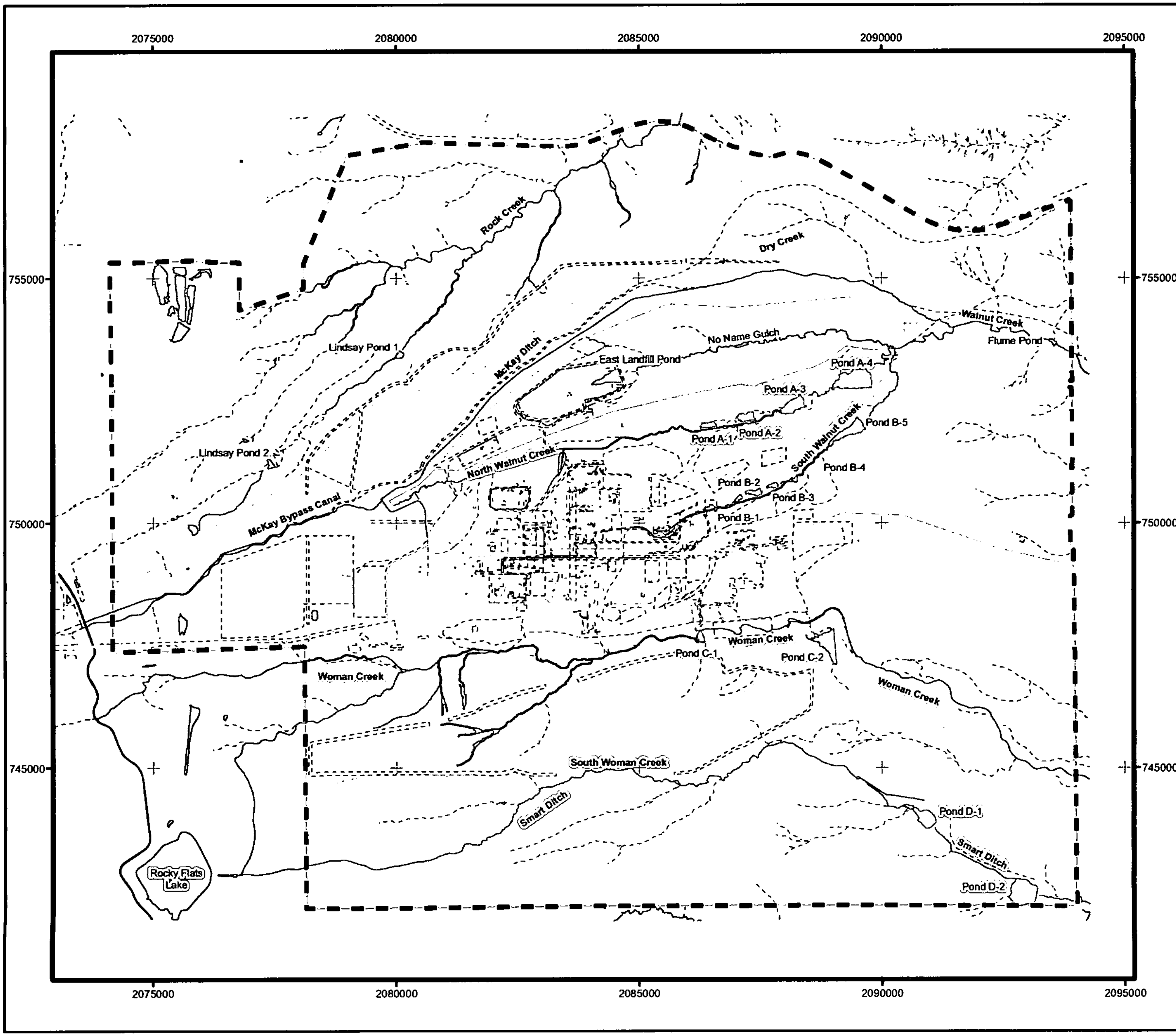

Figure 1.2
IHSS Locations Within
Rocky Flats Environmental
Technology Site

KEY

- Historical IHSS/PAC
- McKay Ditch AEU
- No Name Gulch AEU
- North Walnut Creek AEU
- Rock Creek AEU
- South Walnut Creek AEU
- Southeast AEU
- Woman Creek AEU

Standard Map Features

- Aquatic exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N S W E

0 1,500 3,000 Feet

Scale 1:36,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Technology Site

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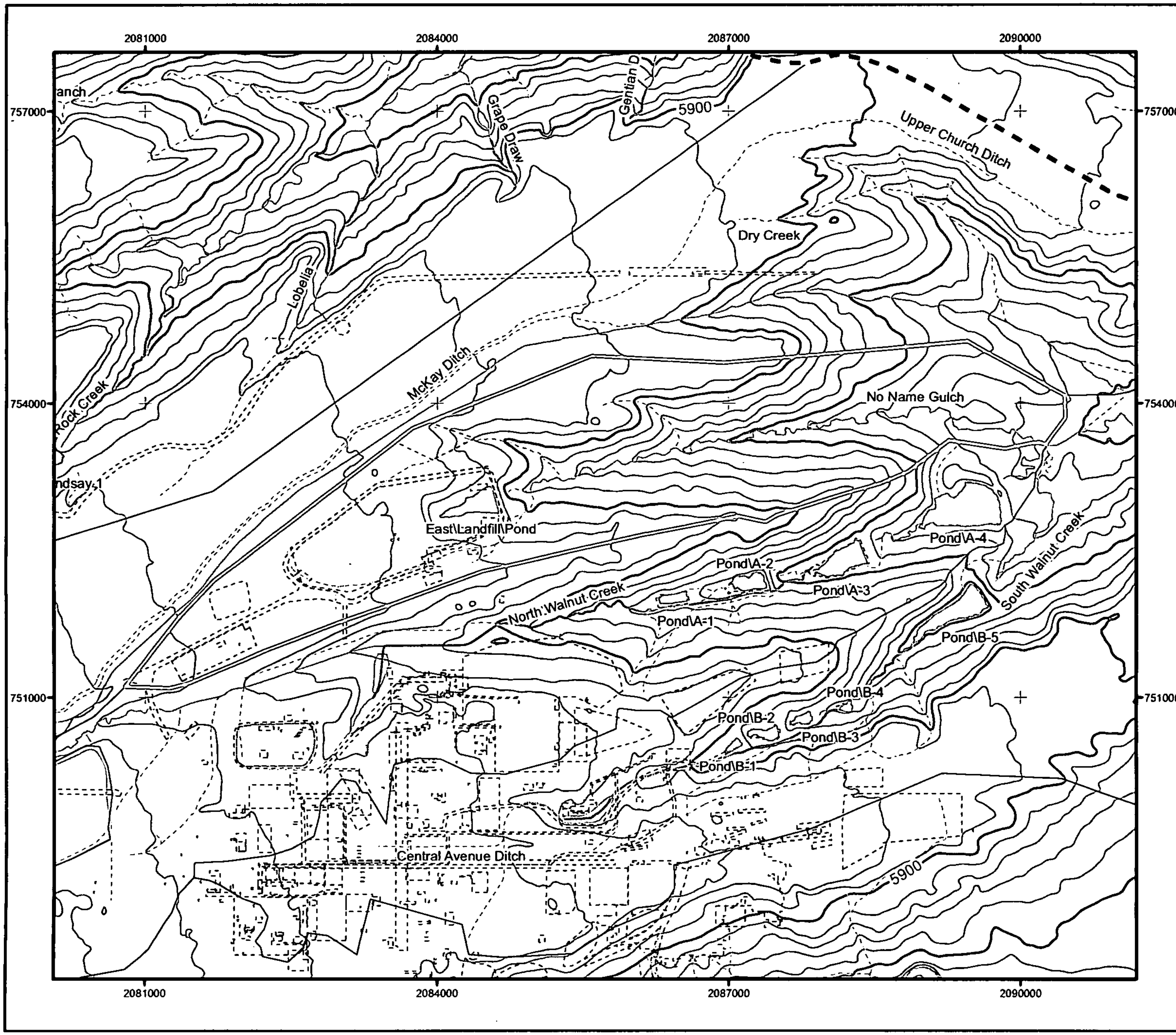

Figure 1.3
Topography and IHSS
Locations in the
No Name Gulch AEU

Key

Sample location
Contour line (20 ft)
Contour line (100 ft)
No Name Gulch AEU
Historical IHSS/PAC

Standard Map Features

Aquatic exposure unit boundary
Pond
Site boundary
Perennial stream
Intermittent stream
Ephemeral stream

N
W E
S

0 850 1,700 Feet

Scale 1:18,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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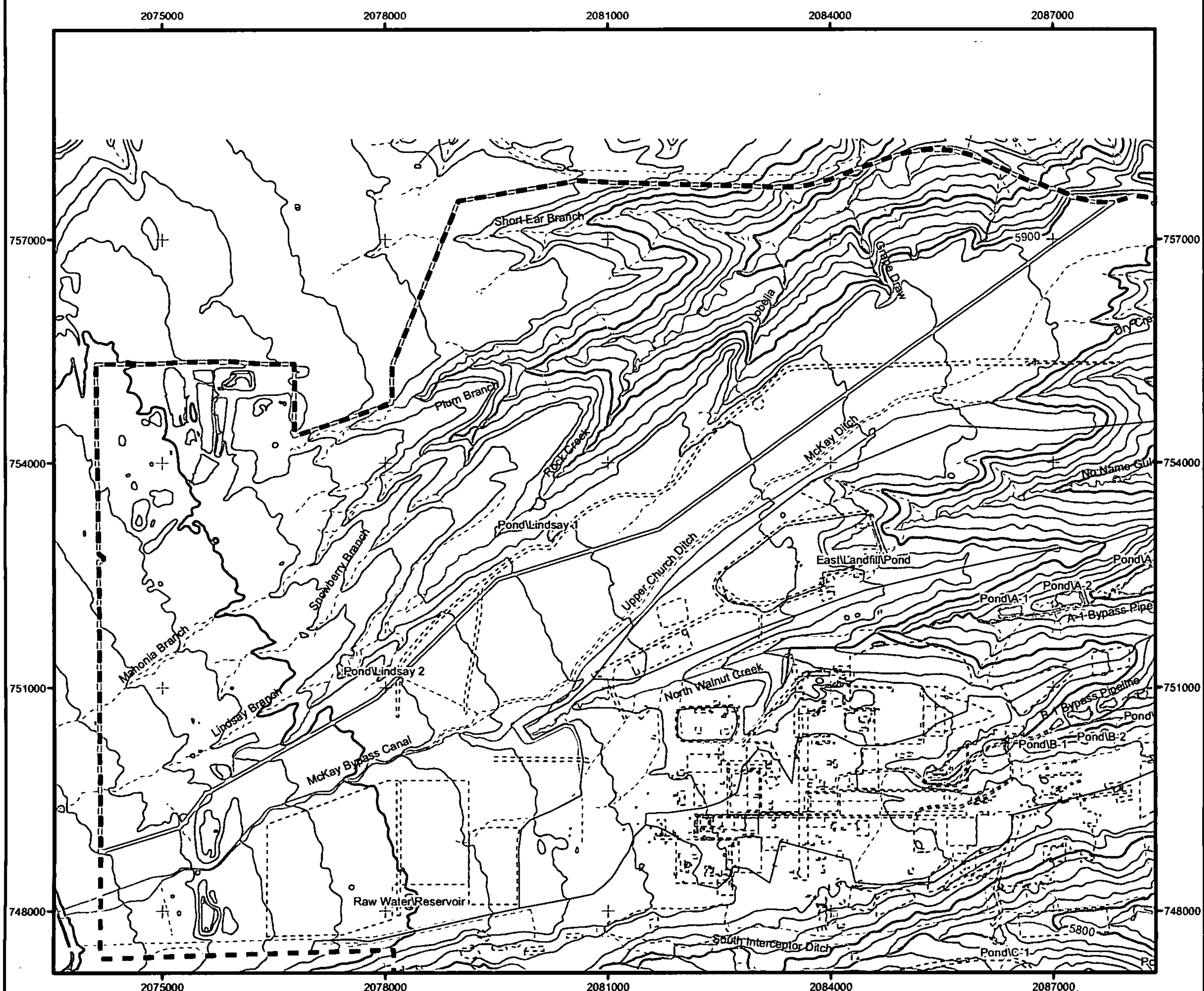

Figure 1.4
Topography and IHSS Locations in the Rock Creek AEU

Key

Sample location
Contour line (20 ft)
Contour line (100 ft)
Rock Creek AEU
Historical IHSS/PAC

Standard Map Features

Aquatic exposure unit boundary
Pond
Site boundary
Perennial stream
Intermittent stream
Ephemeral stream

N
W E
S

0 1,000 2,000 Feet

Scale 1:24,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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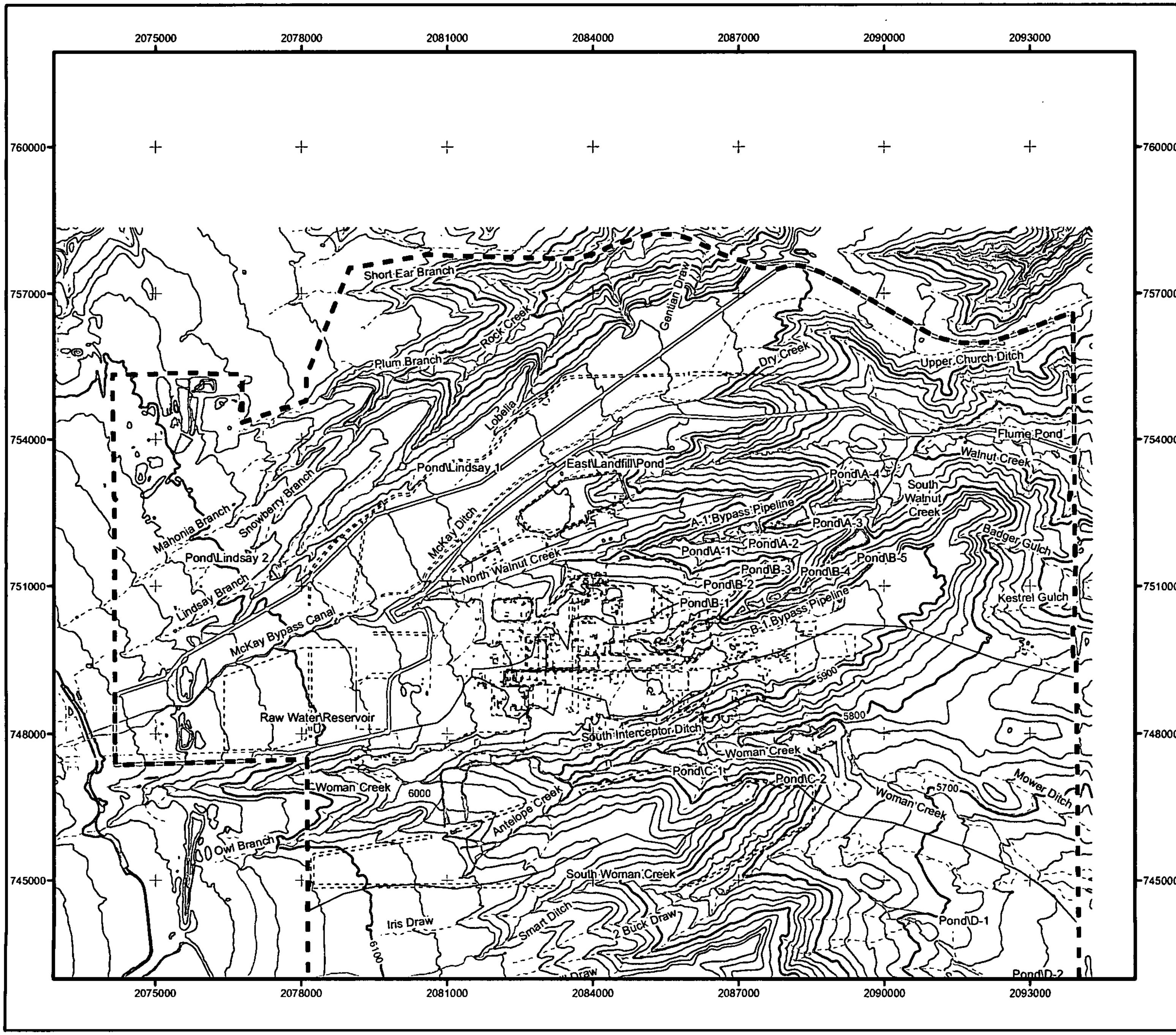

Figure 1.5
Topography and IHSS
Locations in the
McKay Ditch AEU

Key

Sample location
Contour line (20 ft)
Contour line (100 ft)
McKay Ditch AEU
Historical IHSS/PAC

Standard Map Features

Aquatic exposure unit boundary
Pond
Site boundary
Perennial stream
Intermittent stream
Ephemeral stream

N
W E
S

0 1,500 3,000 Feet

Scale 1:36,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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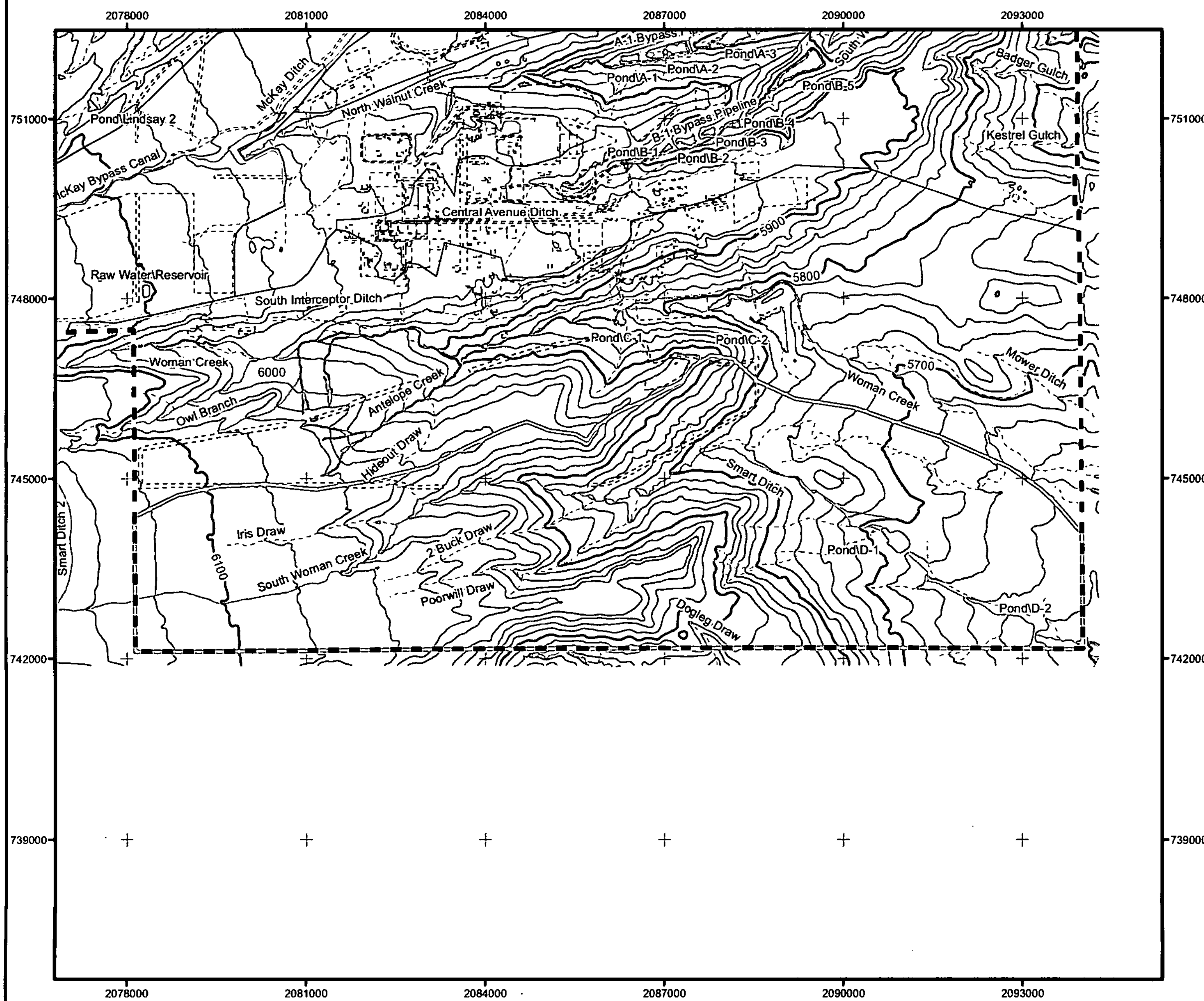
Figure 1.6
Topography and IHSS Locations in the Southeast AEU



Key

Sample location

- Contour line (20 ft)
- Contour line (100 ft)
- Southeast AEU
- Historical IHSS/PAC

Standard Map Features

- Aquatic exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
S

0 1,250 2,500 Feet

Scale 1:30,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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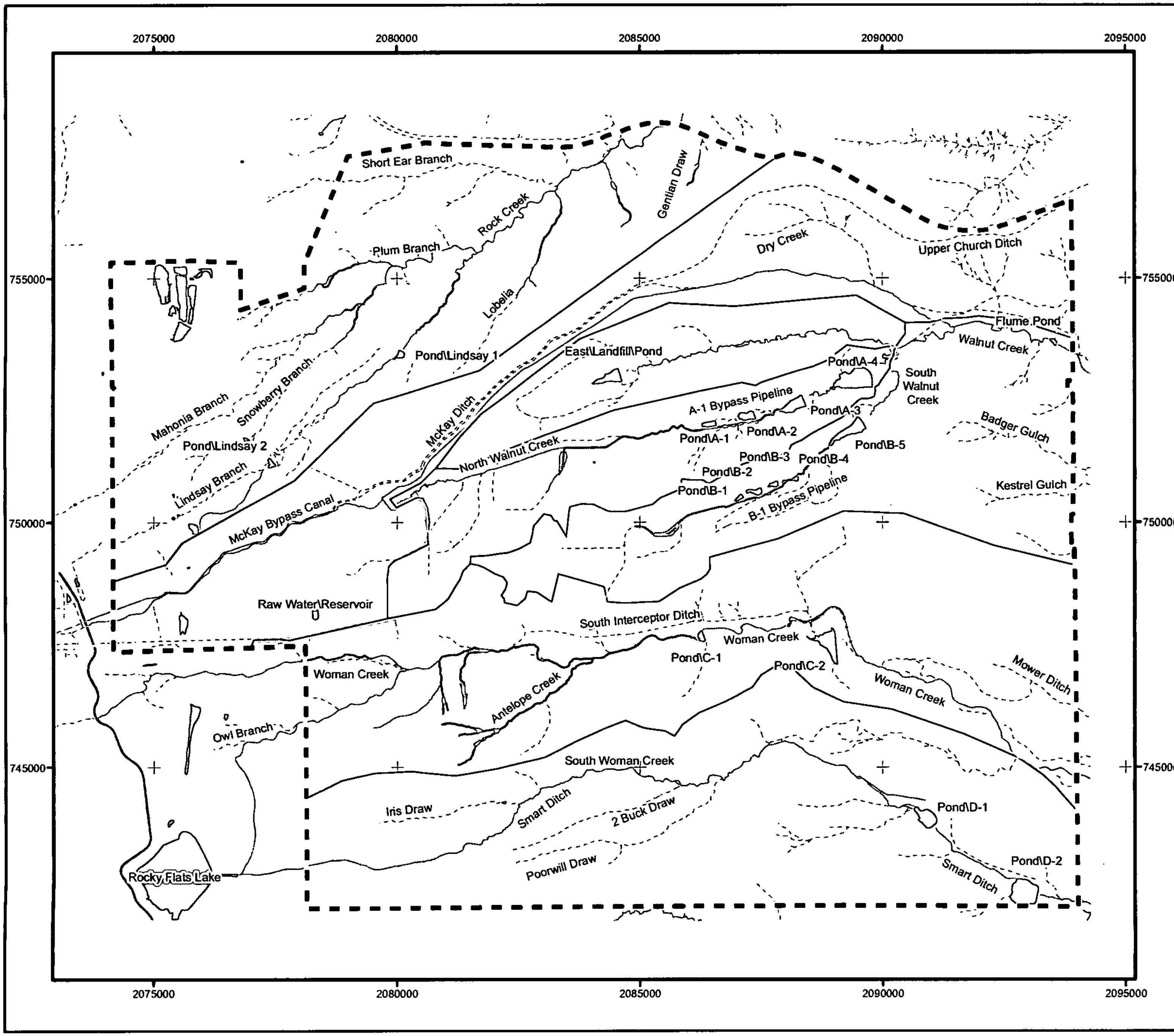

Figure 1.7
Surface Water Hydrology of RFETS

Key

- Aquatic exposure unit boundary
- Pond
- Site boundary
- Perennial stream
- Intermittent stream
- Ephemeral stream

N
W E
S

0 1,500 3,000 Feet

Scale 1:36,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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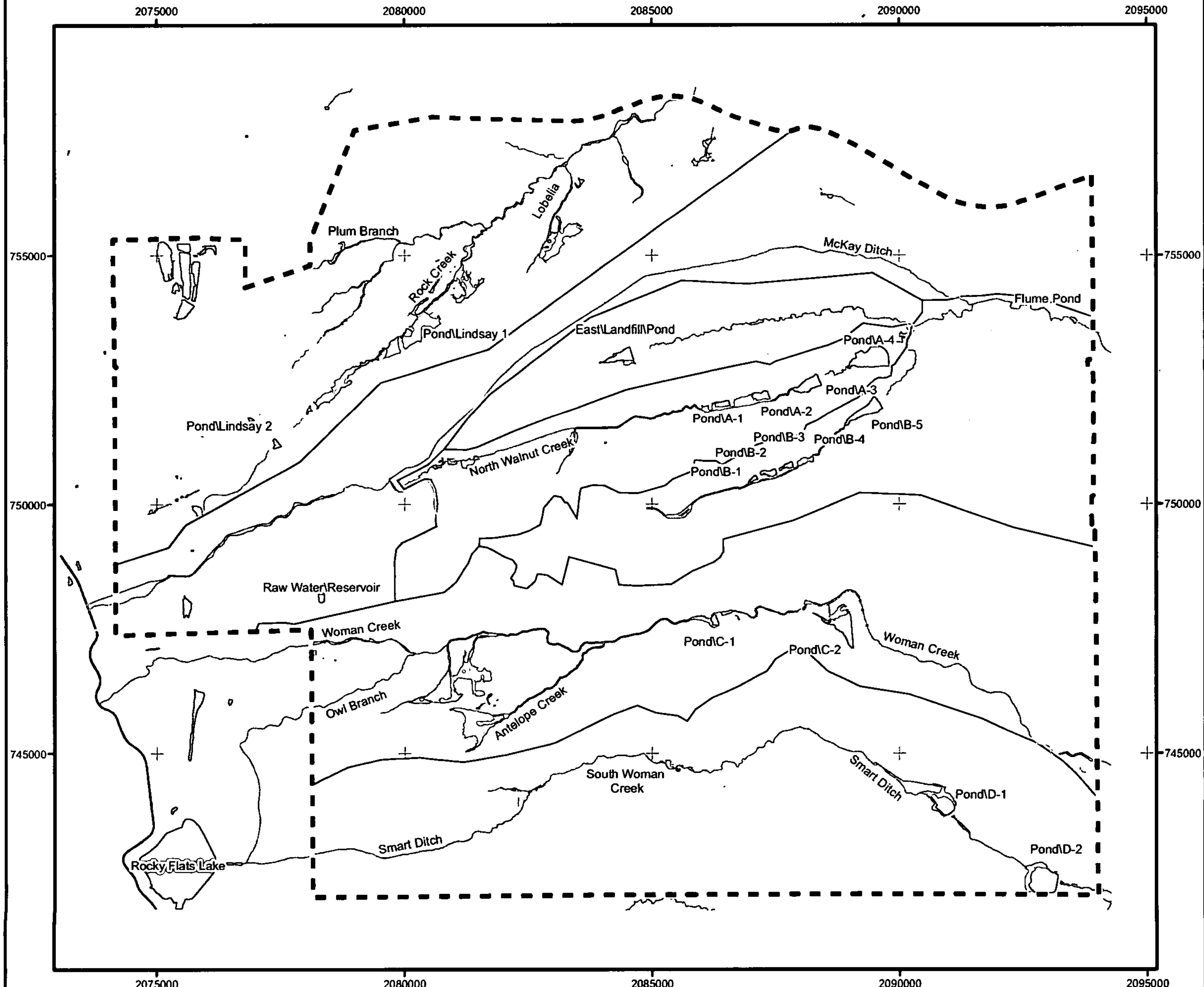

Figure 1.8
Potential Aquatic Habitat Types Within RFETS

Key

Aquatic habitat

Standard Map Features

Aquatic exposure unit boundary
Pond
Site boundary
Perennial stream
Intermittent stream
Ephemeral stream

N
W E
S

0 1,250 2,500 Feet

Scale 1:36,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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104

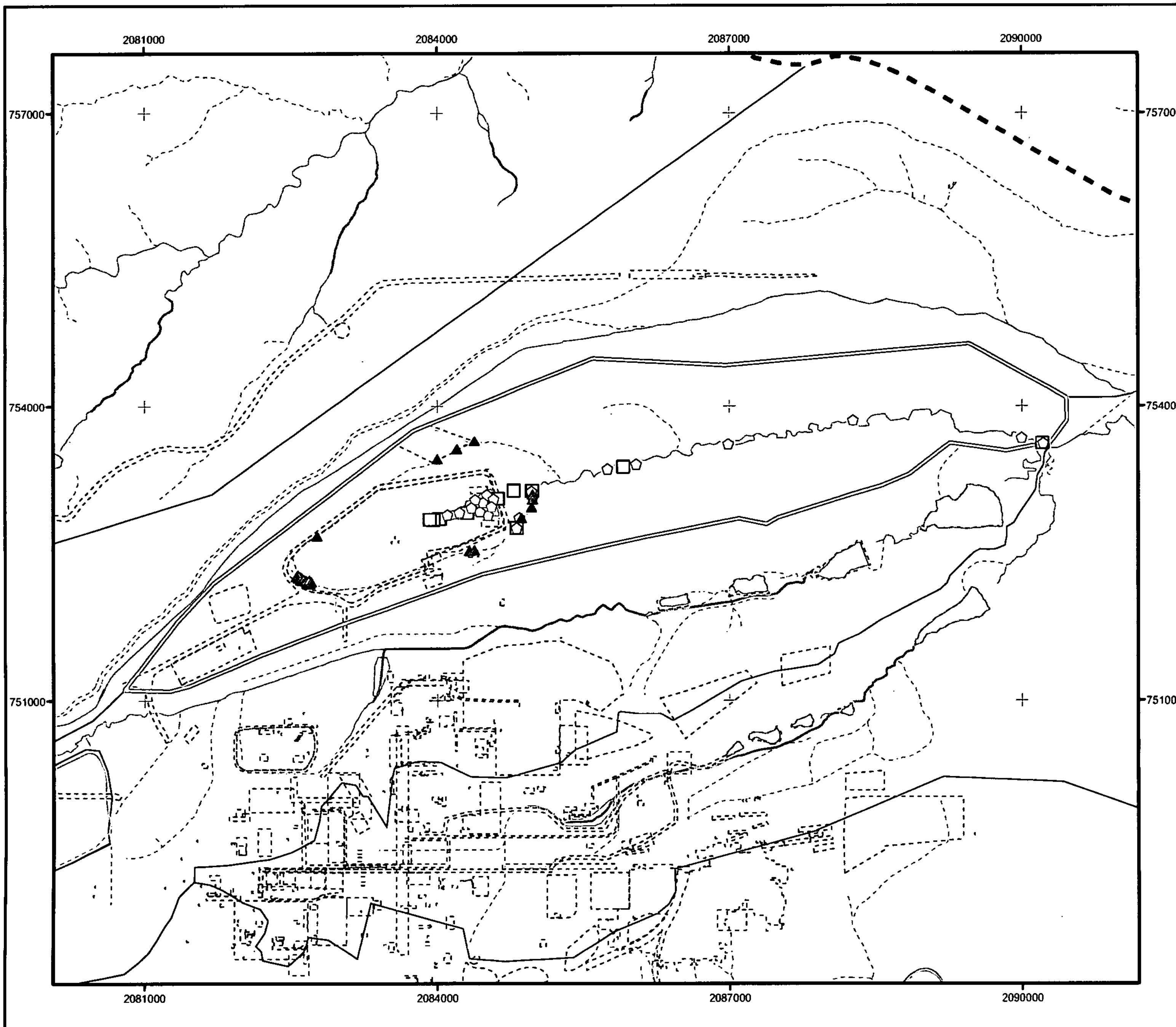

Figure 1.9
No Name Gulch AEU Surface Water, Sediment and Adjacent Surface Soil Sampling Locations

Key

Sample location
- Surface water\sample location
- Surface sediment\sample location
- Surface soil sample location

(Background locations shown in red)
- Surface sediment\sample location
- Surface water sample location
- No Name Gulch AEU
- Historical IHSS/PAC

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

N
W E
S

0 750 1,500 Feet

Scale 1:18,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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105

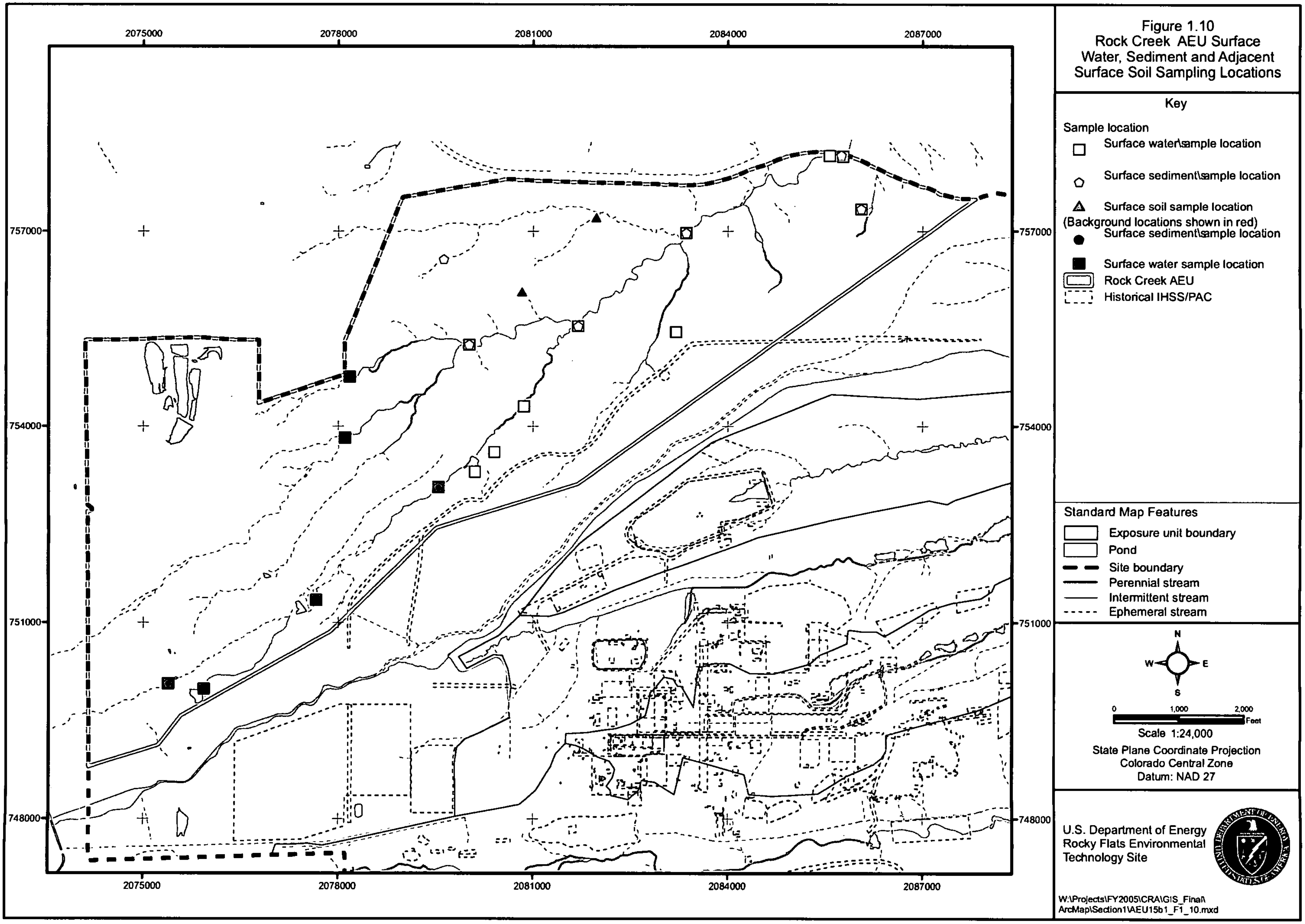

Figure 1.10
Rock Creek AEU Surface Water, Sediment and Adjacent Surface Soil Sampling Locations
2075000
2078000
2081000
2084000
2087000
757000
754000
751000
748000
Key
Sample location
Surface water\sample location
Surface sediment\sample location
Surface soil sample location
(Background locations shown in red)
Surface sediment\sample location
Surface water sample location
Rock Creek AEU
Historical IHSS/PAC
Standard Map Features
Exposure unit boundary
Pond
Site boundary
Perennial stream
Intermittent stream
Ephemeral stream
N
W
E
S
0
1,000
2,000
Feet
Scale 1:24,000
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27
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106

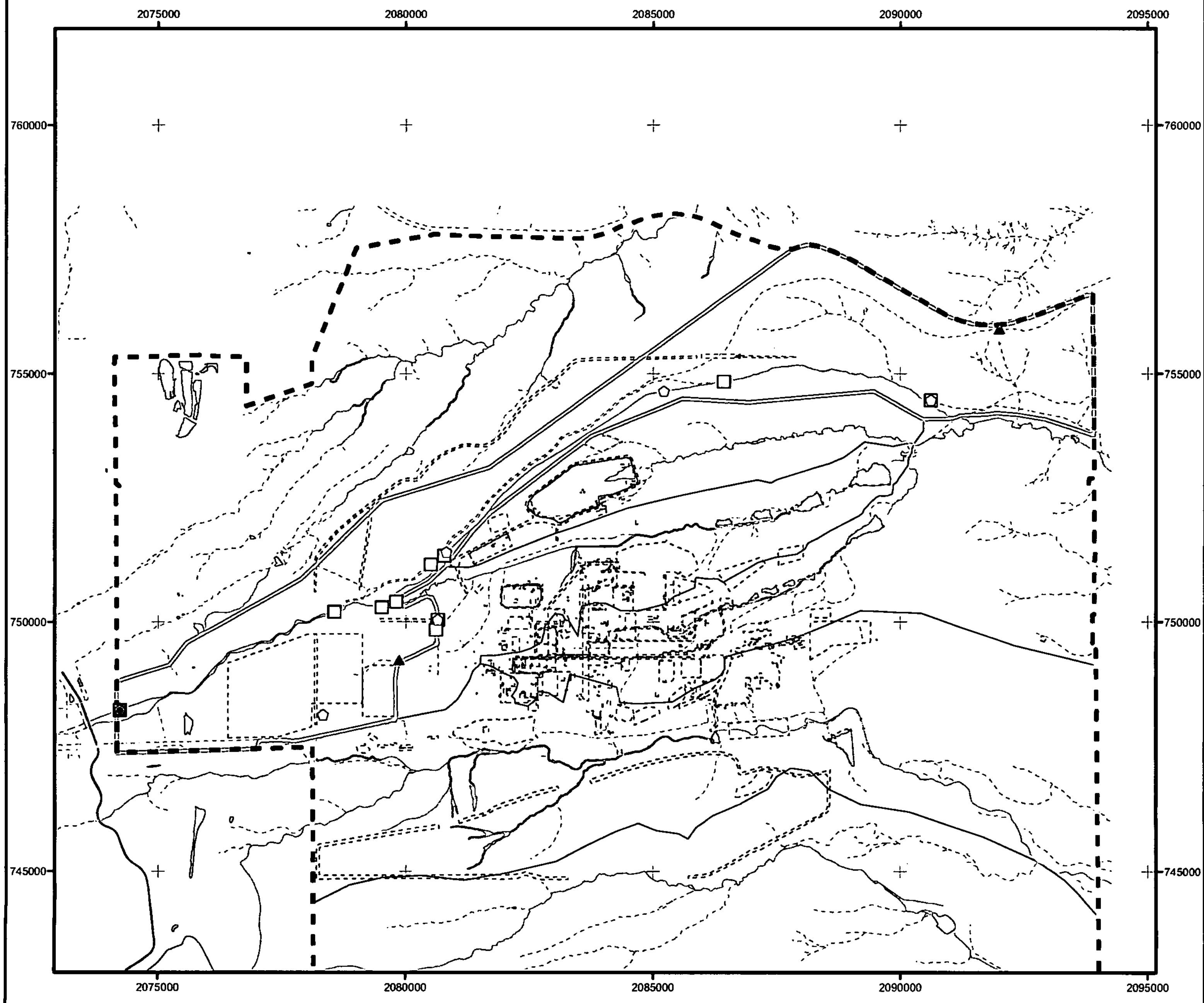

Figure 1.11
McKay Ditch AEU Surface Water, Sediment and Adjacent Surface Soil Sampling Locations

Key

Sample location
- Surface water\sample location
- Surface sediment\sample location
- Surface soil sample location

(Background locations shown in red)
- Surface sediment\sample location
- Surface water sample location
- McKay Ditch AEU
- Historical IHSS/PAC

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

N W E S

0 1,500 3,000 Feet

Scale 1:36,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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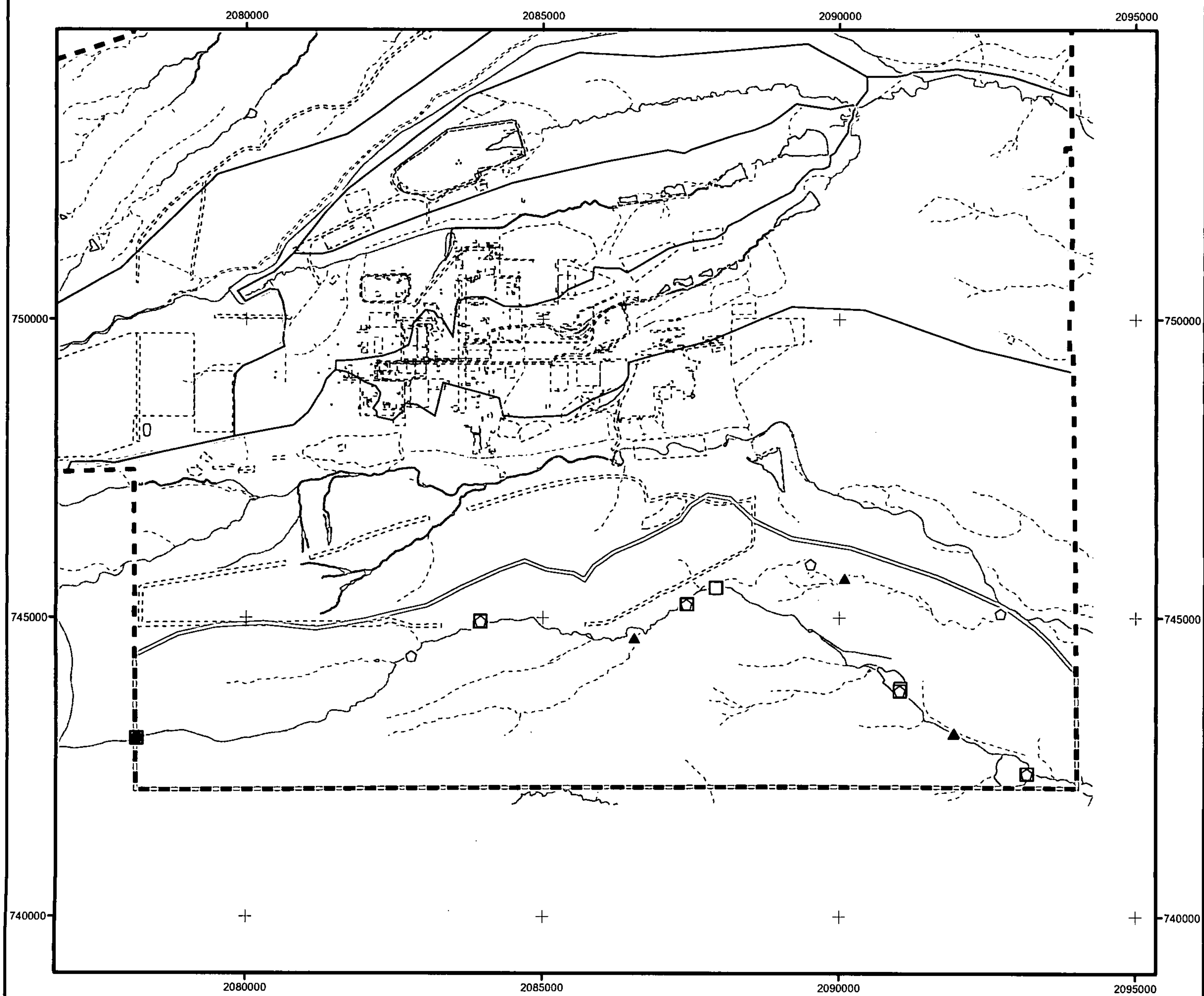

Figure 1.12 Southeast AEU Surface Water, Sediment and Adjacent Surface Soil Sampling Locations

Key

Sample location
- Surface water\sample location
- Surface sediment\sample location
- Surface soil sample location
(Background locations shown in red)
- Surface sediment\sample location
- Surface water sample location
- South Walnut Creek AEU
- Historical IHSS/PAC

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

N
W E
S

0 1,250 2,500 Feet

Scale 1:30,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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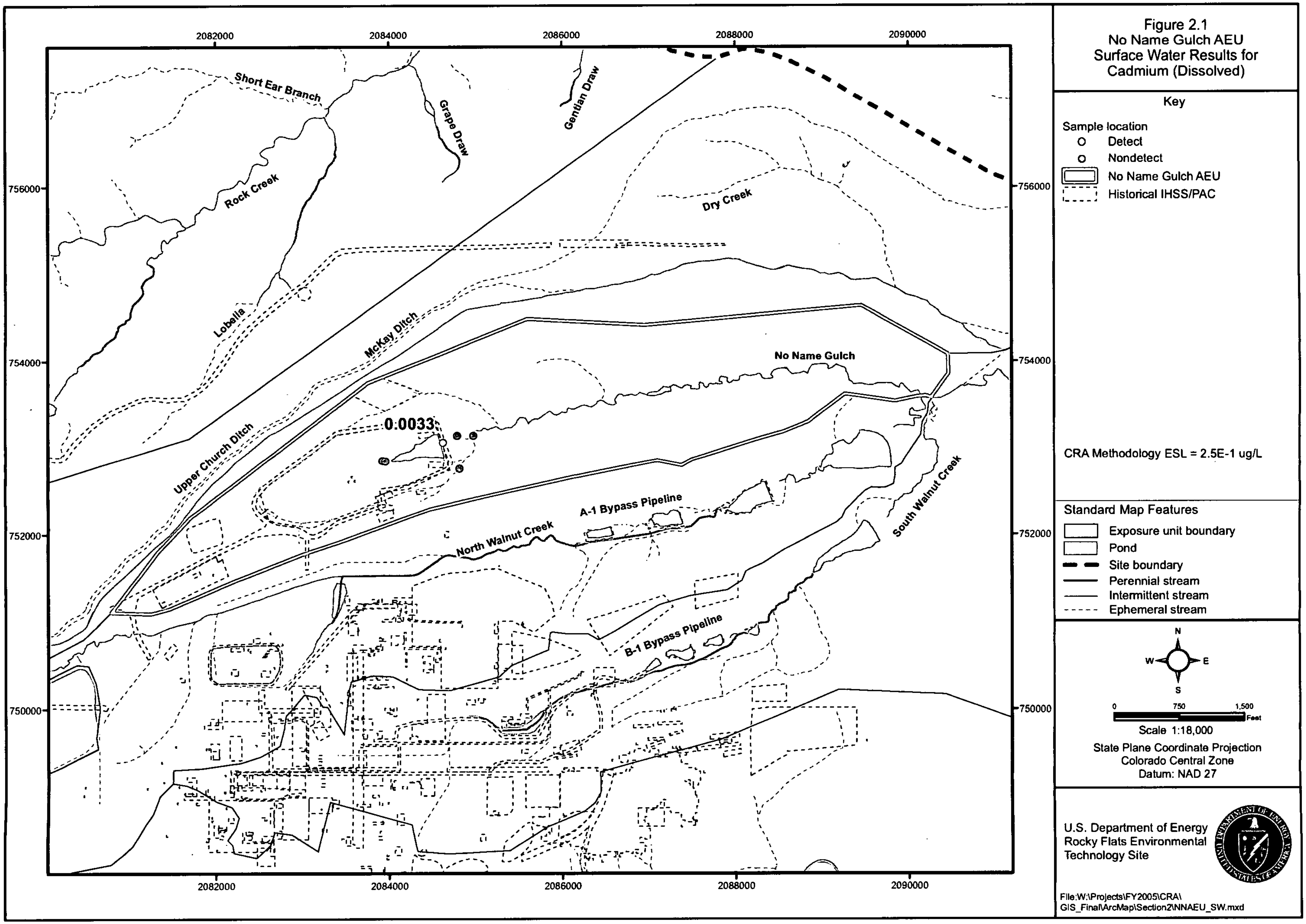

Figure 2.1
No Name Gulch AEU
Surface Water Results for
Cadmium (Dissolved)
Key
Sample location
Detect
Nondetect
No Name Gulch AEU
Historical IHSS/PAC
CRA Methodology ESL = 2.5E-1 ug/L
Standard Map Features
Exposure unit boundary
Pond
Site boundary
Perennial stream
Intermittent stream
Ephemeral stream
N
W
E
S
0
750
1,500
Feet
Scale 1:18,000
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27
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GIS_Final\ArcMap\Section2\NNAEU_SW.mxd
0.0033
Short Ear Branch
Grape Draw
Gentian Draw
Rock Creek
Dry Creek
Lobella
McKay Ditch
No Name Gulch
Upper Church Ditch
A-1 Bypass Pipeline
North Walnut Creek
South Walnut Creek
B-1 Bypass Pipeline
2082000
2084000
2086000
2088000
2090000
756000
754000
752000
750000

108

109

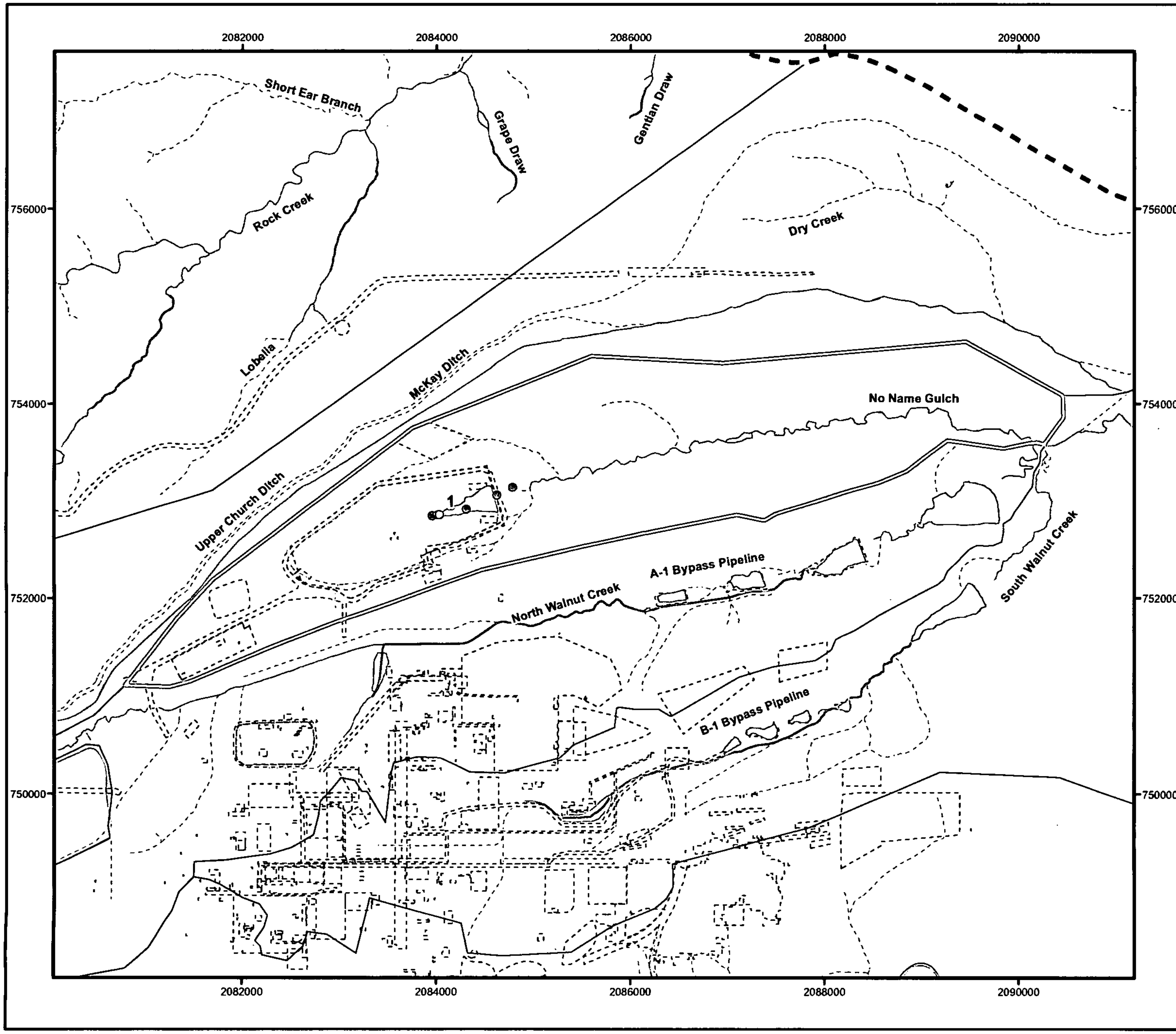

Figure 2.2
No Name Gulch AEU
Surface Water Results for
Benzo(a)pyrene

Key

Sample location
- Detect
- Nondetect
- No Name Gulch AEU
- Historical IHSS/PAC

CRA Methodology ESL = 1.4E-2 ug/L

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

N
W E
S

0 750 1,500
Feet

Scale 1:18,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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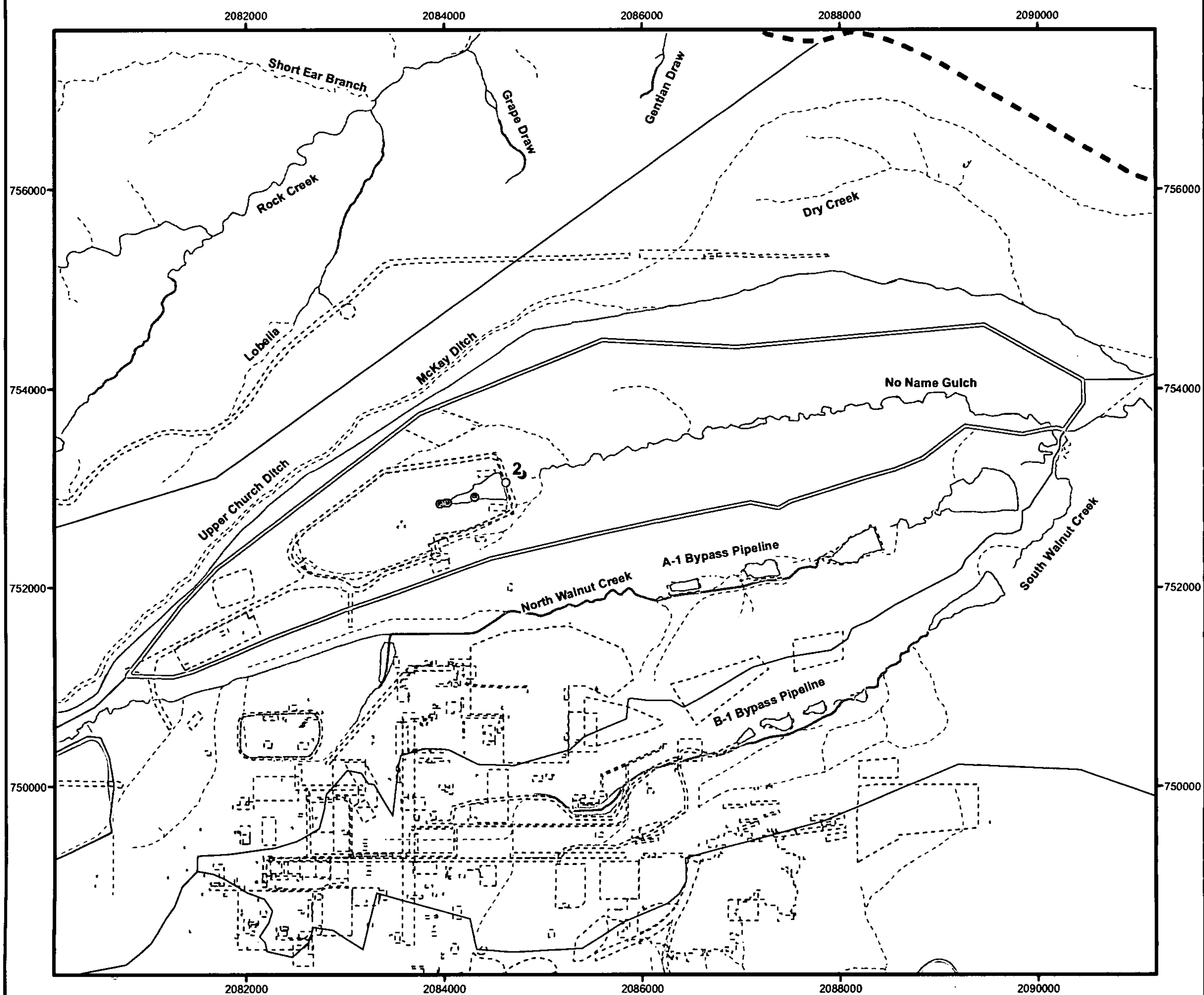

Figure 2.3
No Name Gulch AEU
Surface Water Results for Pyrene

Key

Sample location
- Detect
- Nondetect
- No Name Gulch AEU
- Historical IHSS/PAC

CRA Methodology ESL = 2.5E-2 ug/L

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

N W E S

0 750 1,500 Feet

Scale 1:18,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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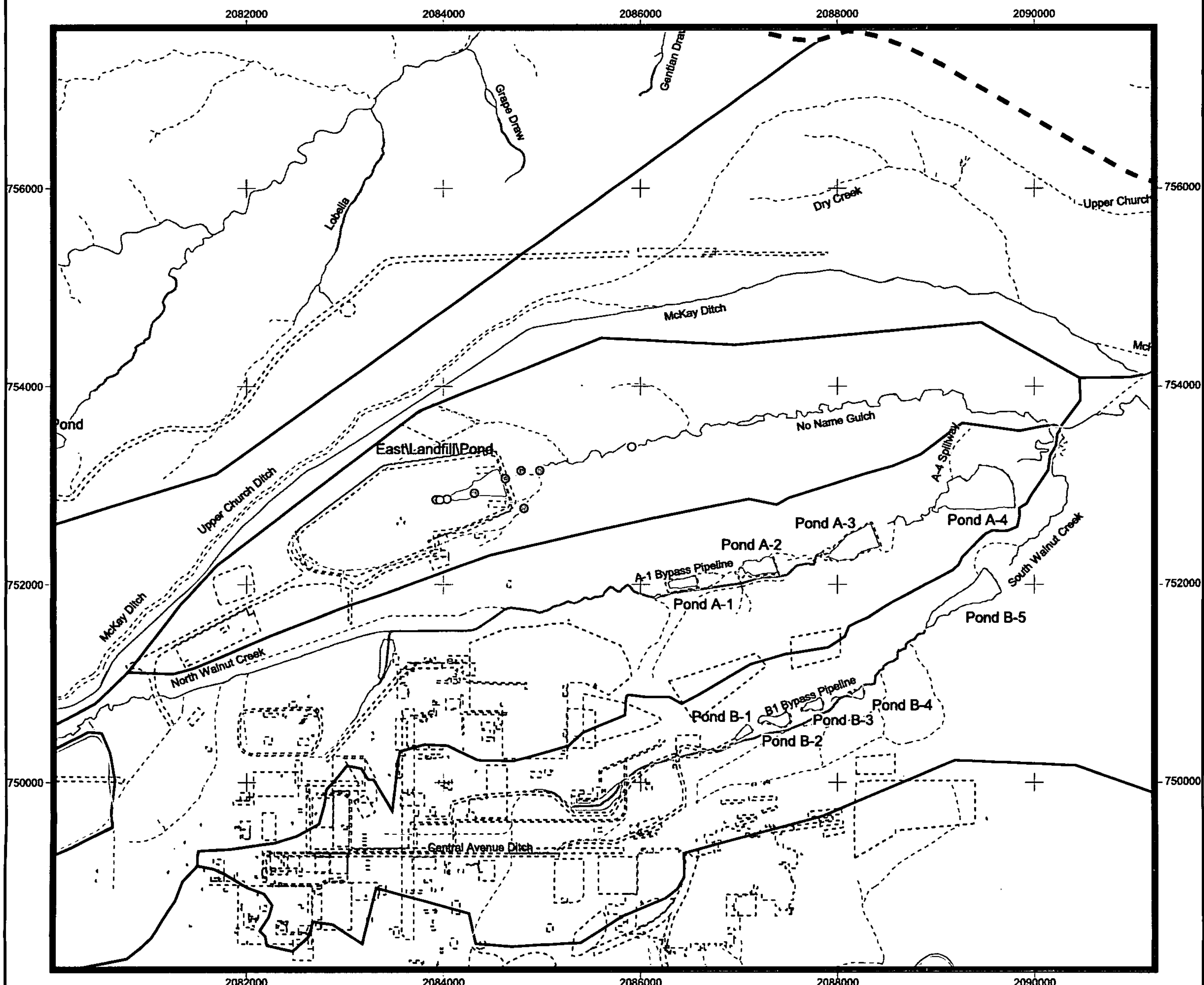
Figure 2.4
No Name Gulch AEU
Surface Water Sampling Locations
for Beryllium (Total)



KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 0.0024 mg/L

Standard Map Features
- No Name Gulch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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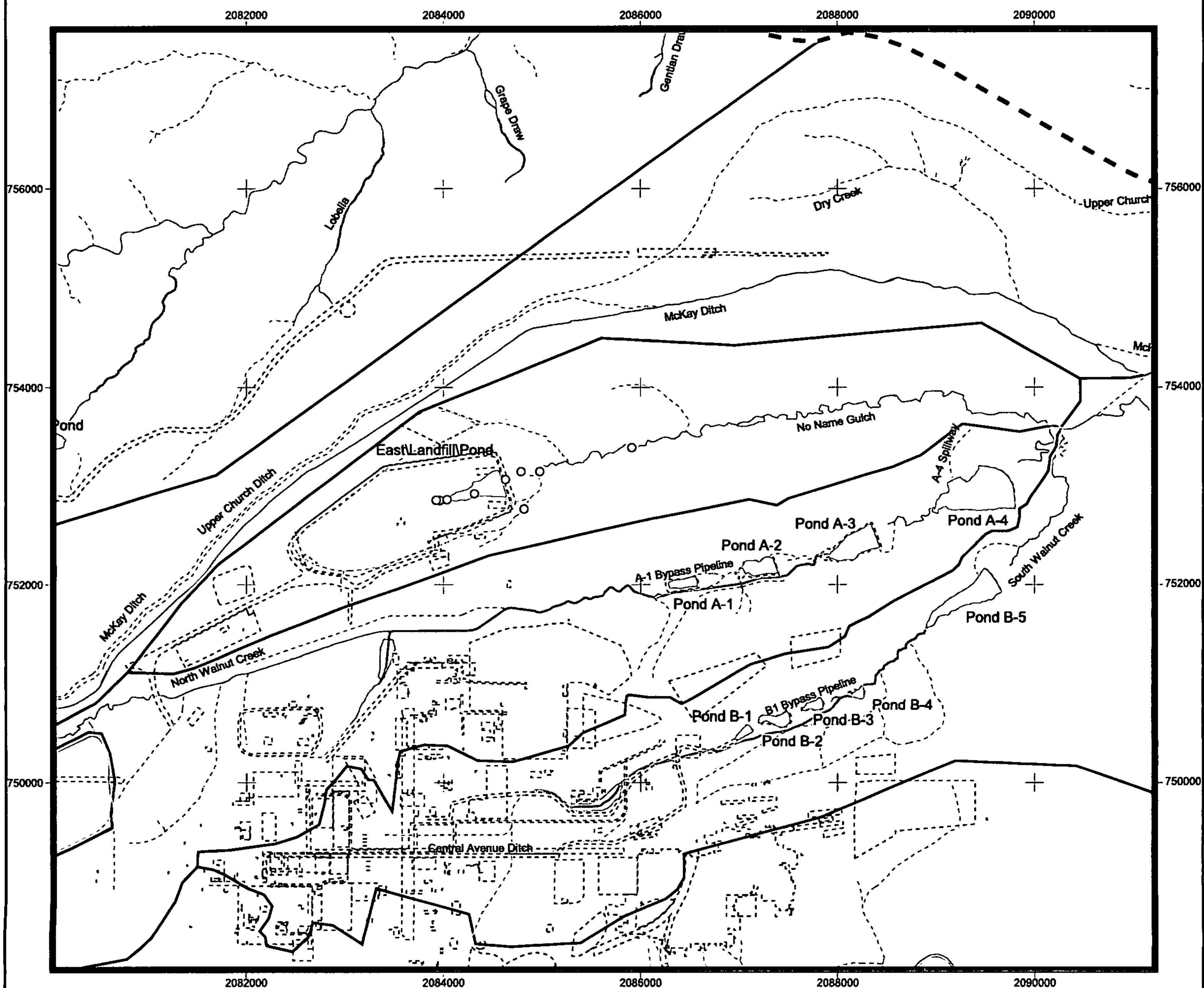

Figure 2.5
No Name Gulch AEU
Surface Water Sampling Locations
for Lithium (Total)

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 0.096 mg/L

Standard Map Features
- No Name Gulch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N
W E
S

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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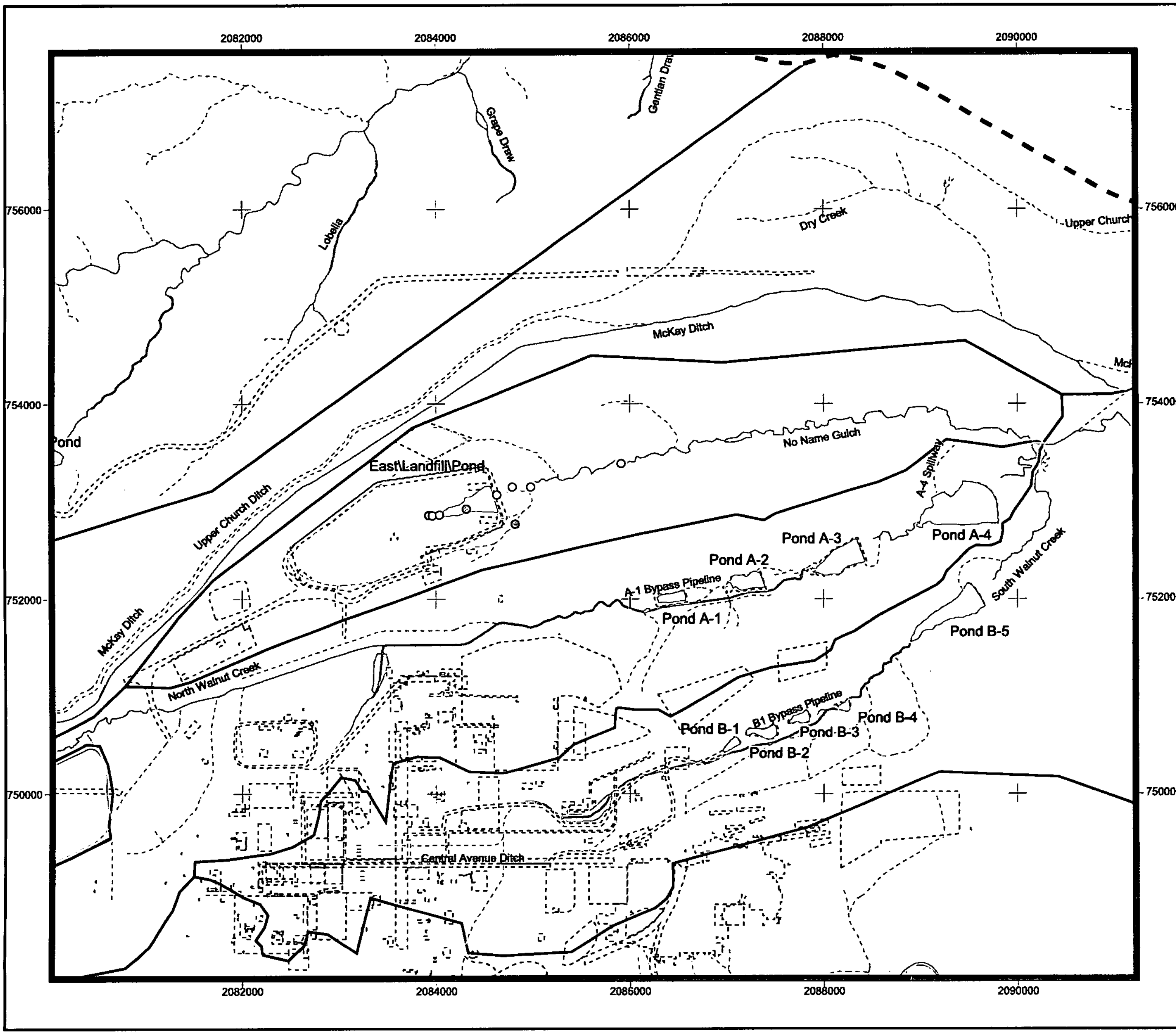

Figure 2.6
No Name Gulch AEU
Surface Water Sampling Locations
for Selenium (Total)

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 0.0046 mg/L

Standard Map Features
- No Name Gulch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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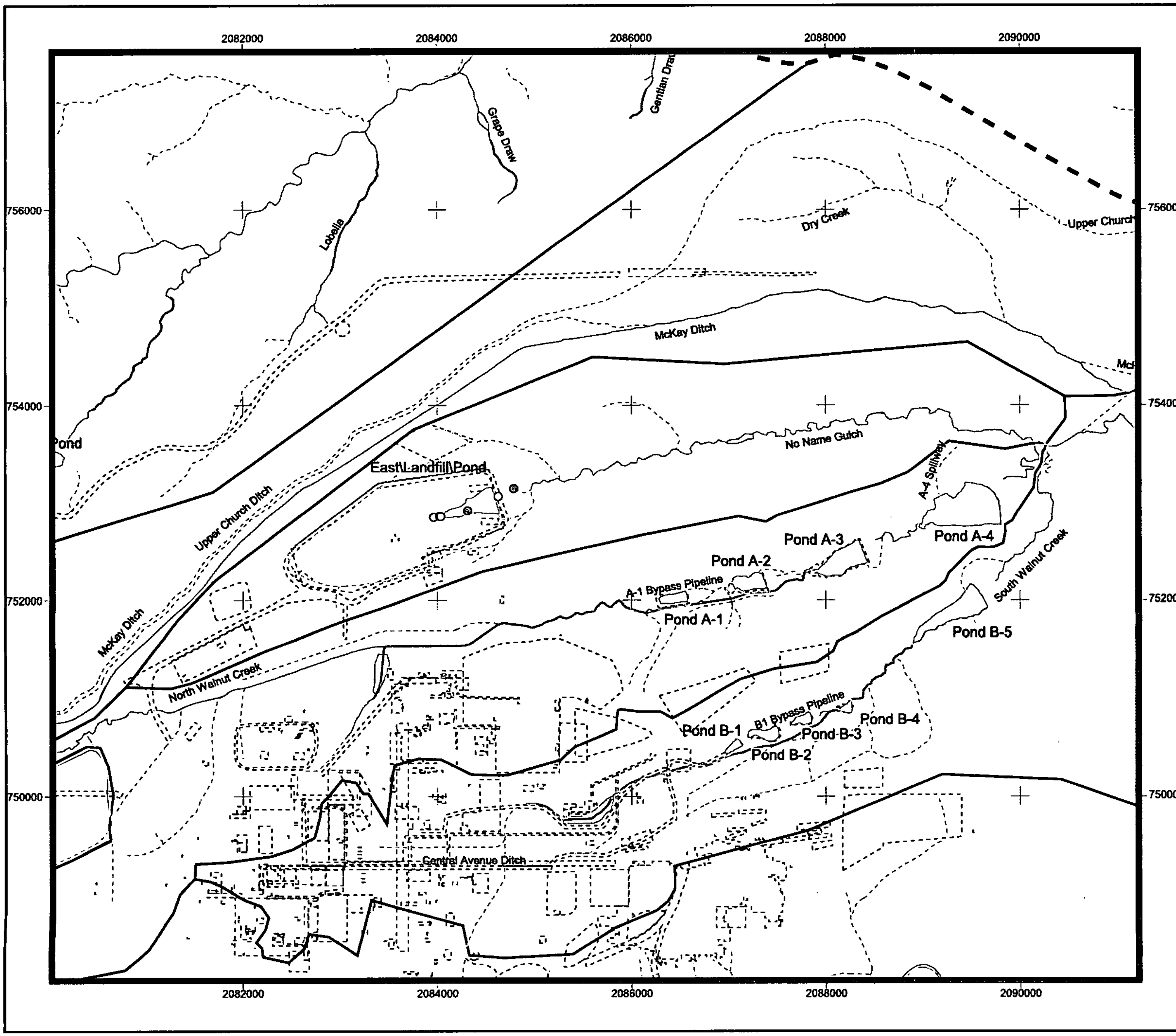

Figure 2.7
No Name Gulch AEU
Surface Water Sampling Locations
for bis(2-ethylhexyl)phthalate

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 28.5 ug/L

Standard Map Features
- No Name Gulch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Technology Site

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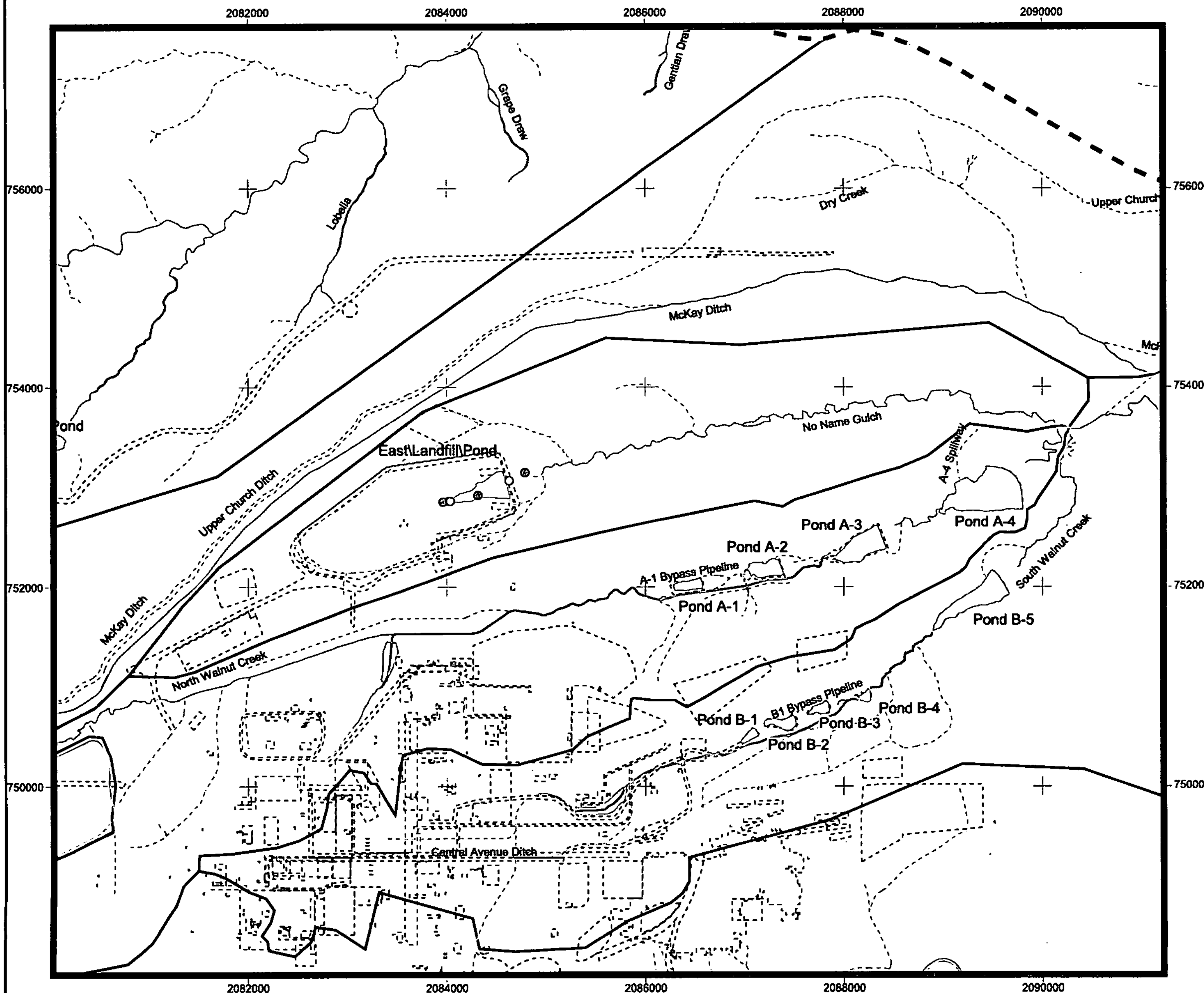
Figure 2.8
No Name Gulch AEU
Surface Water Sampling Locations
for Di-n-butylphthalate



KEY

Sampling location

- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 9.7 ug/L

Standard Map Features

- No Name Gulch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N
W E
S

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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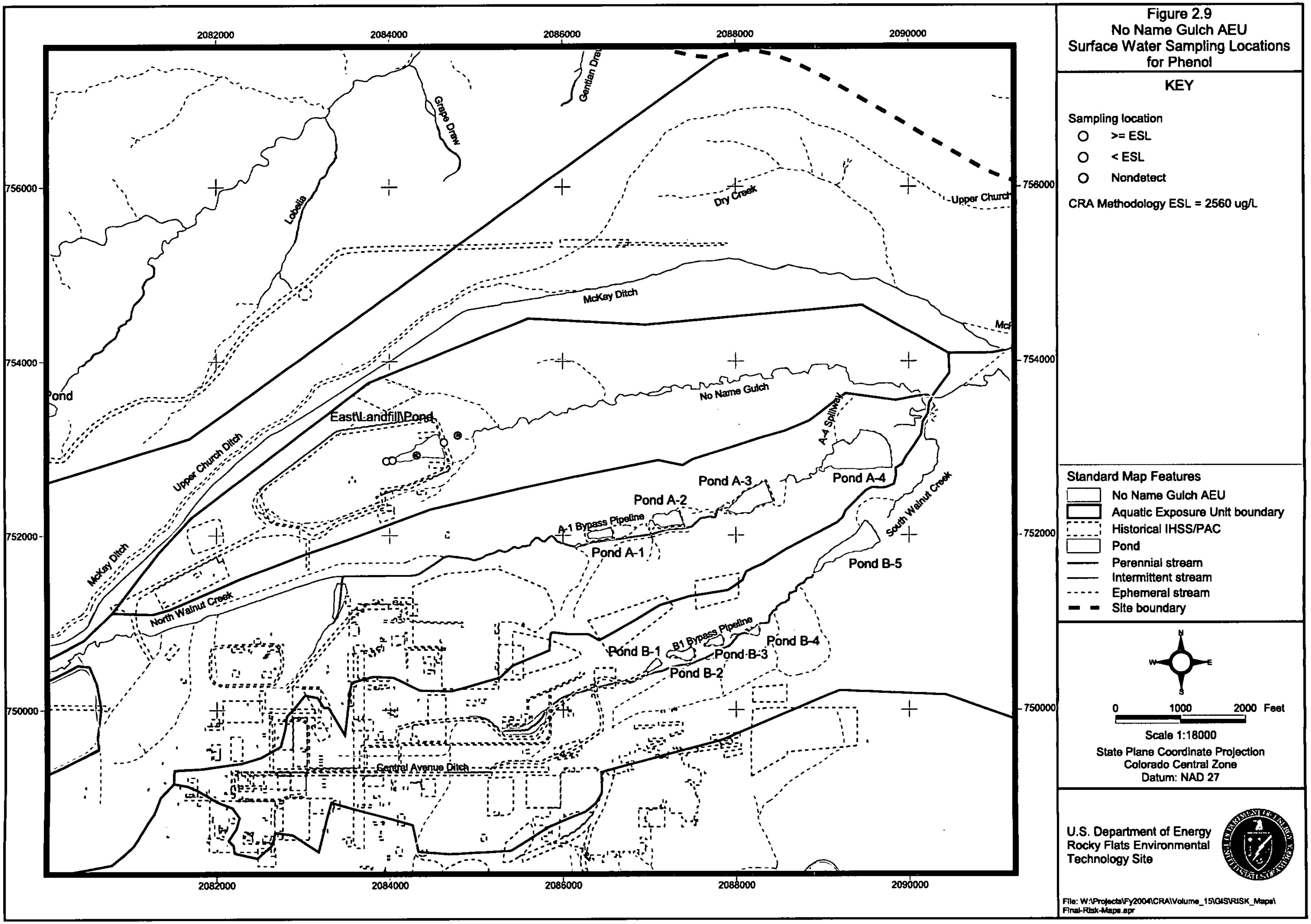

Figure 2.9
No Name Gulch AEU
Surface Water Sampling Locations
for Phenol

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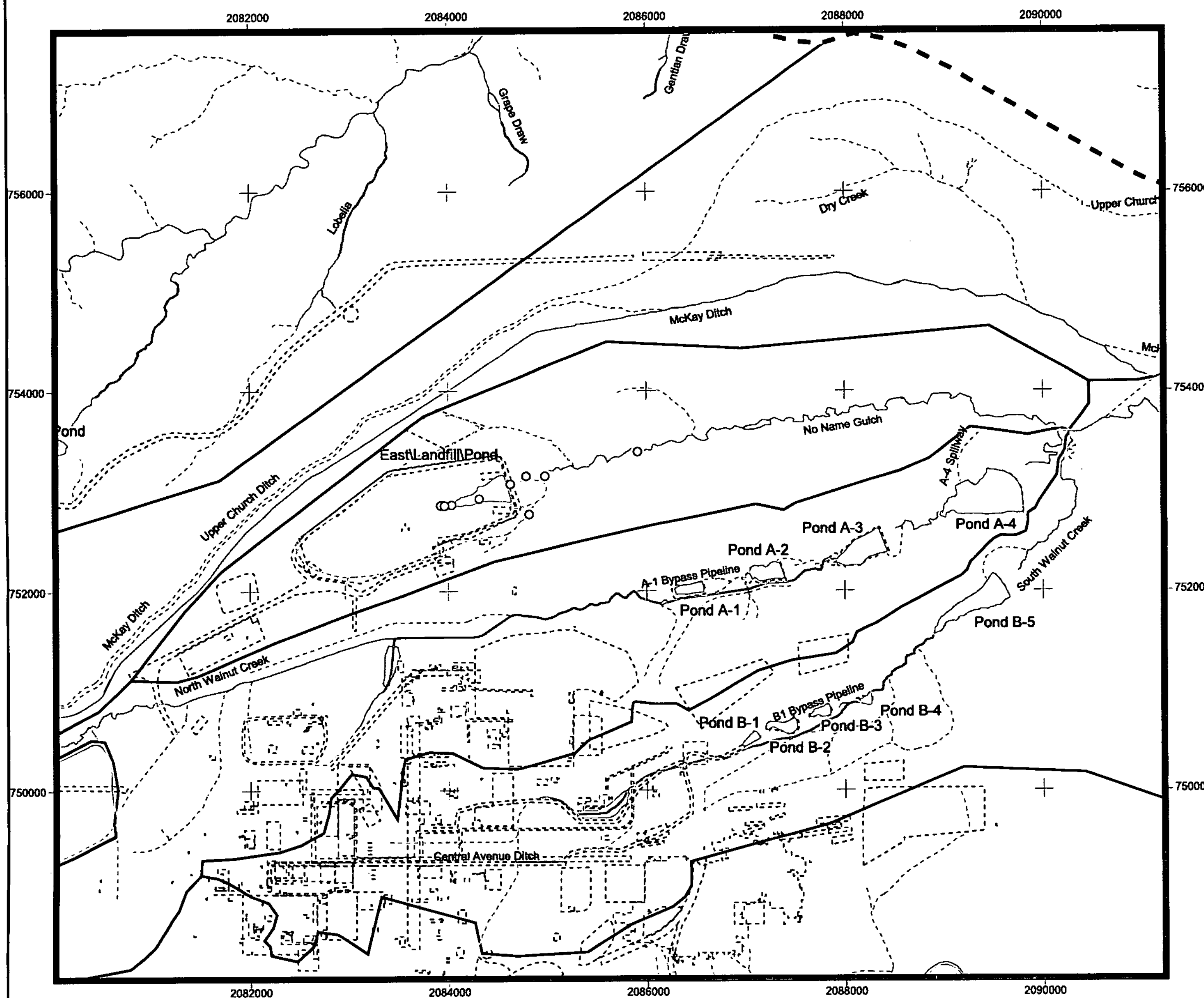
Figure 2.10
No Name Gulch AEU
Surface Water Sampling Locations
for Barium (Total)



KEY

Sampling location
- O >= ESL
- O < ESL
- O Nondetect

Site-specific ESL = 0.856 mg/L

Standard Map Features
- No Name Gulch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N S E W

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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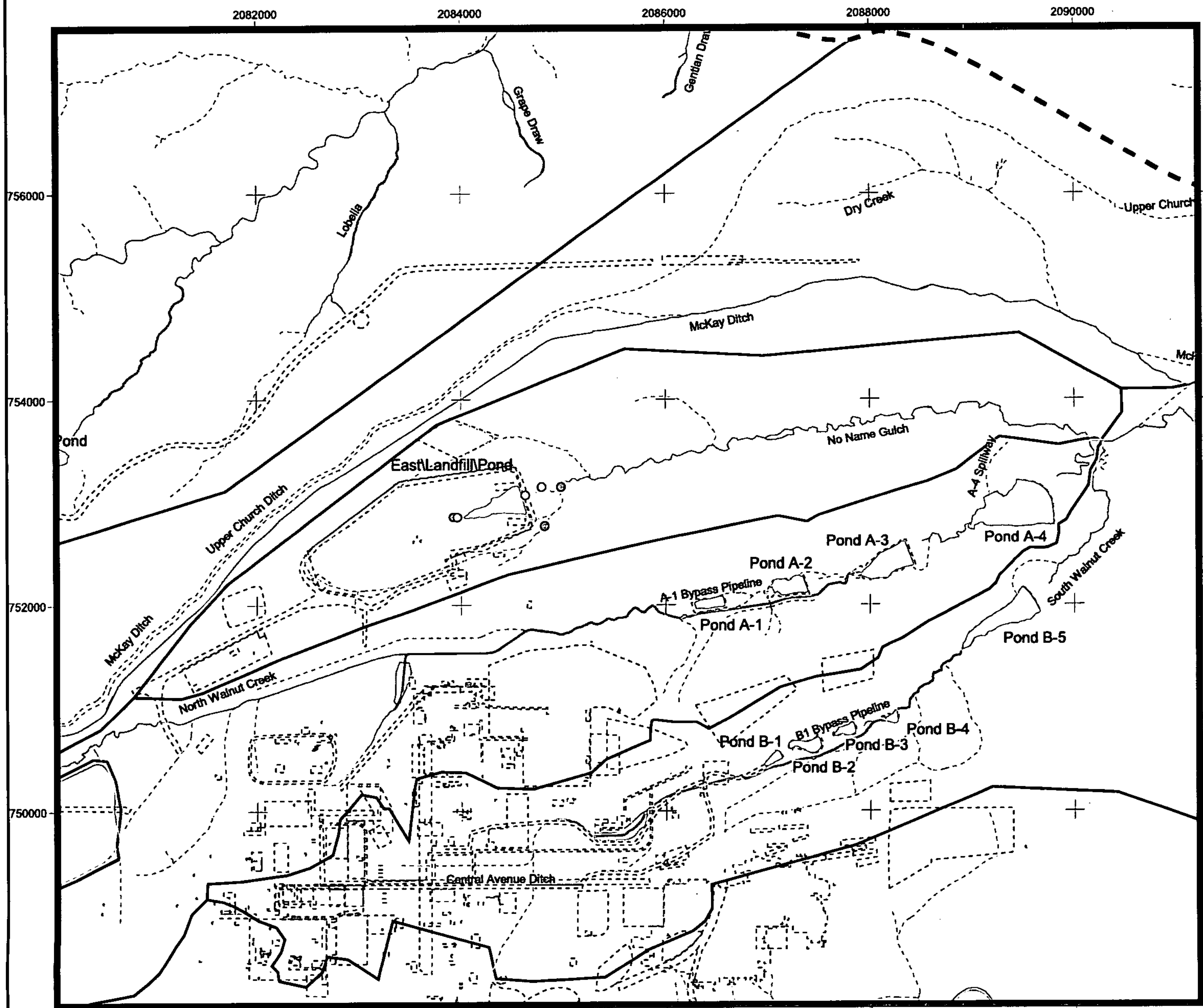

Figure 2.11
No Name Gulch AEU
Surface Water Sampling Locations for Lead (Dissolved)

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

Site-specific ESL = 0.005 mg/L

Standard Map Features
- No Name Gulch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N
W E
S

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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120

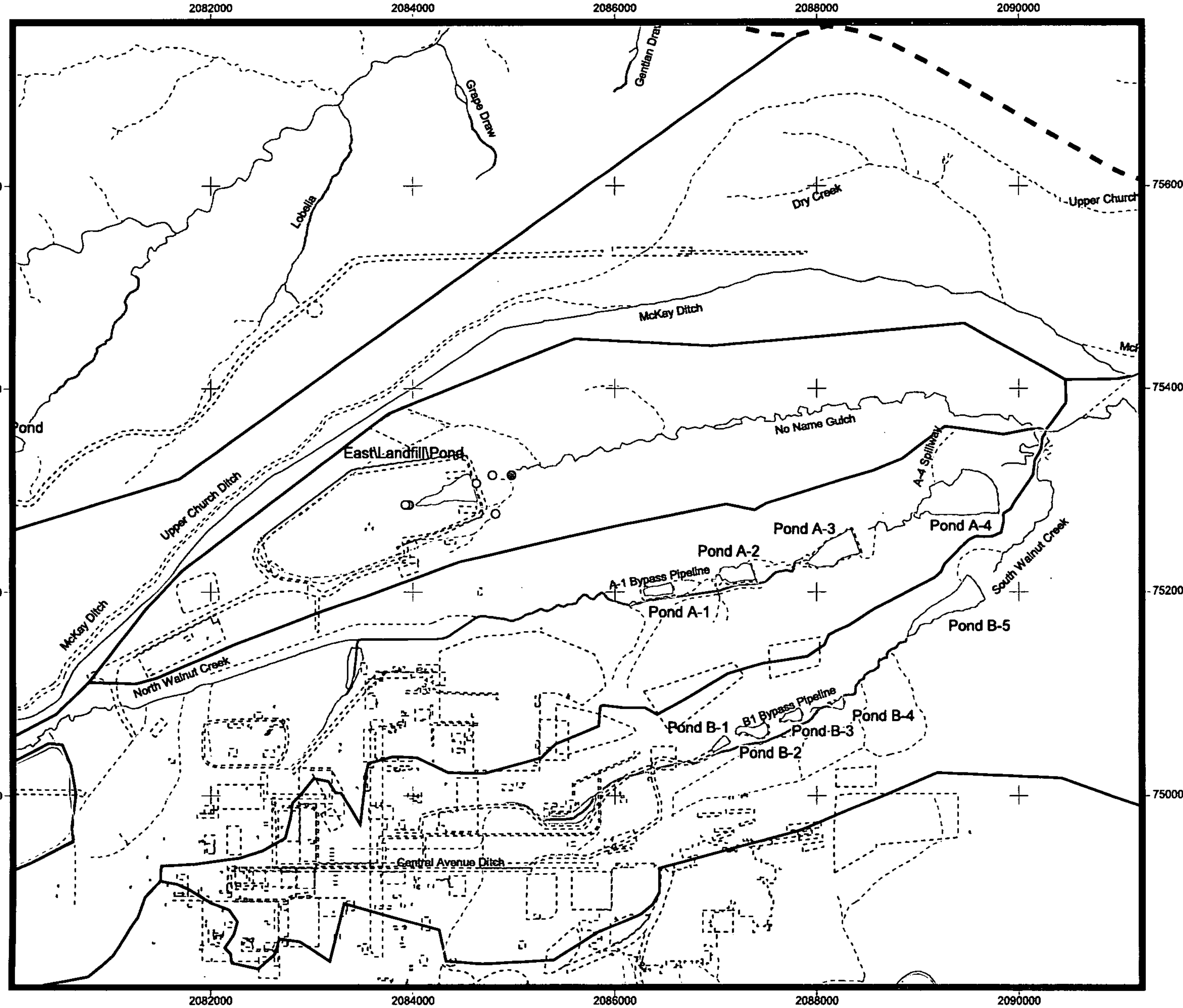

Figure 2.12
No Name Gulch AEU
Surface Water Sampling Locations
for Silver (Dissolved)

KEY

Sampling location
>= ESL
< ESL
Nondetect

Site-specific ESL = 0.0009 mg/L

Standard Map Features
No Name Gulch AEU
Aquatic Exposure Unit boundary
Historical IHSS/PAC
Pond
Perennial stream
Intermittent stream
Ephemeral stream
Site boundary

N
W E
S

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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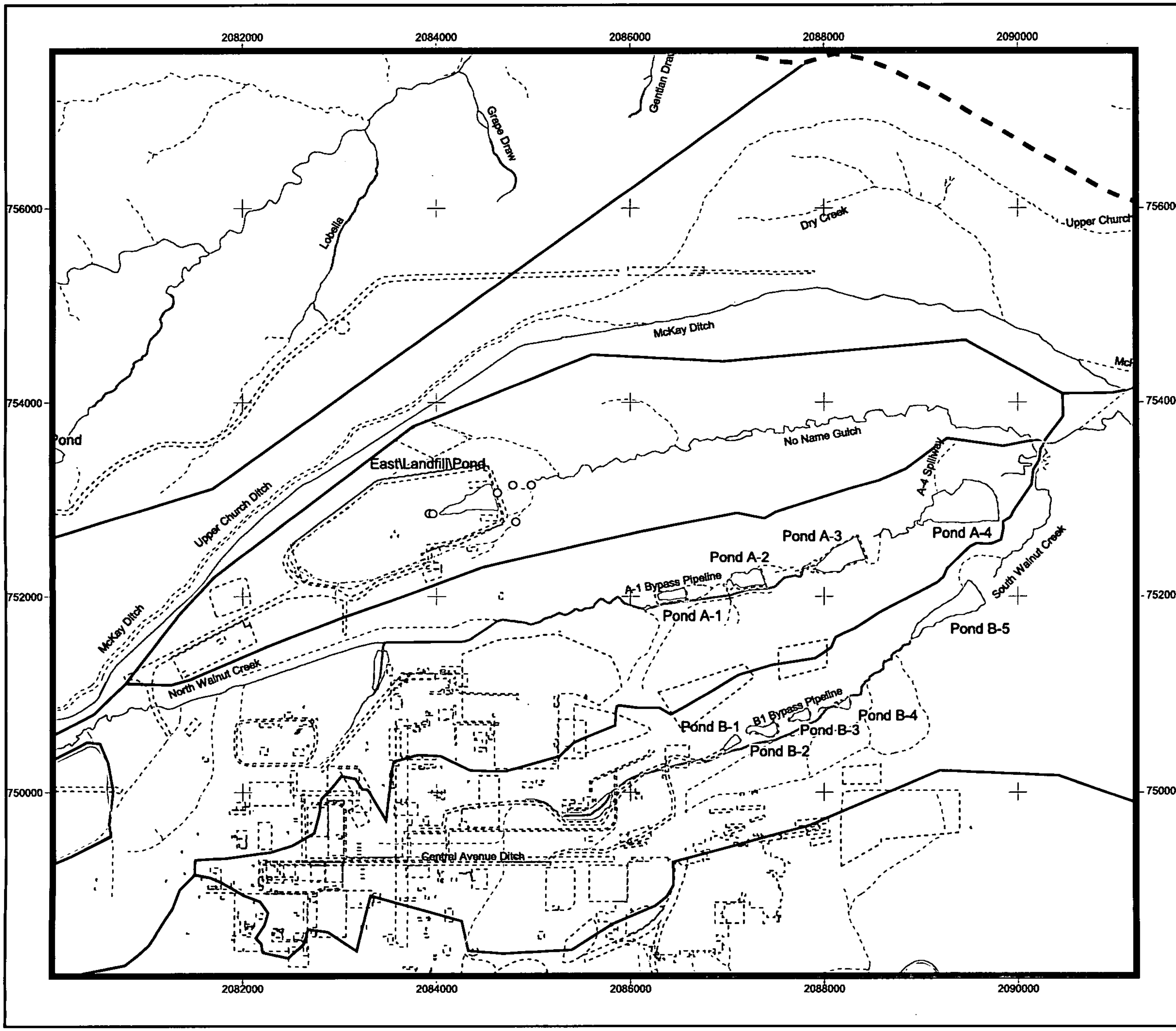
Figure 2.13
No Name Gulch AEU
Surface Water Sampling Locations
for Zinc (Dissolved)



KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

Site-specific ESL = 0.202 mg/L

Standard Map Features
- No Name Gulch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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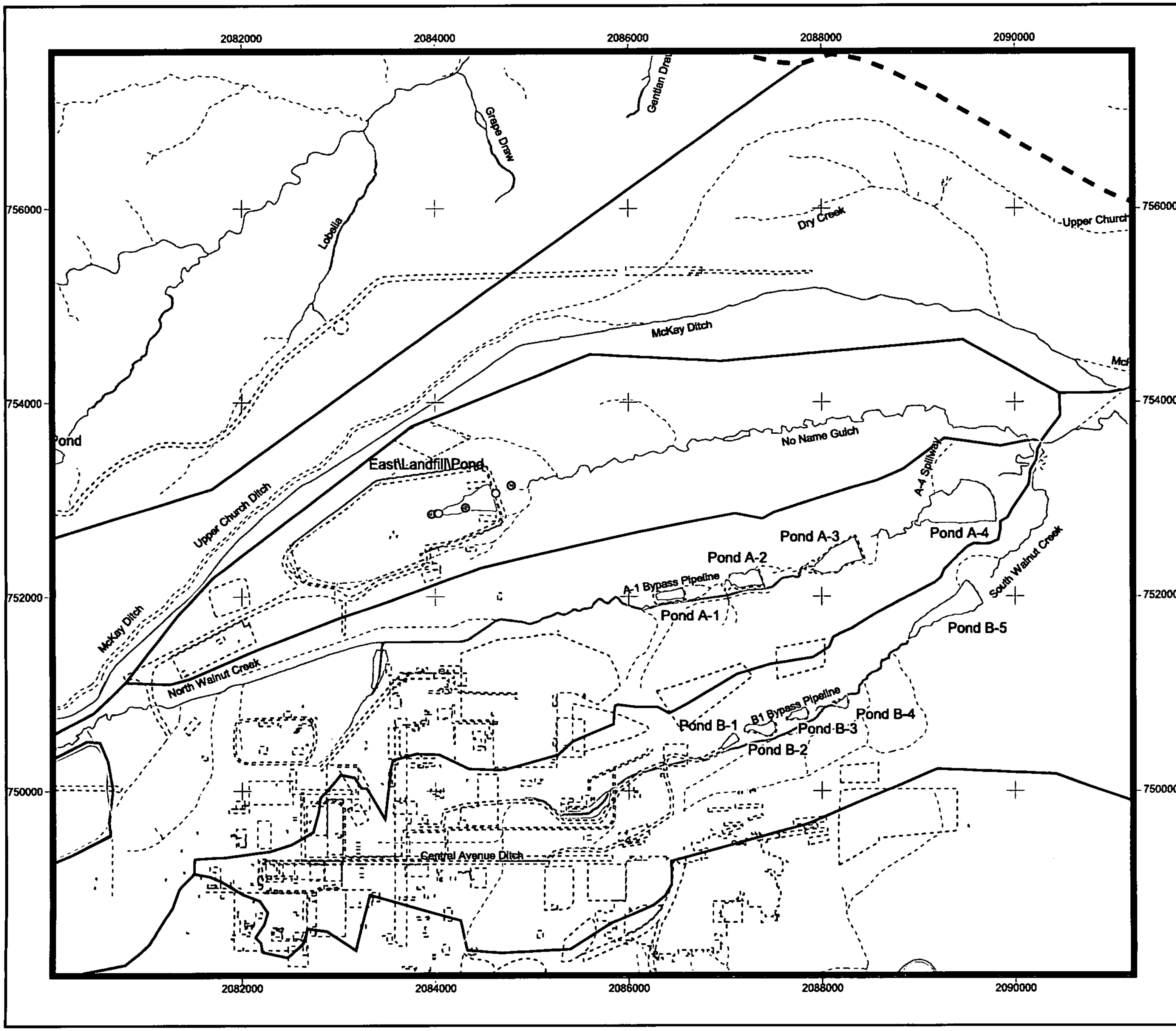

Figure 2.14
No Name Gulch AEU
Surface Water Sampling Locations for Pentachlorophenol

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

Site-specific ESL = 21.1 ug/L

Standard Map Features
- No Name Gulch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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File: W:\Projects\Fy2004\CRA\Volume_15\GIS\RISK_Maps\Final-Risk-Maps.apr

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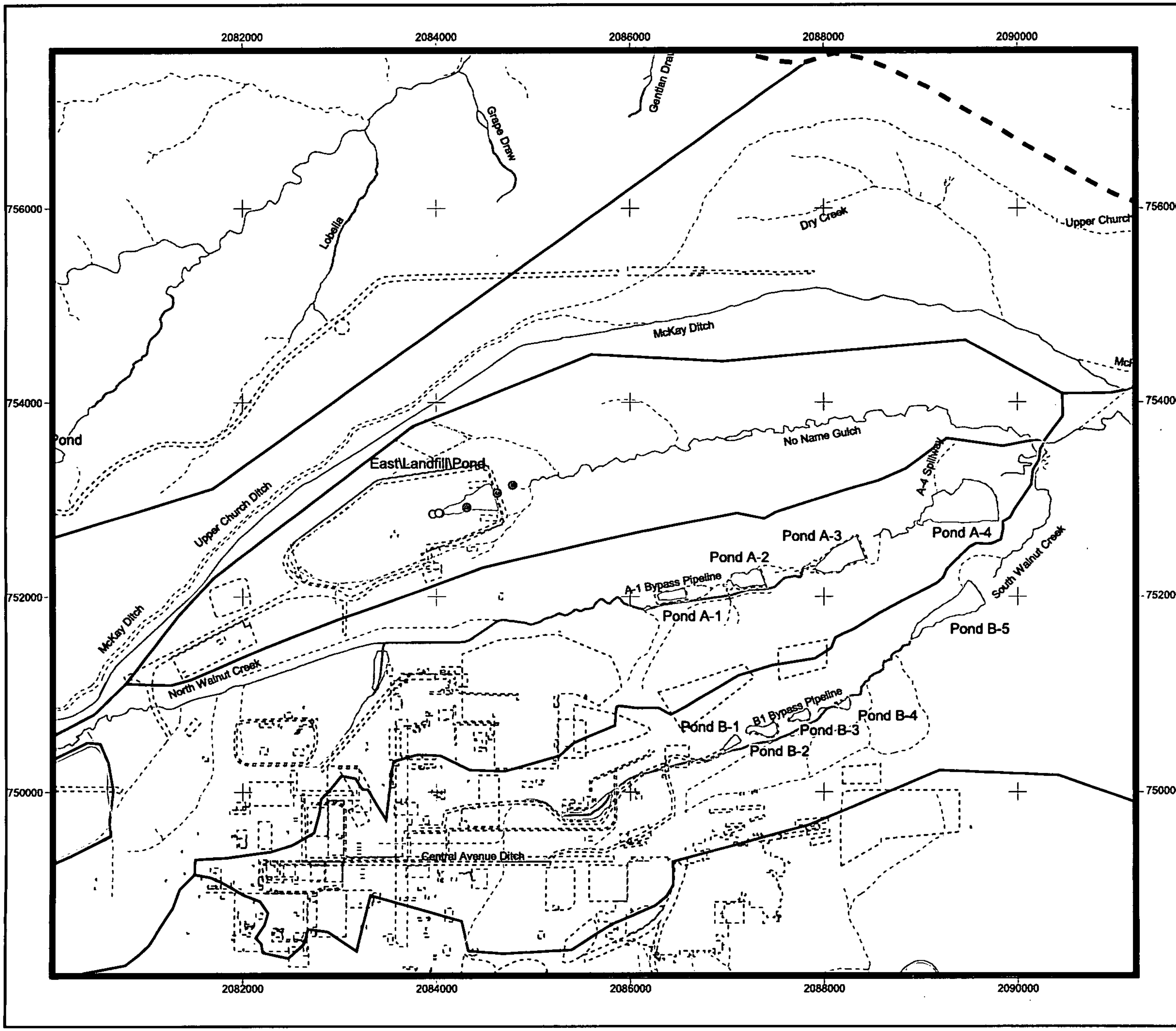

Figure 2.15
No Name Gulch AEU
Surface Water Sampling Locations
for Phenanthrene

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 2.4 ug/L

Standard Map Features
- No Name Gulch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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File: W:\Projects\Fy2004\CRA\Volume_15\GIS\RISK_Maps\Final-Risk-Maps.apr

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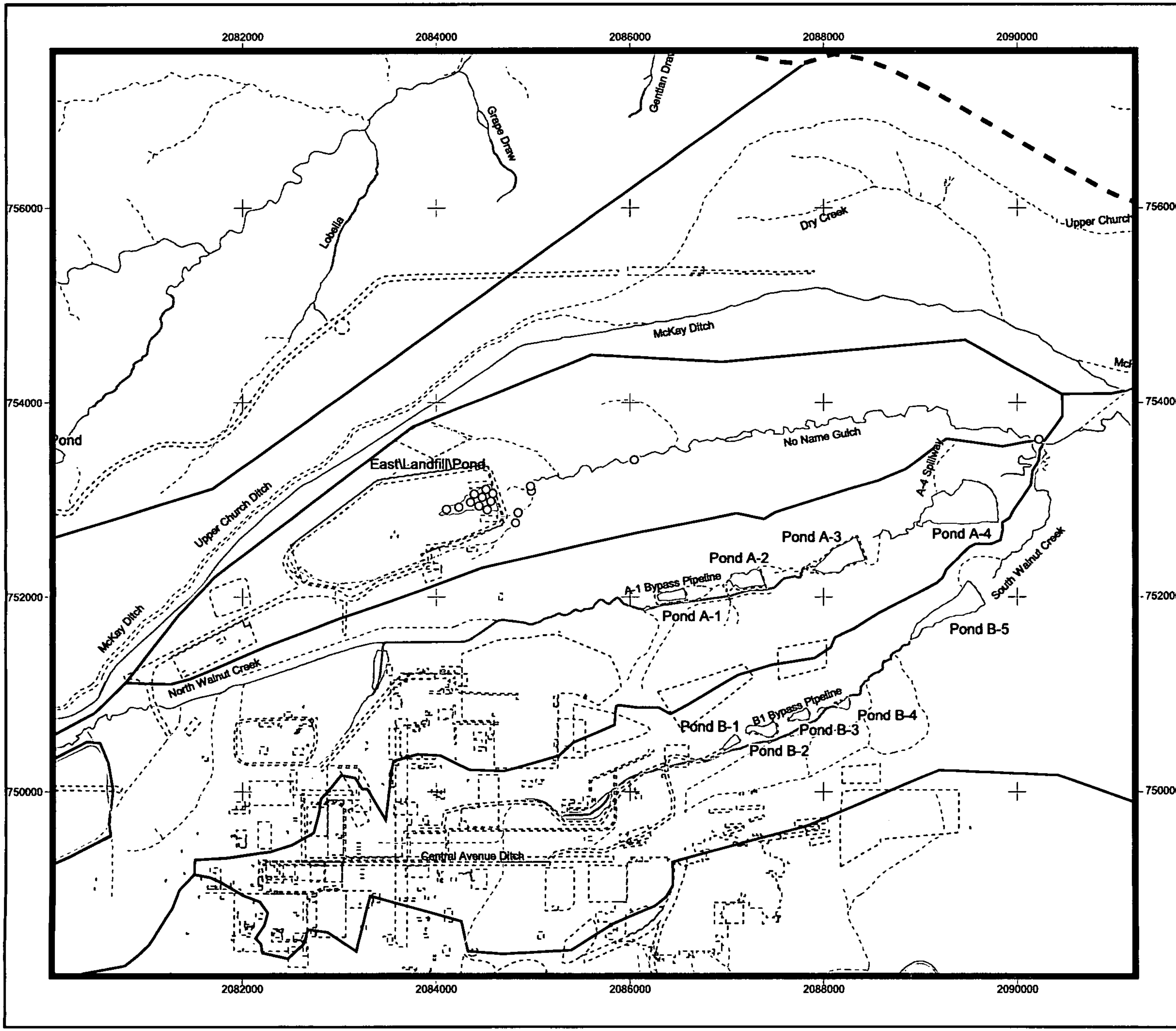

Figure 2.16
No Name Gulch AEU
Sediment Sampling Locations
for Aluminum

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 15900 mg/kg

Standard Map Features
- No Name Gulch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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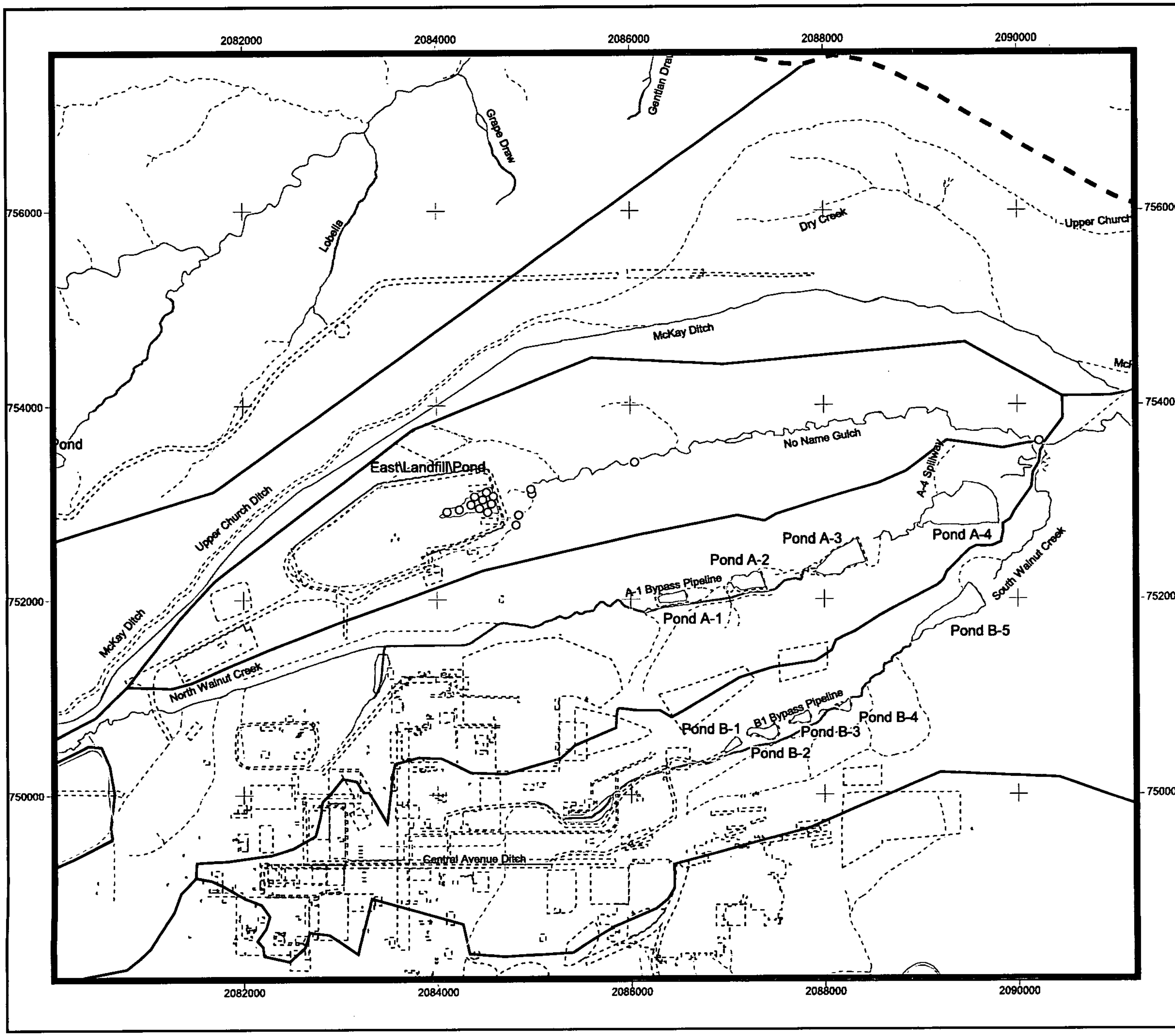

Figure 2.17
No Name Gulch AEU
Sediment Sampling Locations
for Barium

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 189 mg/kg

Standard Map Features
- No Name Gulch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

File: W:\Projects\Fy2004\CRA\Volume_15\GIS\RISK_Maps\Final-Risk-Maps.apr

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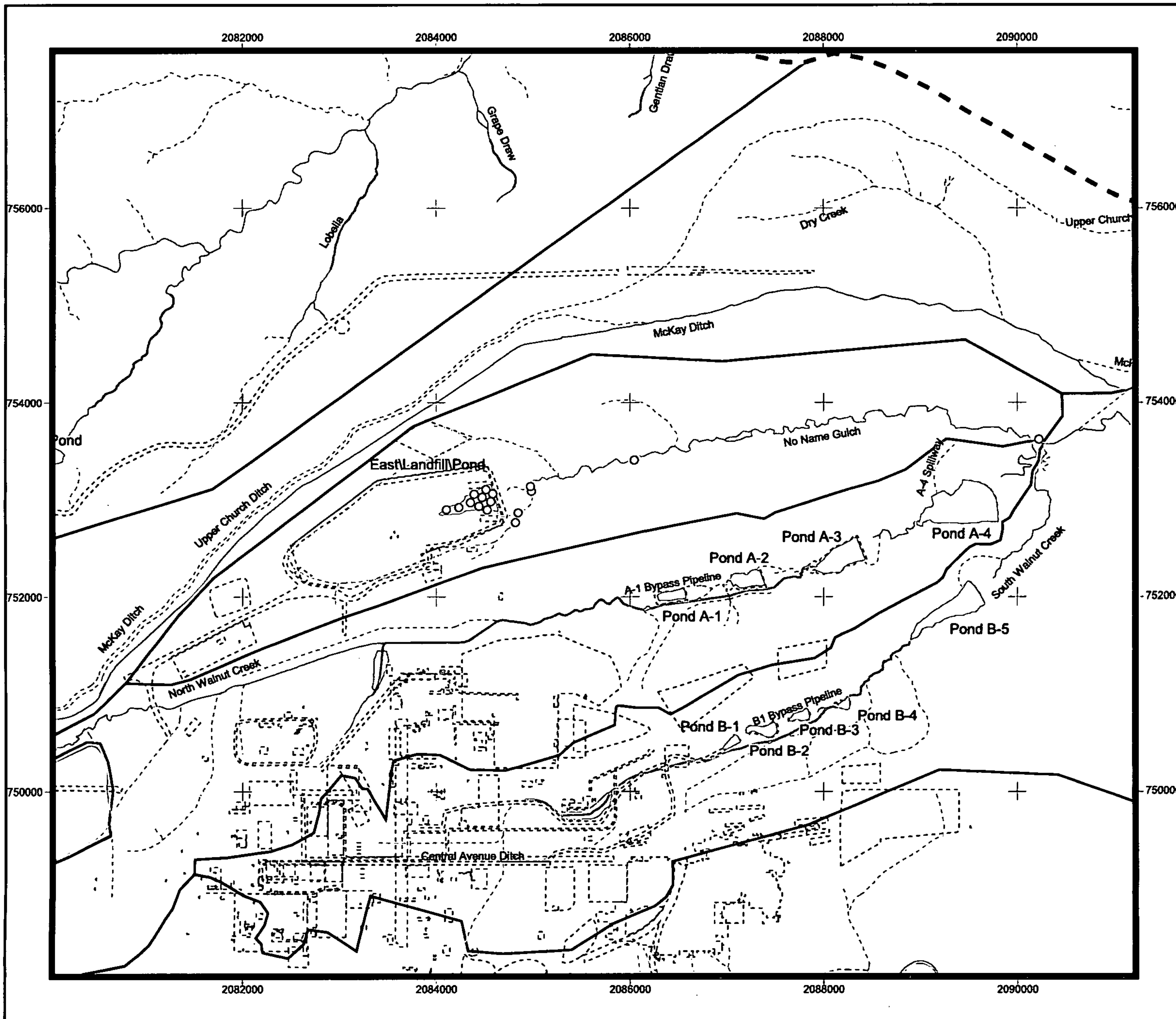

Figure 2.18
No Name Gulch AEU
Sediment Sampling Locations for Iron

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 20000 mg/kg

Standard Map Features
- No Name Gulch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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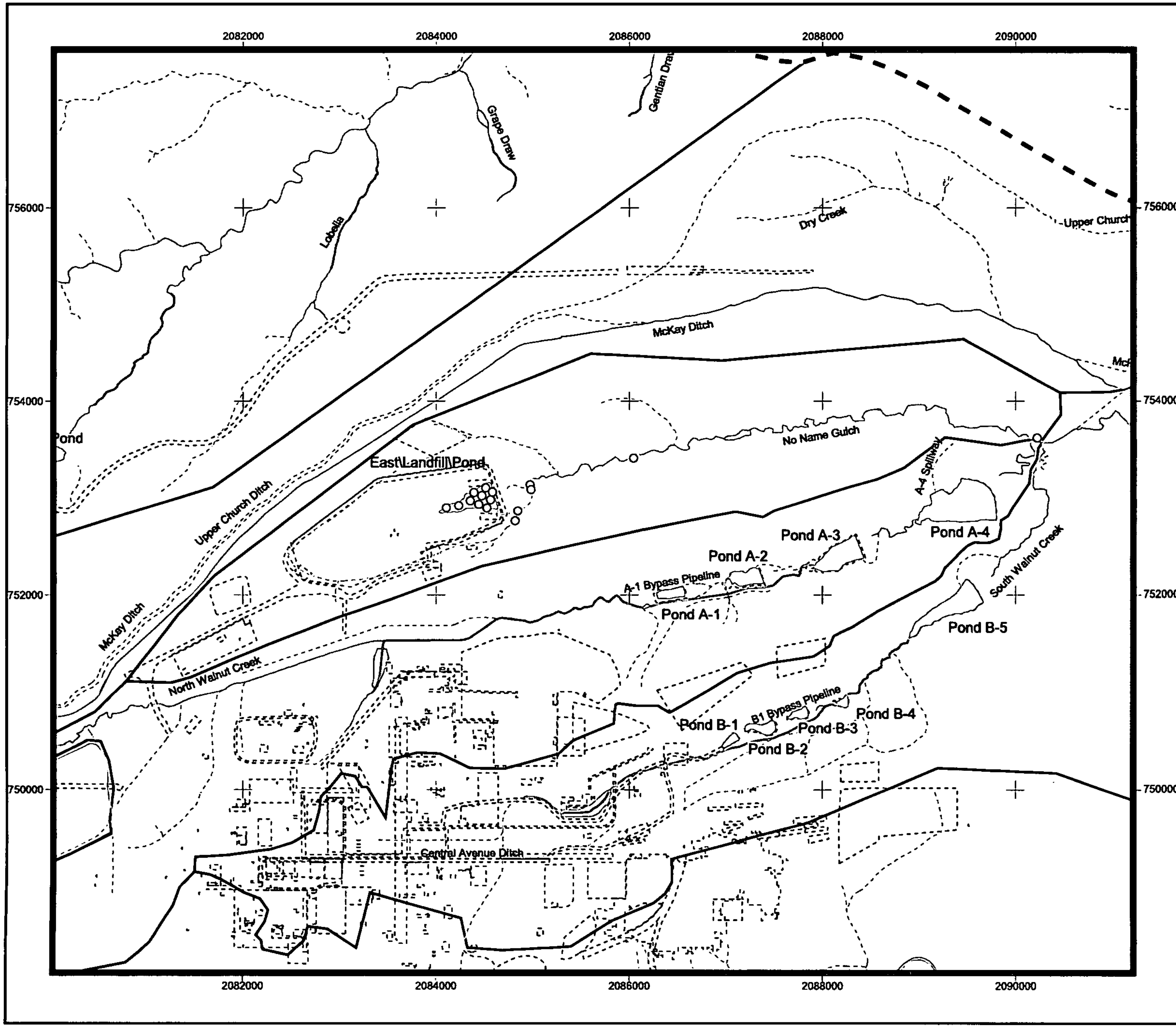

Figure 2.19
No Name Gulch AEU
Sediment Sampling Locations
for Lead

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 35.8 mg/kg

Standard Map Features
- No Name Gulch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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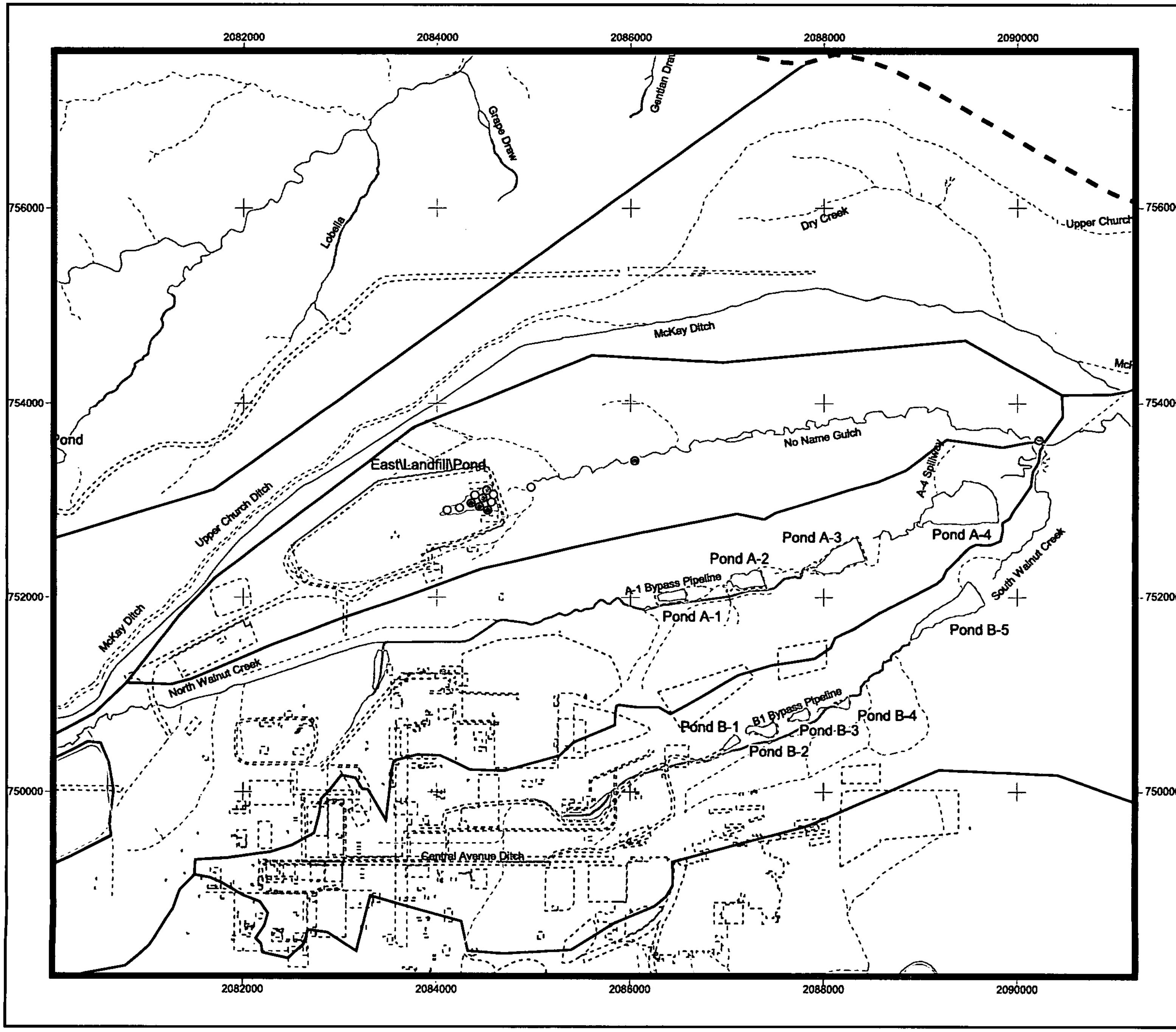

Figure 2.20
No Name Gulch AEU
Sediment Sampling Locations for Benzo(a)anthracene

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 108 ug/kg

Standard Map Features
- No Name Gulch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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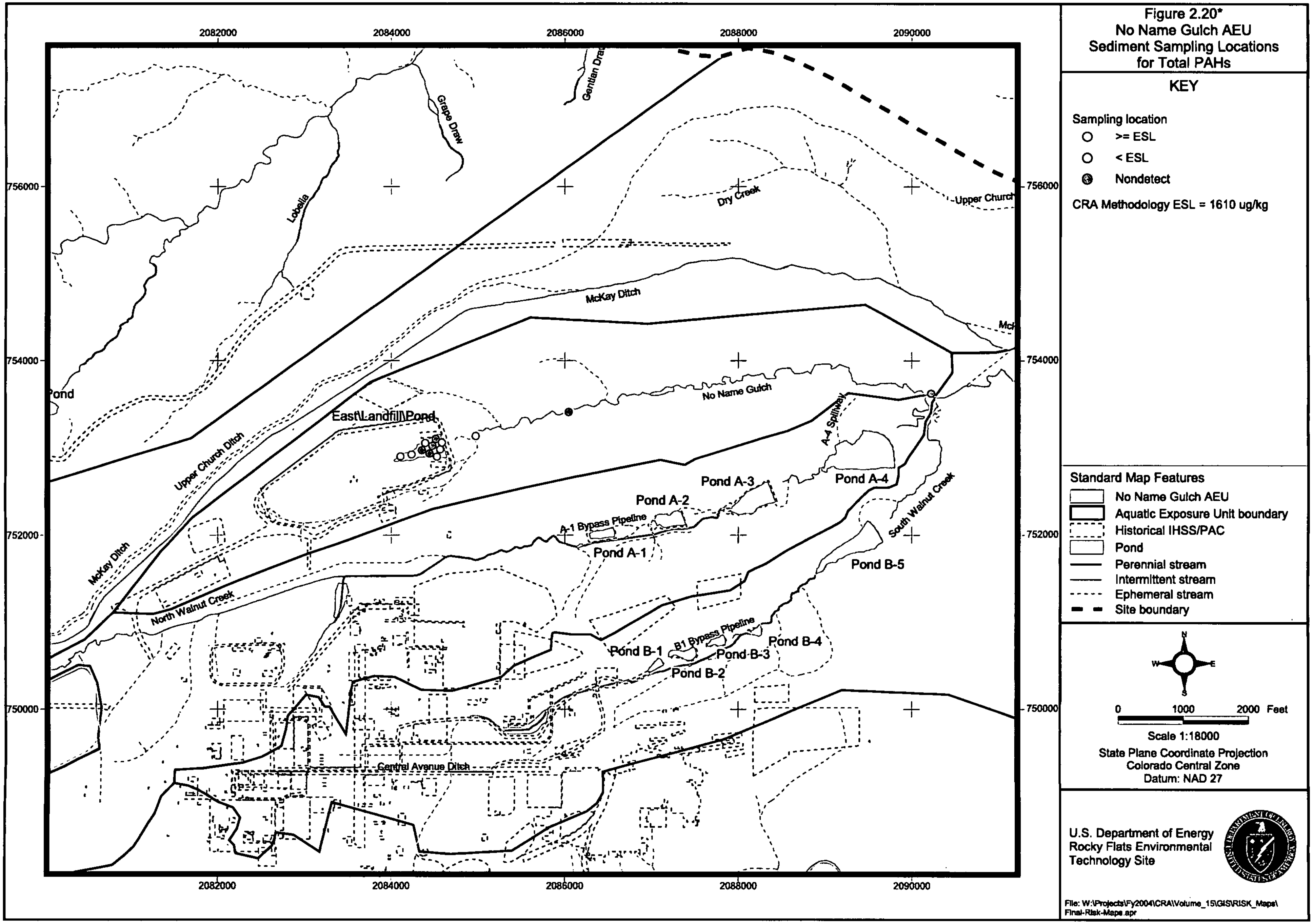
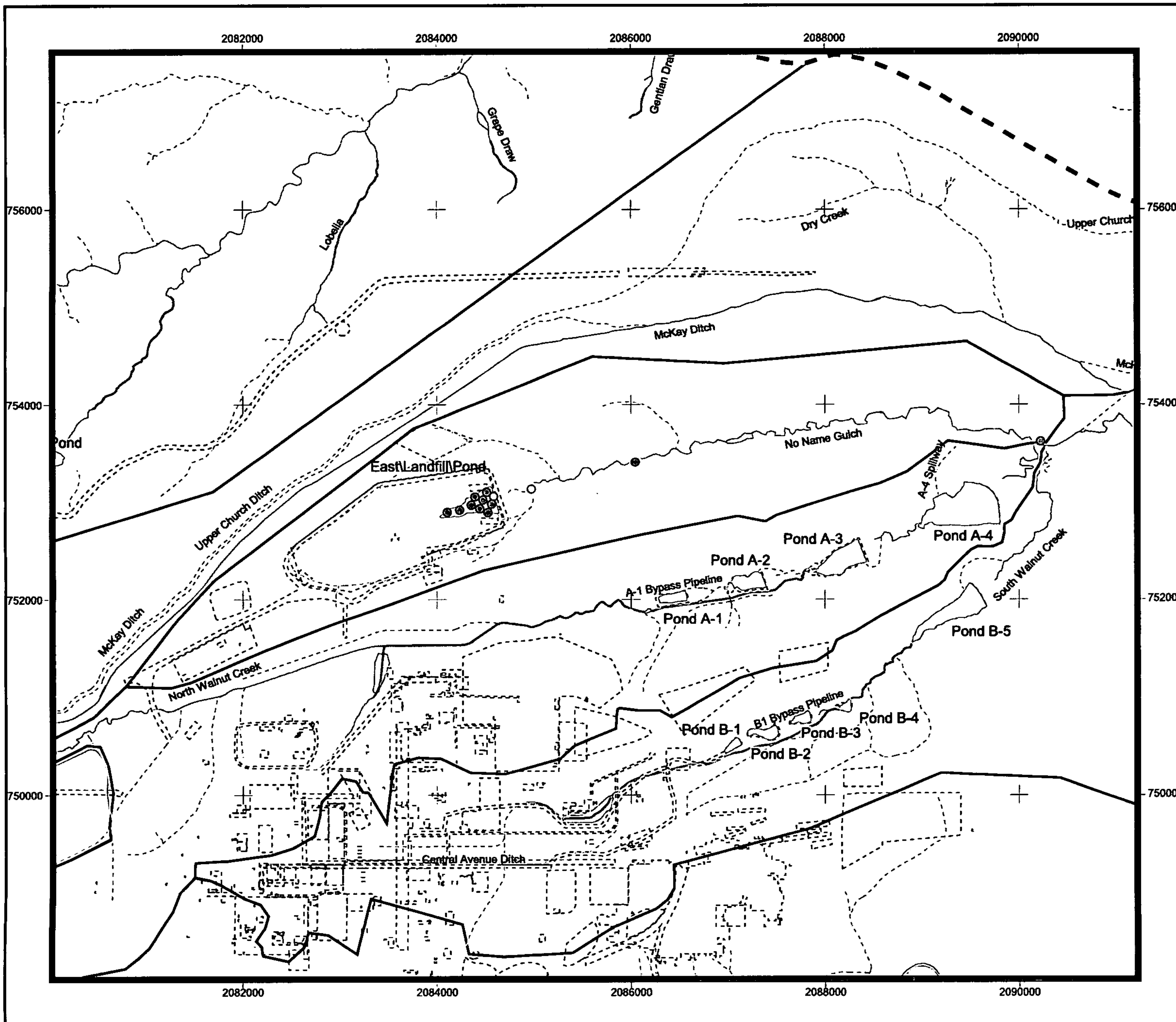


Figure 2.20*
No Name Gulch AEU
Sediment Sampling Locations
for Total PAHs
KEY
Sampling location
>= ESL
< ESL
Nondetect
CRA Methodology ESL = 1610 ug/kg
Standard Map Features
No Name Gulch AEU
Aquatic Exposure Unit boundary
Historical IHSS/PAC
Pond
Perennial stream
Intermittent stream
Ephemeral stream
Site boundary
N
W
E
S
0
1000
2000 Feet
Scale 1:18000
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27
U.S. Department of Energy
Rocky Flats Environmental
Technology Site
File: W:\Projects\Fy2004\CRA\Volume_15\GIS\RISK_Maps\Final-Risk-Maps.apr
2082000
2084000
2086000
2088000
2090000
756000
754000
752000
750000
Gentian Draw
Grape Draw
Lobelia
Dry Creek
Upper Church
McKay Ditch
No Name Gulch
East Landfill Pond
A-4 Spillway
Upper Church Ditch
Pond A-3
Pond A-4
Pond A-2
A-1 Bypass Pipeline
Pond A-1
South Walnut Creek
Pond B-5
North Walnut Creek
Pond B-1
B1 Bypass Pipeline
Pond B-4
Pond B-3
Pond B-2
Central Avenue Ditch
Pond

130

Figure 2.21
No Name Gulch AEU
Sediment Sampling Locations
for Benzo(a)pyrene



KEY

Sampling location

- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 150 ug/kg

Standard Map Features

- No Name Gulch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N
W E
S

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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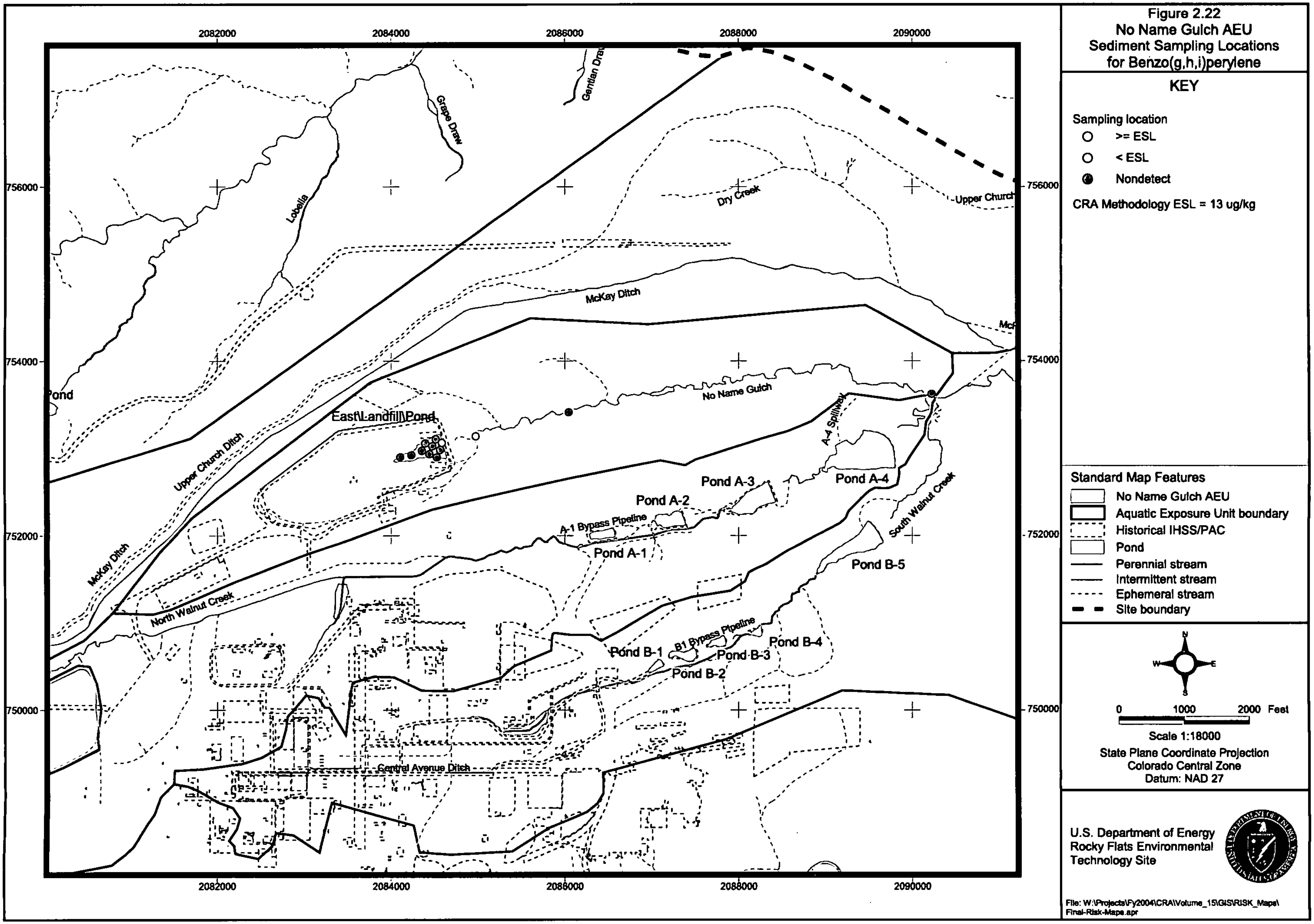

Figure 2.22
No Name Gulch AEU
Sediment Sampling Locations
for Benzo(g,h,i)perylene
KEY
Sampling location
>= ESL
< ESL
Nondetect
CRA Methodology ESL = 13 ug/kg
Standard Map Features
No Name Gulch AEU
Aquatic Exposure Unit boundary
Historical IHSS/PAC
Pond
Perennial stream
Intermittent stream
Ephemeral stream
Site boundary
Scale 1:18000
0 1000 2000 Feet
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27
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Technology Site
File: W:\Projects\Fy2004\CRA\Volume_15\GIS\RISK_Maps\Final-Risk-Maps.apr
No Name Gulch
East\Landfill\Pond
McKay Ditch
Upper Church Ditch
North Walnut Creek
South Walnut Creek
Dry Creek
Lobelia
Grape Draw
Gentian Draw
Pond A-1
Pond A-2
Pond A-3
Pond A-4
A-4 Spillway
A-1 Bypass Pipeline
Pond B-1
Pond B-2
Pond B-3
Pond B-4
Pond B-5
B1 Bypass Pipeline
Central Avenue Ditch

132

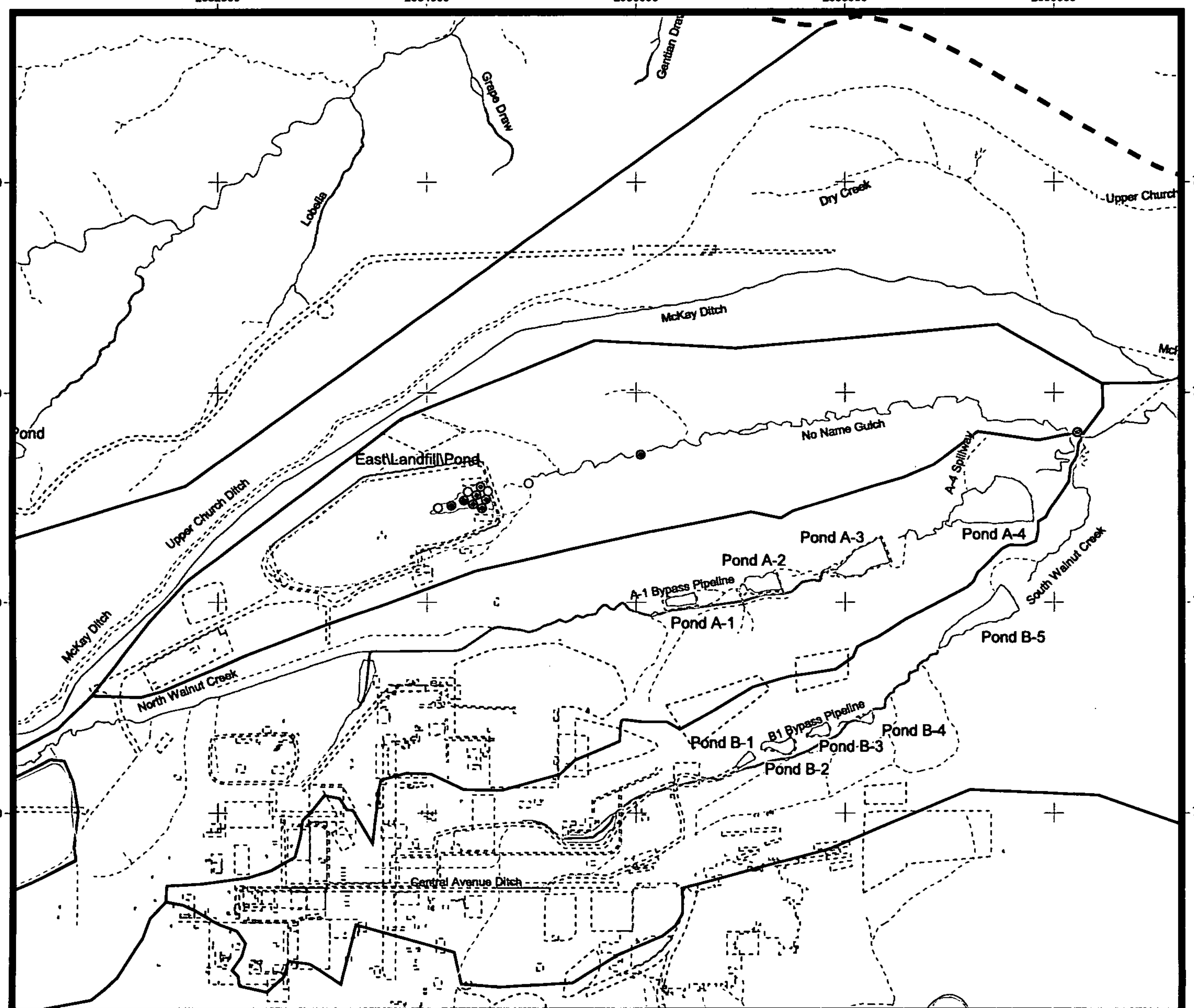

Figure 2.23
No Name Gulch AEU
Sediment Sampling Locations
for Chrysene

KEY

Sampling location

- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 166 ug/kg

Standard Map Features

- No Name Gulch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N
W E
S

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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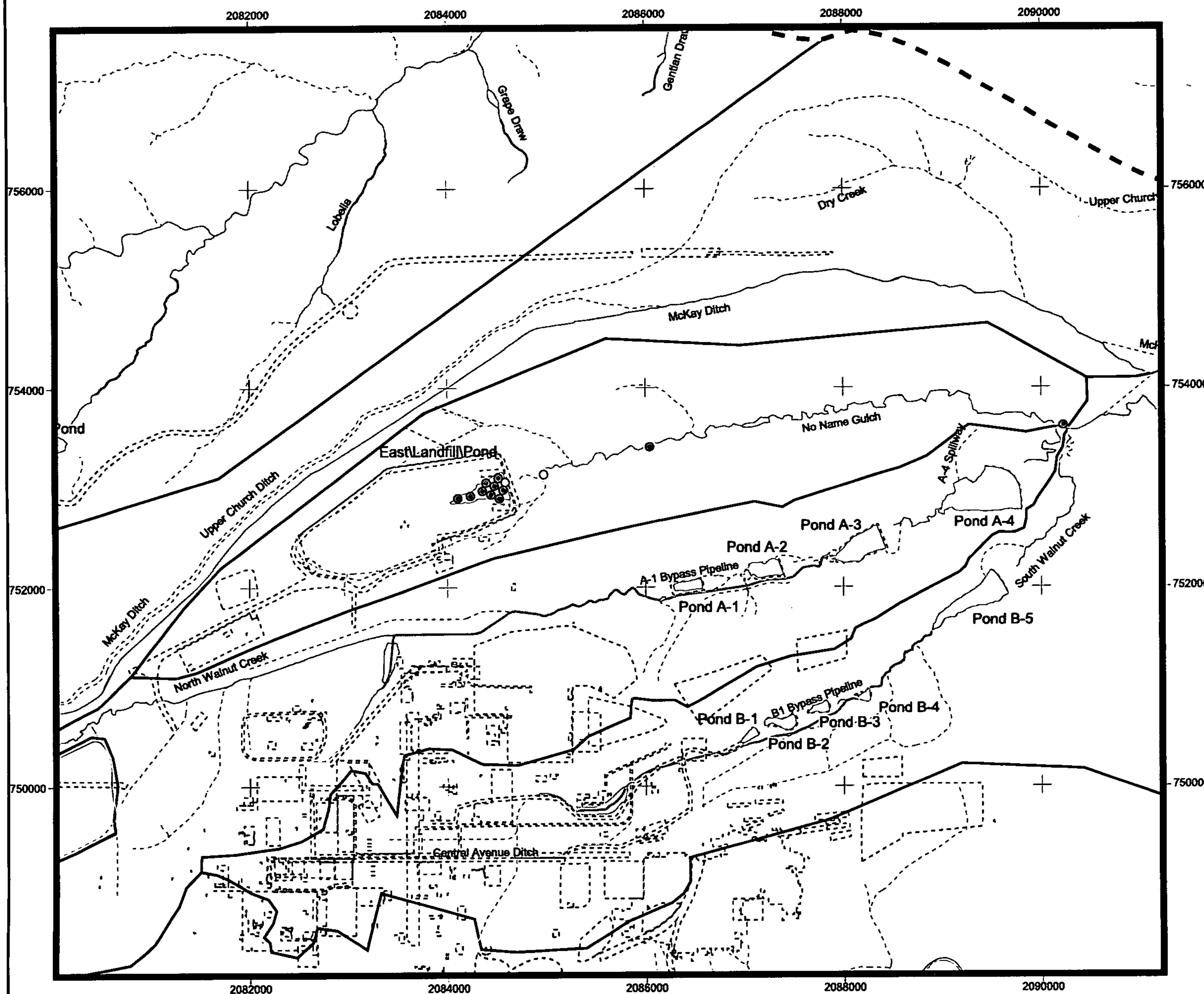
Figure 2.24
No Name Gulch AEU
Sediment Sampling Locations
for Indeno(1,2,3-cd)pyrene



KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 17 ug/kg

Standard Map Features
- No Name Gulch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N
W E
S

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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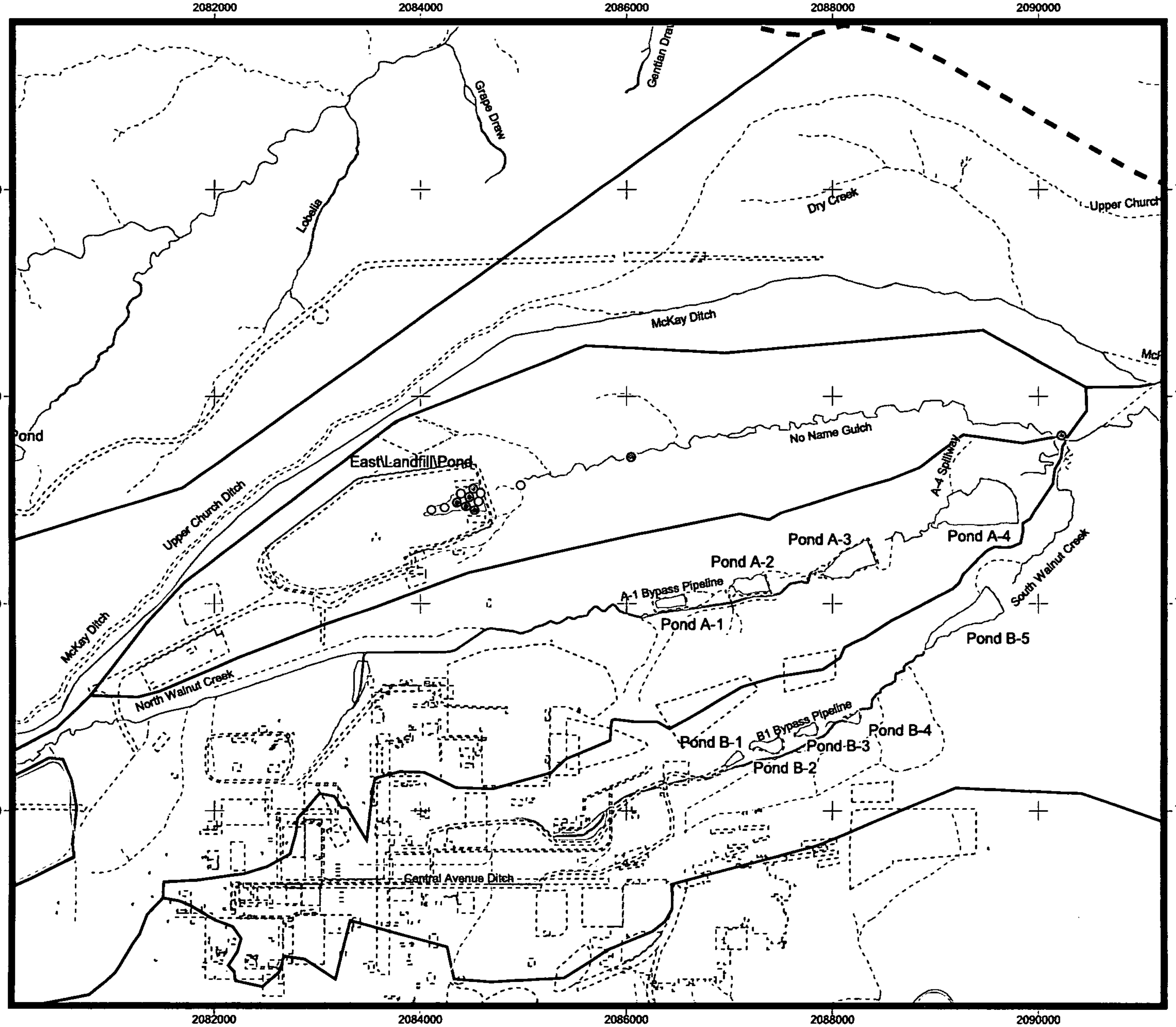

Figure 2.25
No Name Gulch AEU
Sediment Sampling Locations
for Phenanthrene

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 204 ug/kg

Standard Map Features
- No Name Gulch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Technology Site

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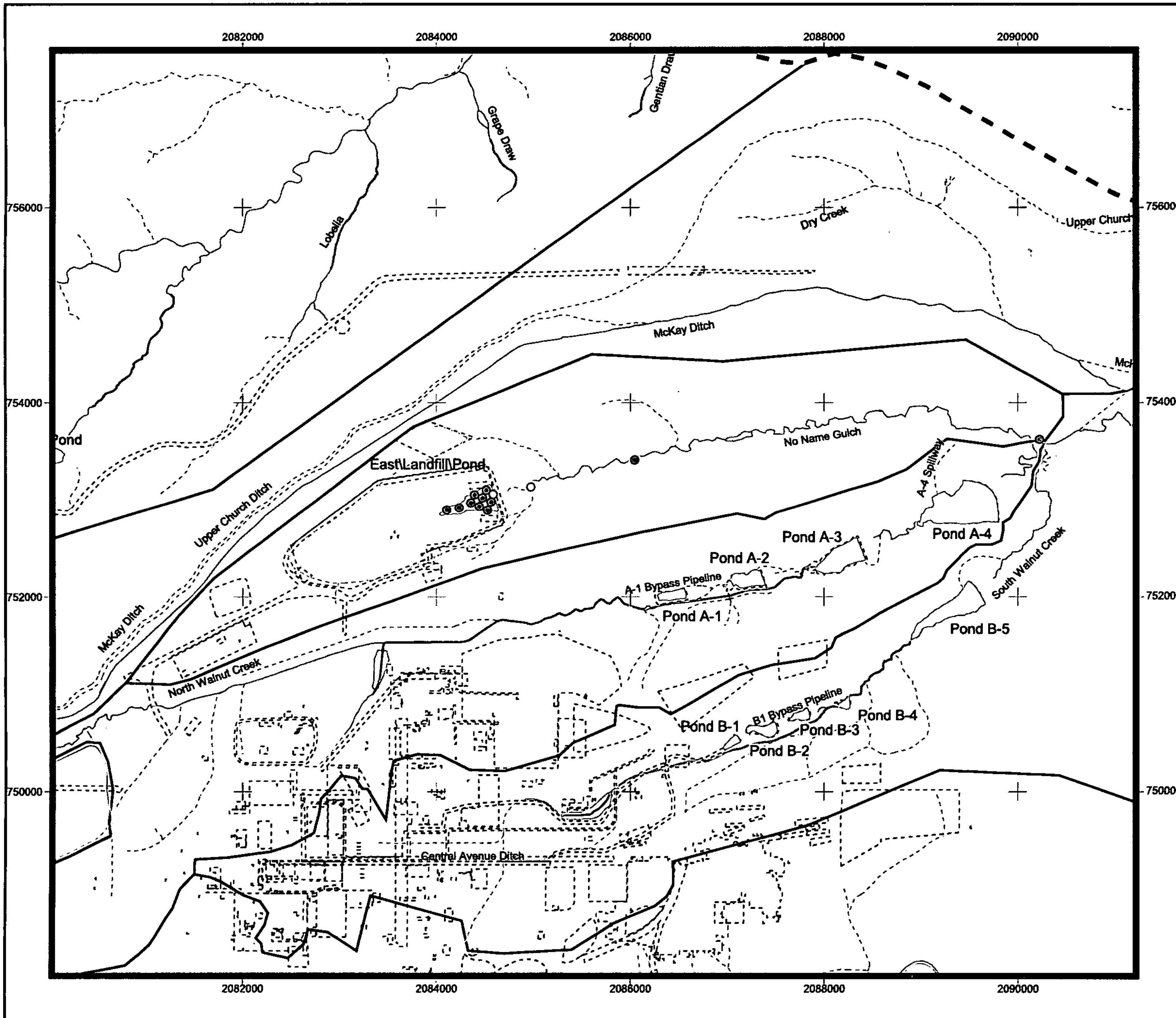

Figure 2.26
No Name Gulch AEU
Sediment Sampling Locations
for Pyrene

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 195 ug/kg

Standard Map Features
- No Name Gulch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:18000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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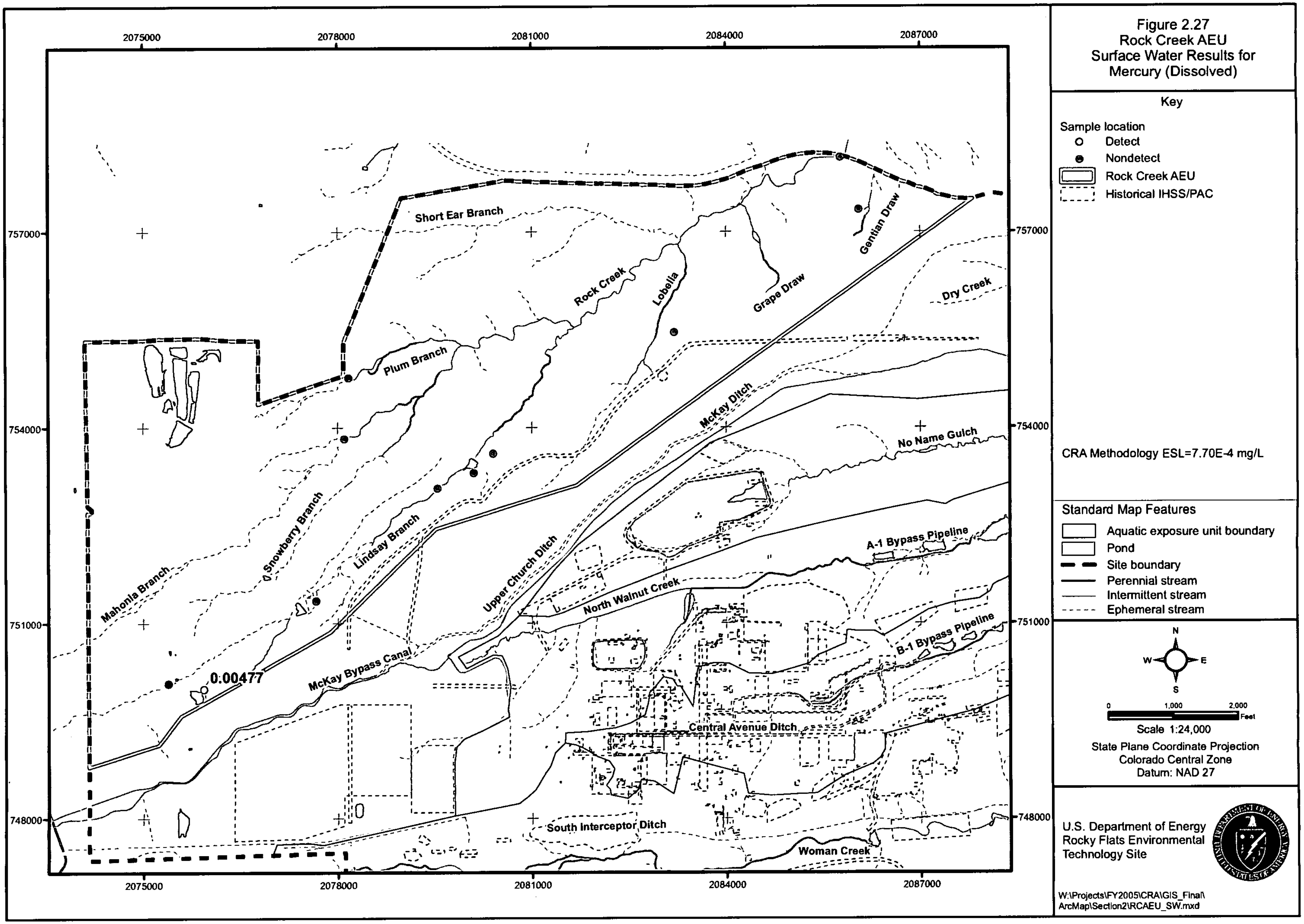

Figure 2.27
Rock Creek AEU
Surface Water Results for
Mercury (Dissolved)

137

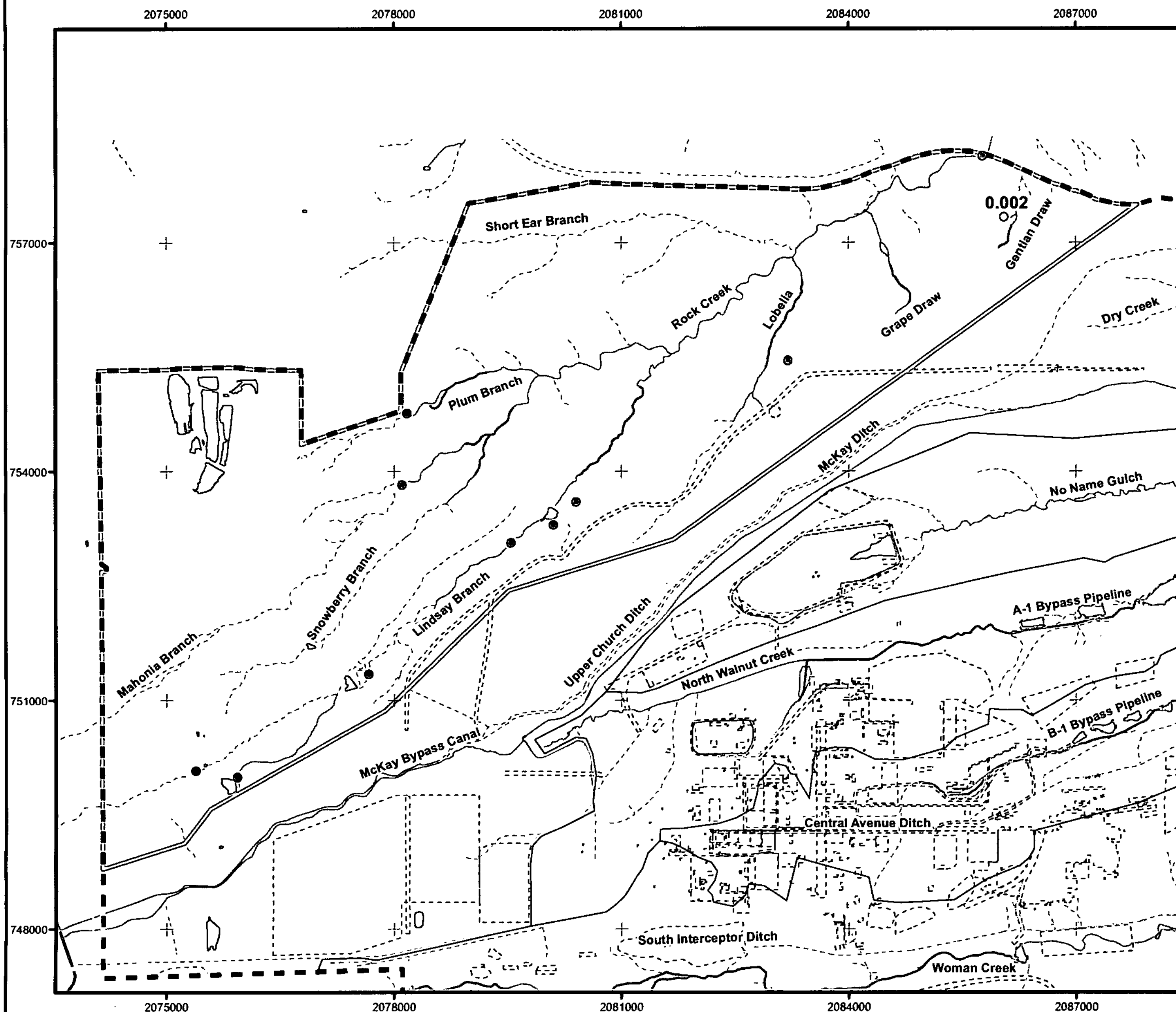

Figure 2.28
Rock Creek AEU
Surface Water Results for
Silver (Dissolved)

Key

Sample location
- Detect
- Nondetect
- Rock Creek AEU
- Historical IHSS/PAC

CRA Methodology ESL=3.20E-4 mg/L

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

N W E S

0 1,000 2,000 Feet

Scale 1:24,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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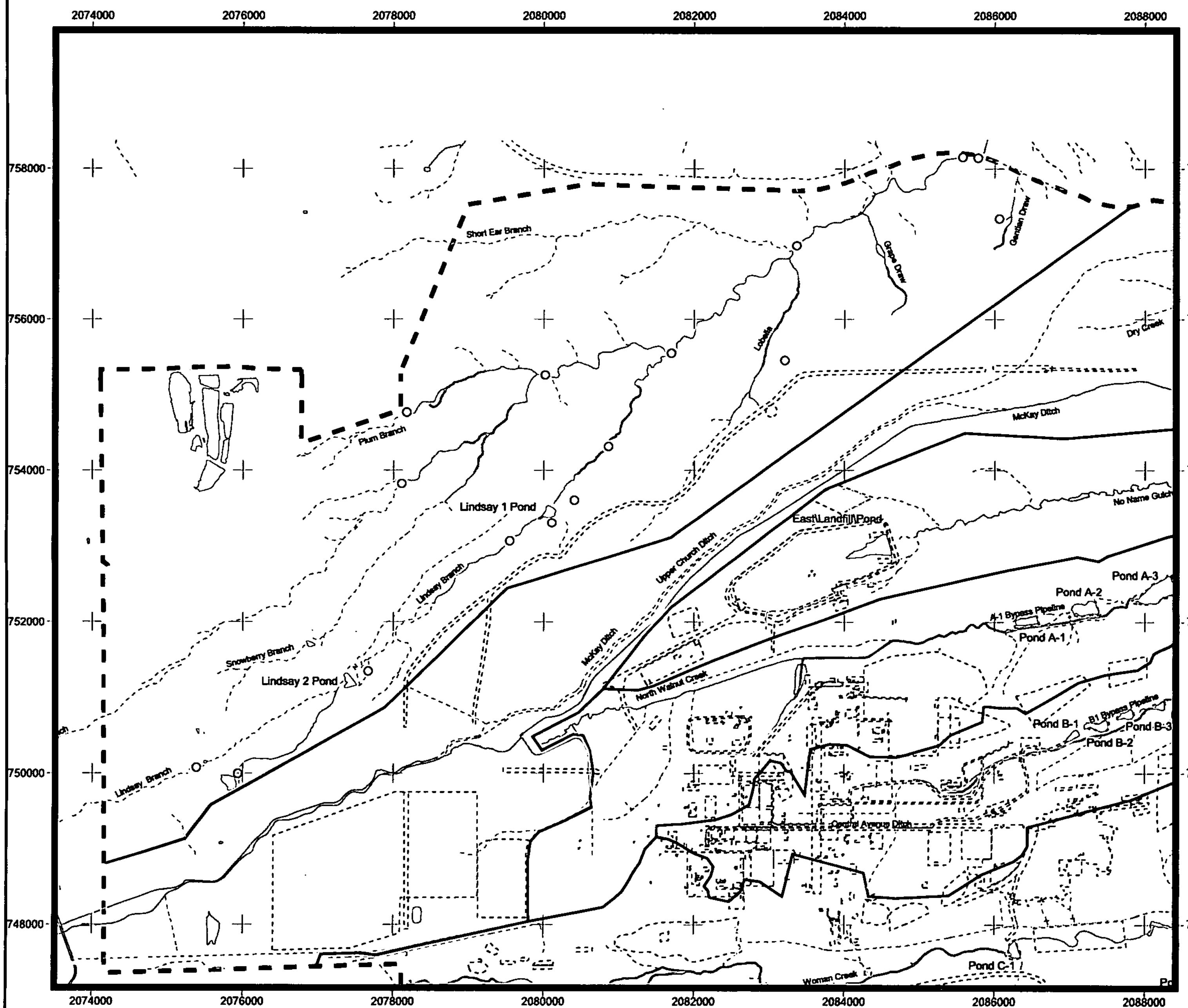

Figure 2.29
Rock Creek AEU
Surface Water Sampling Locations
for Barium (Total)

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 0.438 mg/L

Standard Map Features
- Rock Creek AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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File: W:\Projects\Fy2004\CRA\Volume_15\GIS\RISK_Maps\Final-Risk-Maps.apr

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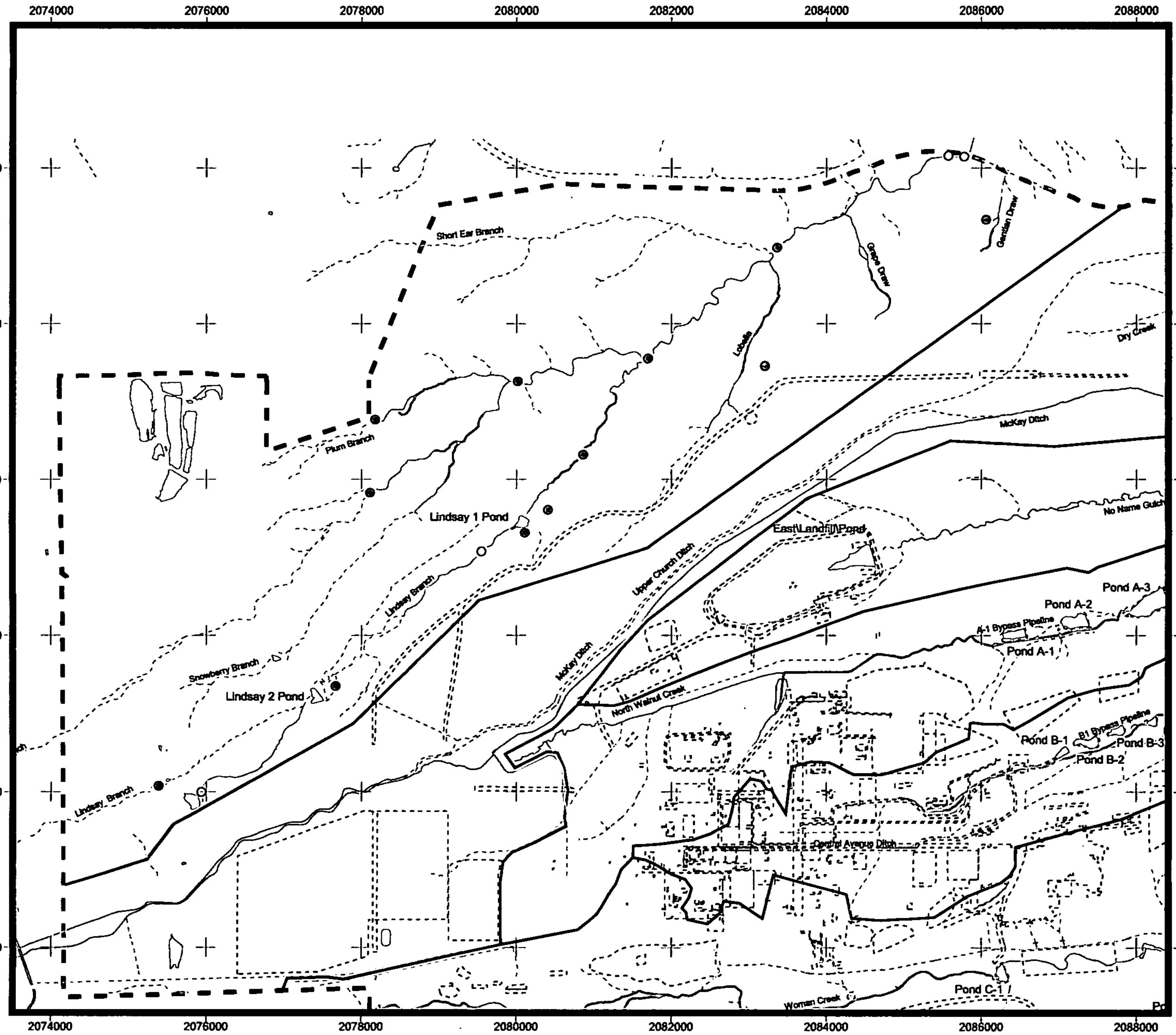

Figure 2.30
Rock Creek AEU
Surface Water Sampling Locations
for Beryllium (Total)

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 0.0024 mg/L

Standard Map Features
- Rock Creek AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

0 1000 2000 Feet

Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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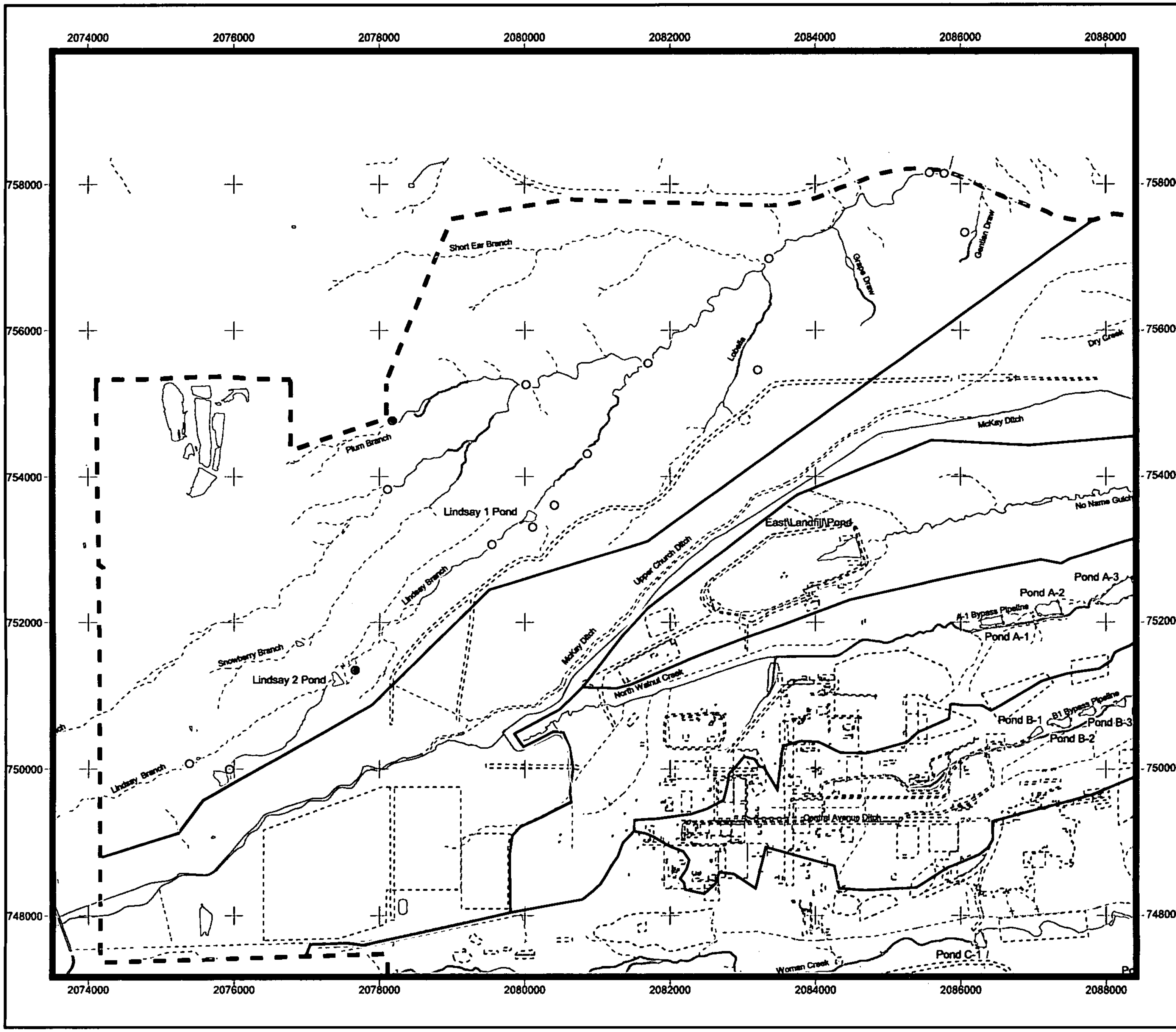

Figure 2.31
Rock Creek AEU
Surface Water Sampling Locations
for Lithium (Total)

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 0.096 mg/L

Standard Map Features
- Rock Creek AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N
W E
S

0 1000 2000 Feet

Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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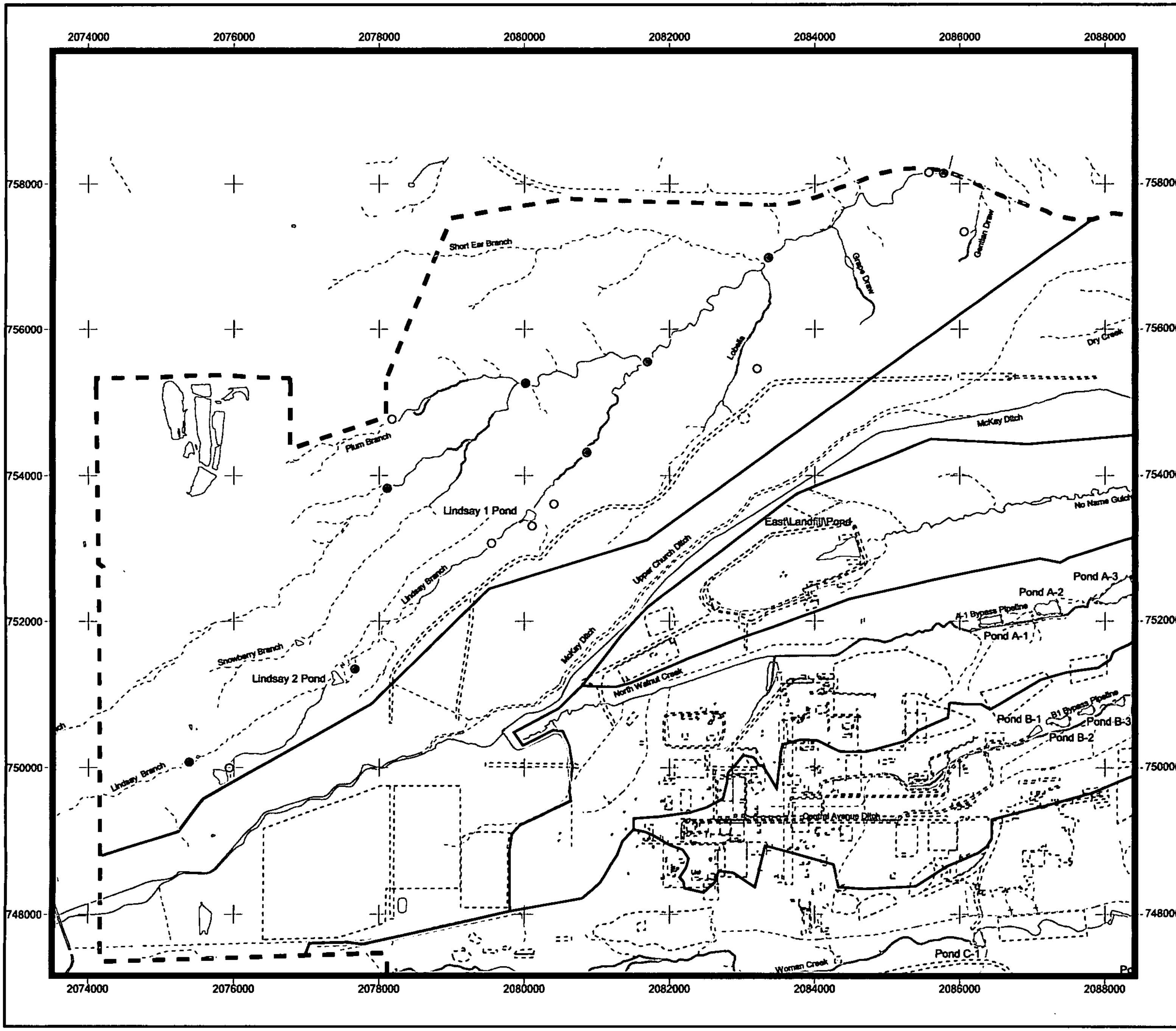
Figure 2.32
Rock Creek AEU
Surface Water Sampling Locations for Selenium (Total)



KEY

Sampling location

- ○ >= ESL
- ○ < ESL
- ● Nondetect

CRA Methodology ESL = 0.0046 mg/L

Standard Map Features

- Rock Creek AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N
W E
S

0 1000 2000 Feet

Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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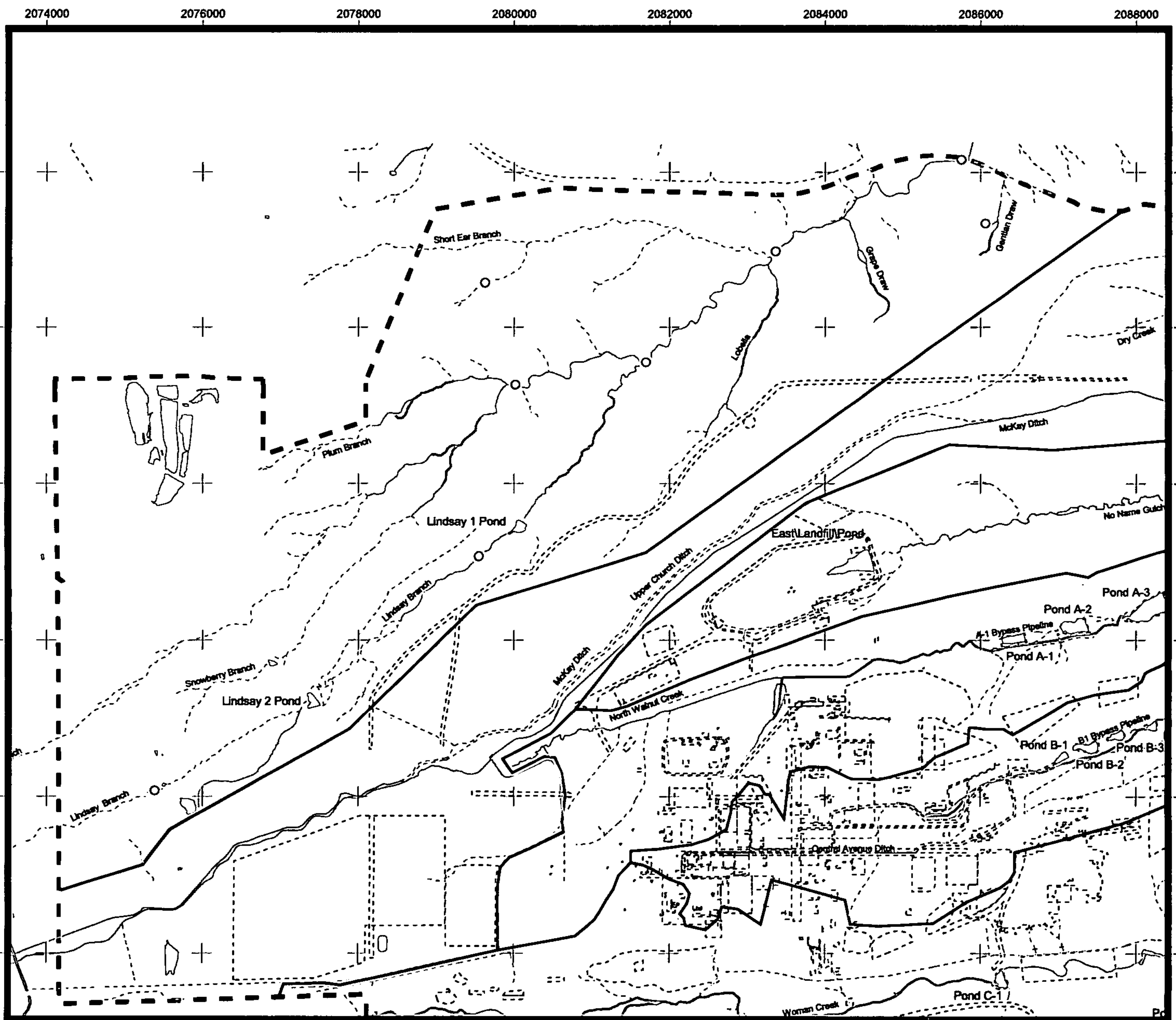

Figure 2.33
Rock Creek AEU
Sediment Sampling Locations
for Nickel

KEY

Sampling location
>= ESL
< ESL
Nondetect

CRA Methodology ESL = 22.7 mg/kg

Standard Map Features
Rock Creek AEU
Aquatic Exposure Unit boundary
Historical IHSS/PAC
Pond
Perennial stream
Intermittent stream
Ephemeral stream
Site boundary

N
W E
S

0 1000 2000 Feet

Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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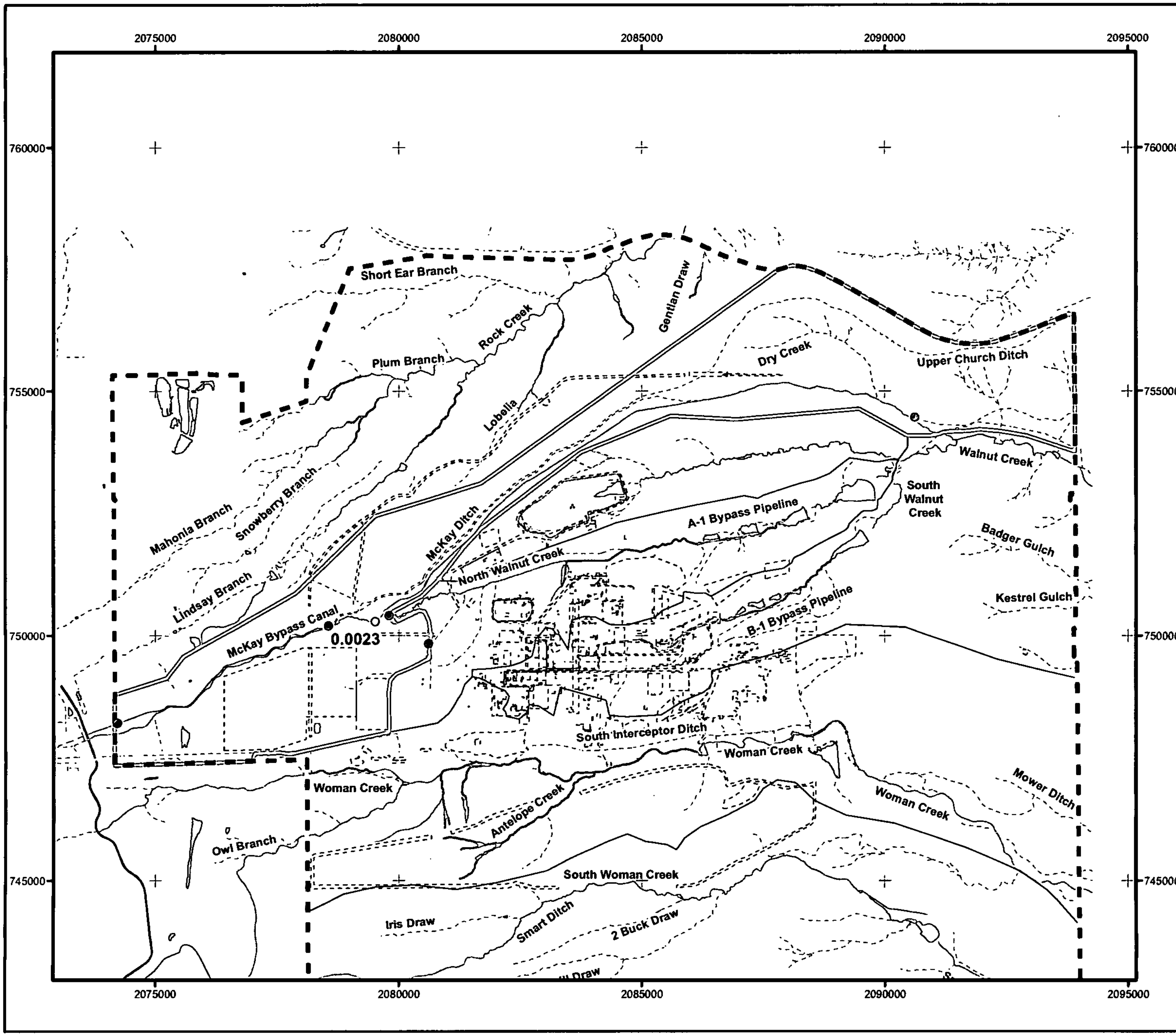

Figure 2.34
McKay Ditch AEU
Surface Water Results for
Silver (Dissolved)

Key

Sample location
- Detect
- Nondetect
- McKay Ditch AEU
- Historical IHSS/PAC

CRA Methodology ESL=3.20E-4 mg/L

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

N
W E
S

0 1,500 3,000 Feet
Scale 1:36,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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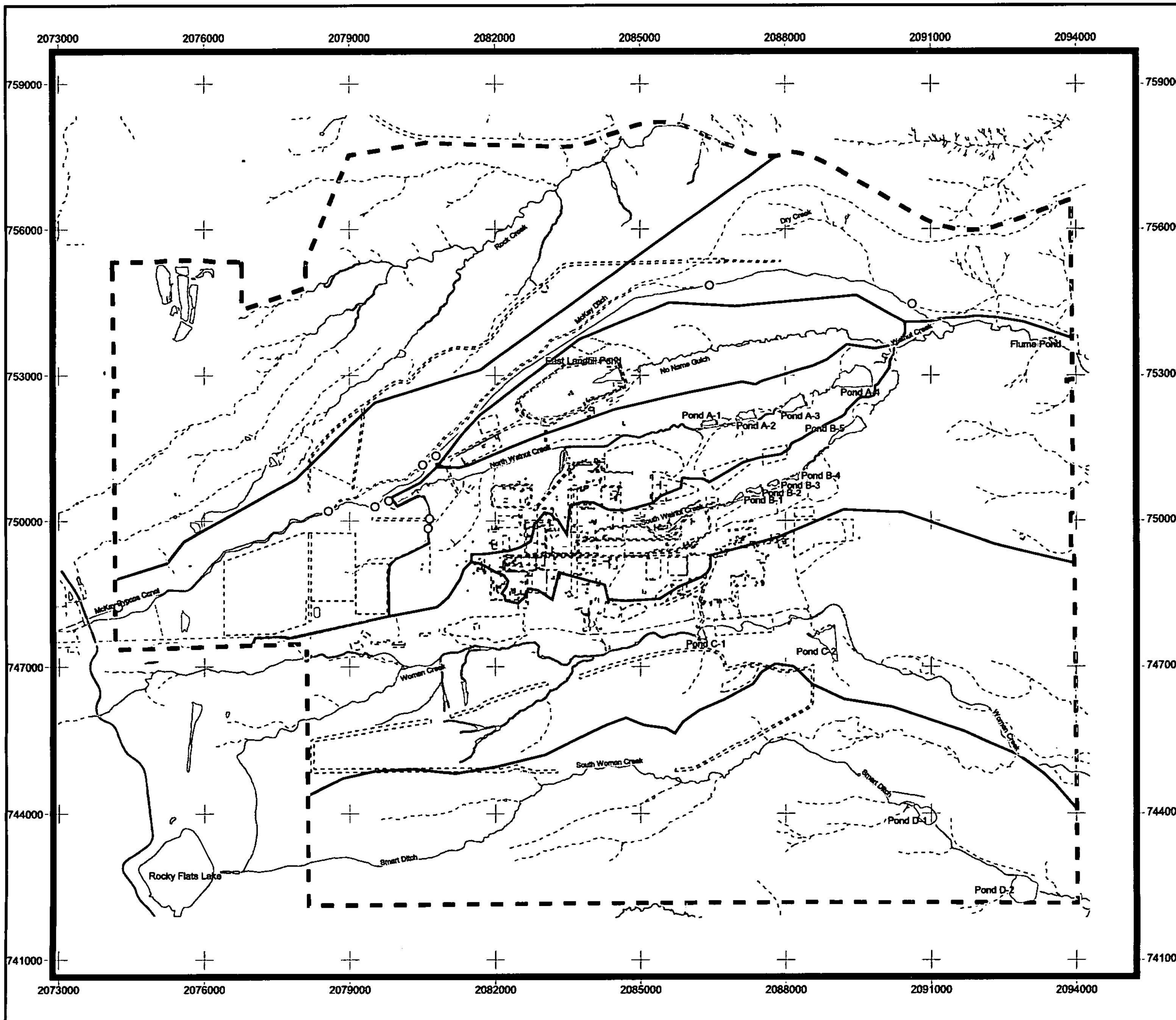
Figure 2.35
McKay Ditch AEU
Surface Water Sampling Locations for Aluminum (Total)



KEY

Sampling location

- O >= ESL
- O < ESL
- ◎ Nondetect

Site-wide ESL = 0.75 mg/L

Standard Map Features

- McKay Ditch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:36000

State Plane Coordinate Projection
Colorado Central Zone
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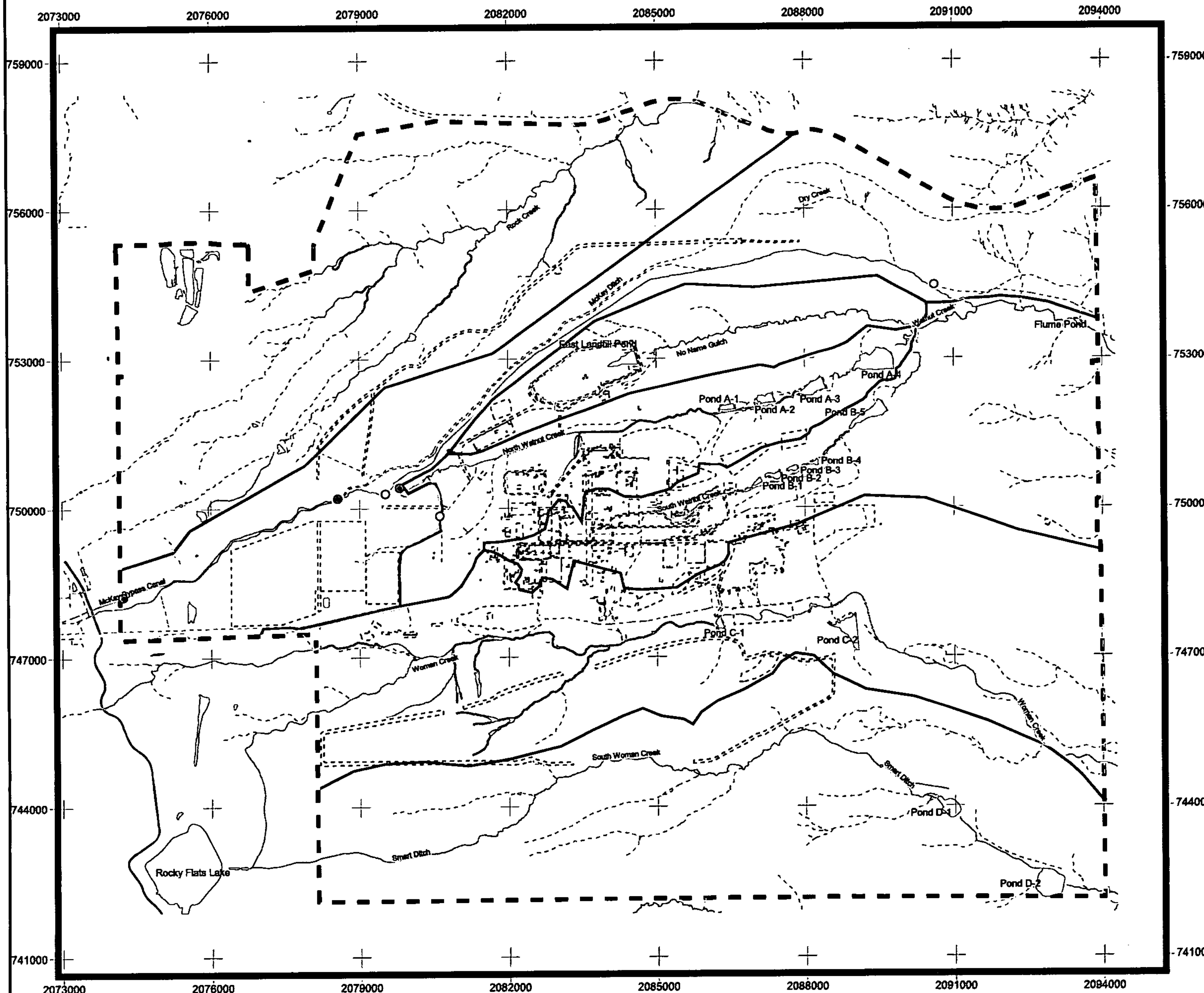
Figure 2.36
McKay Ditch AEU
Surface Water Sampling Locations for Cadmium (Dissolved)



KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

Site-wide ESL = 0.0037 mg/L

Standard Map Features
- McKay Ditch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:36000

State Plane Coordinate Projection
Colorado Central Zone
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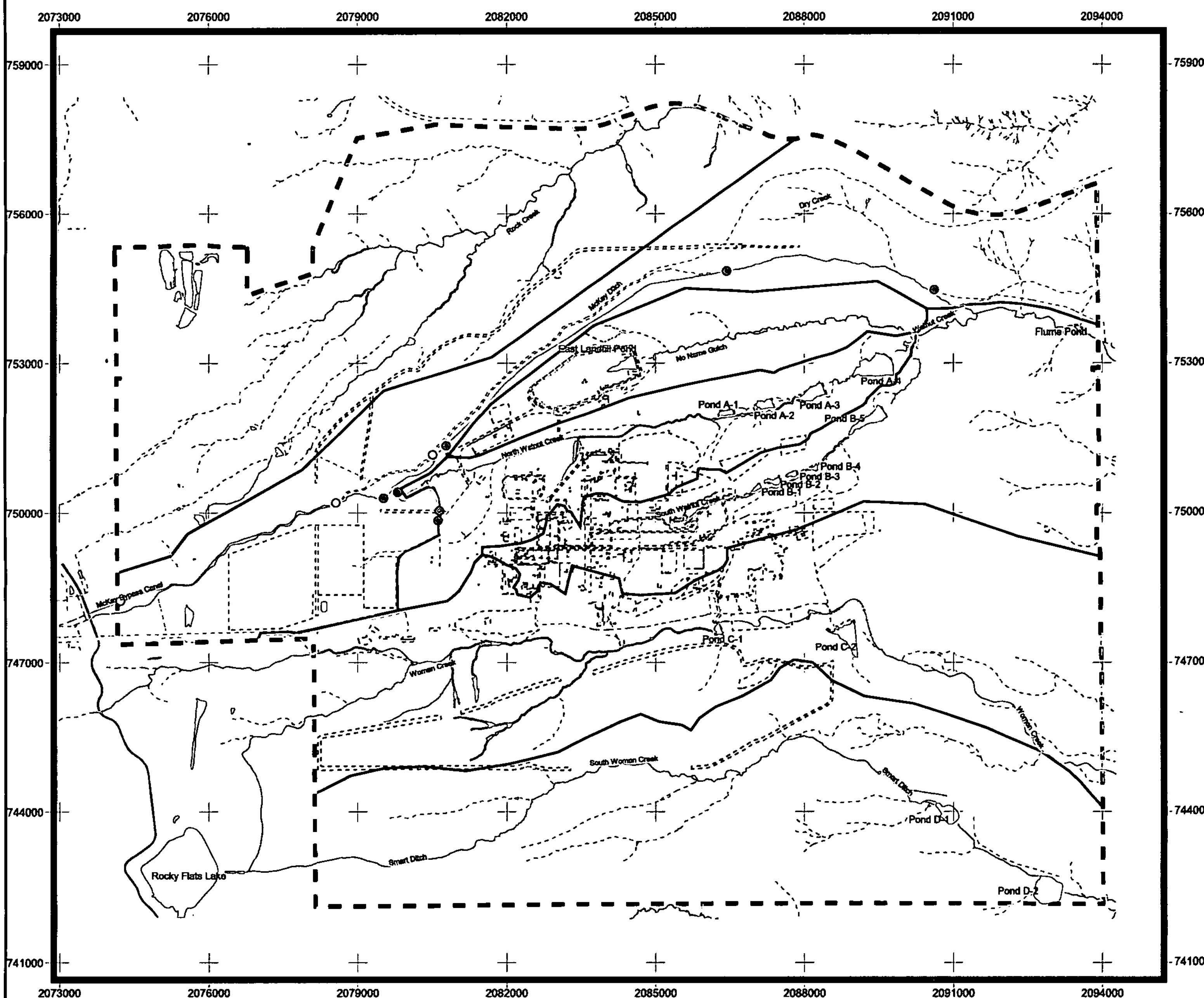

Figure 2.37
McKay Ditch AEU
Surface Water Sampling Locations for Selenium (Total)

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 0.0046 mg/L

Standard Map Features
- McKay Ditch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N
W
E
S

0 1000 2000 Feet

Scale 1:36000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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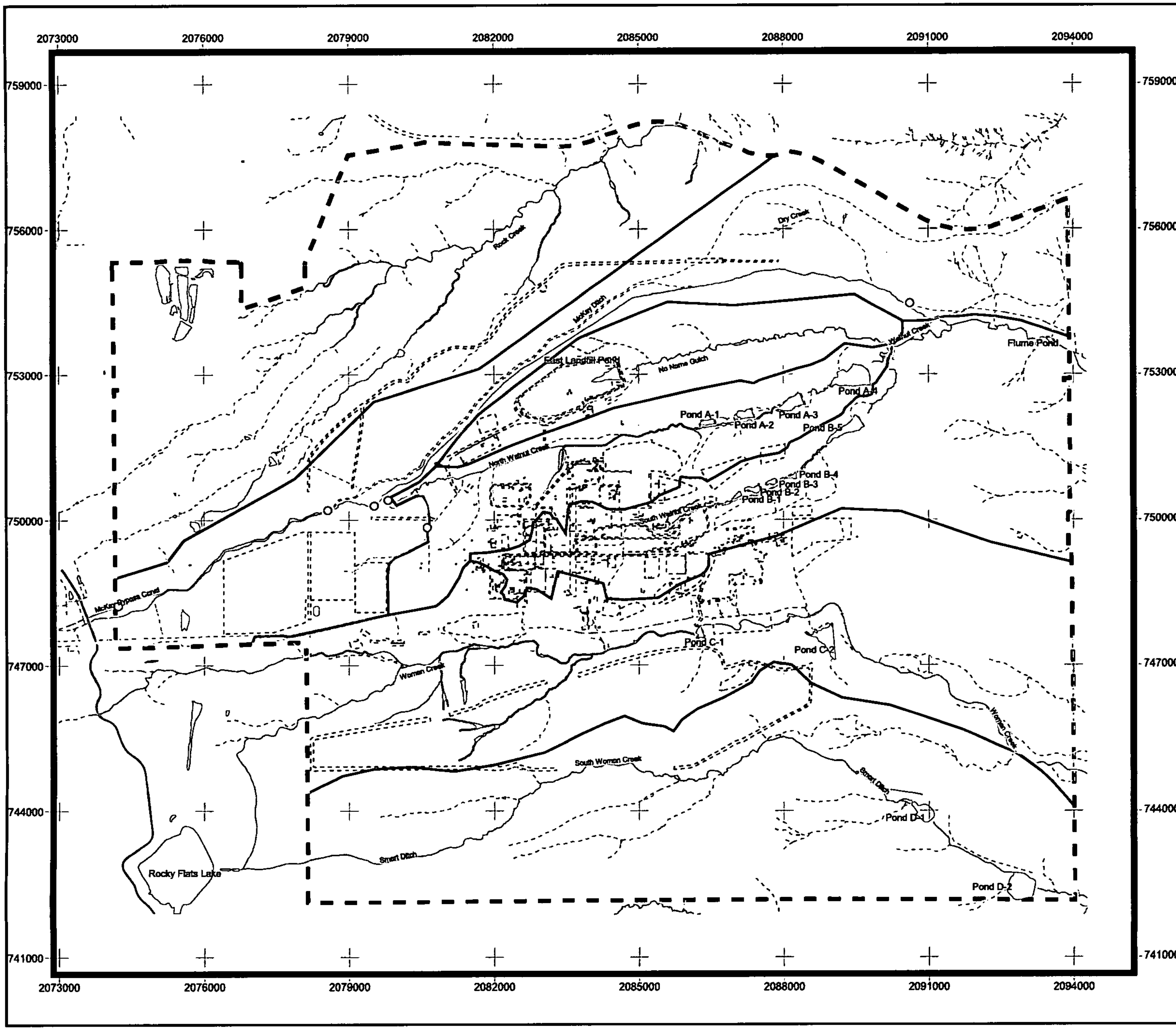

Figure 2.38
McKay Ditch AEU Surface Water Sampling Locations for Zinc (Dissolved)

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

Site-wide ESL = 0.211 mg/L

Standard Map Features
- McKay Ditch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N
W E
S

0 1000 2000 Feet

Scale 1:36000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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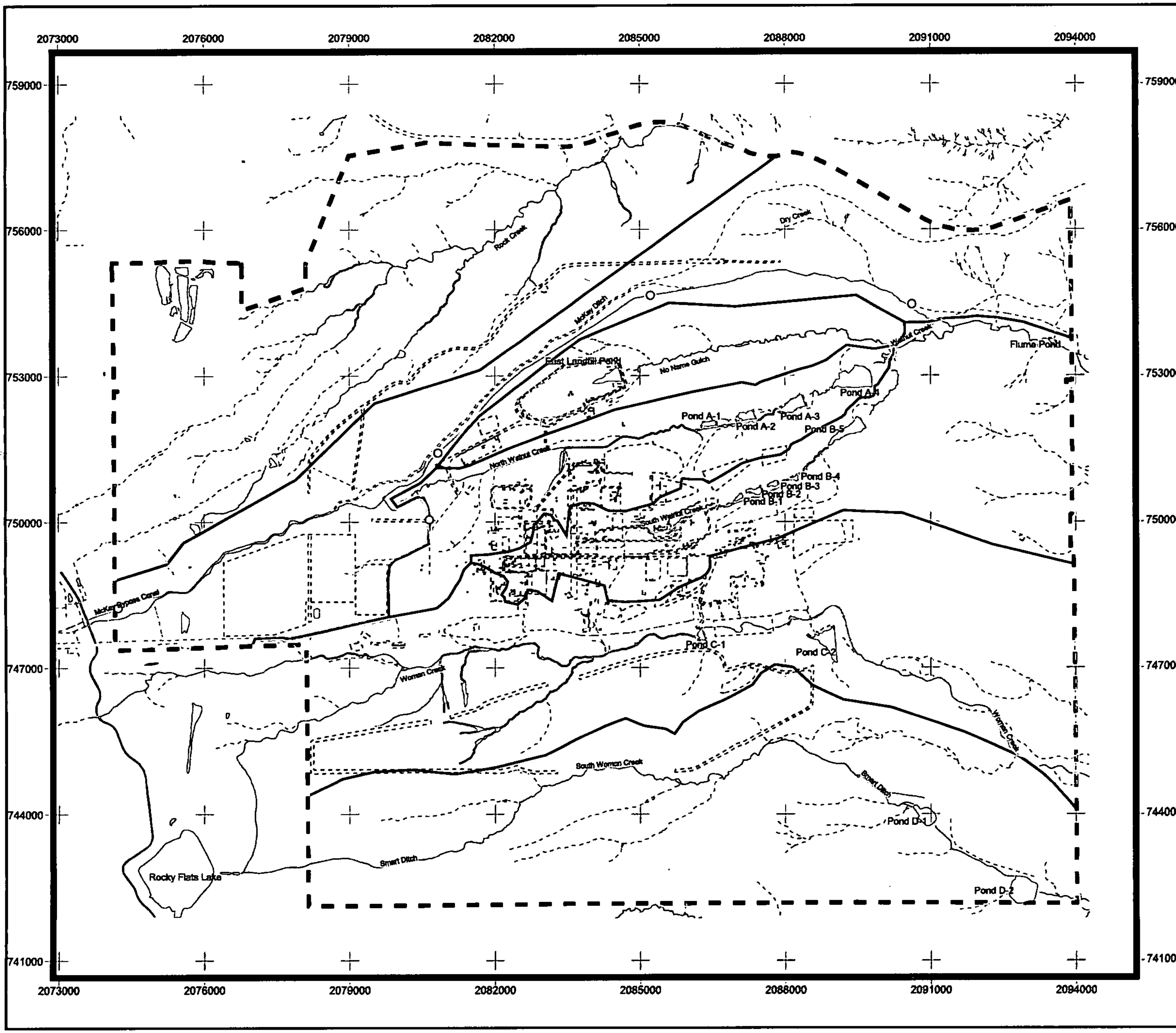

Figure 2.39
McKay Ditch AEU
Sediment Sampling Locations
for Aluminum

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 15900 mg/kg

Standard Map Features
- McKay Ditch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:36000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

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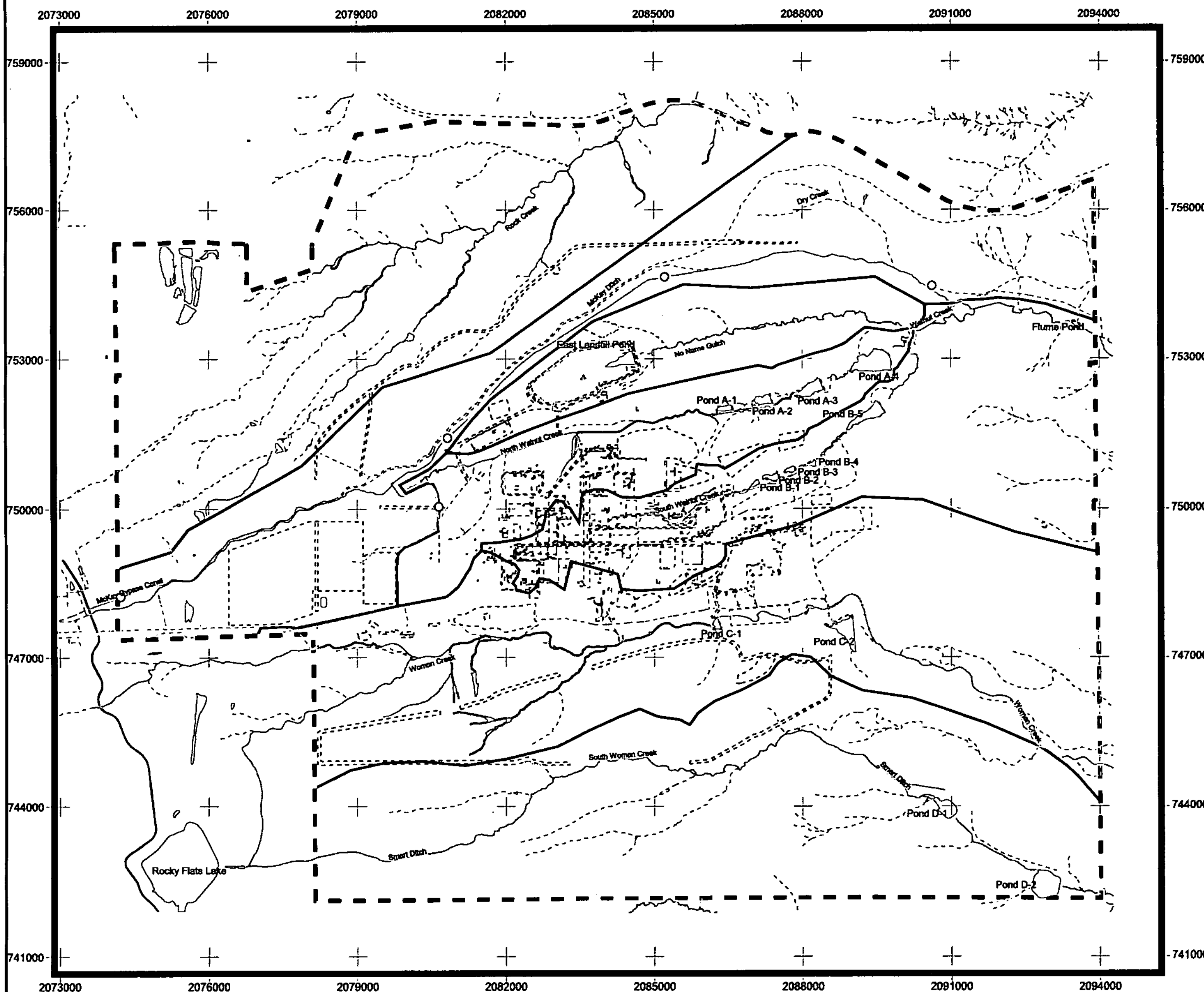

Figure 2.40
McKay Ditch AEU
Sediment Sampling Locations for Chromium

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 43.4 mg/kg

Standard Map Features
- McKay Ditch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:36000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

File: W:\Projects\Fy2004\CRA\Volume_15\GIS\RISK_Maps\Final-Risk-Maps.apr

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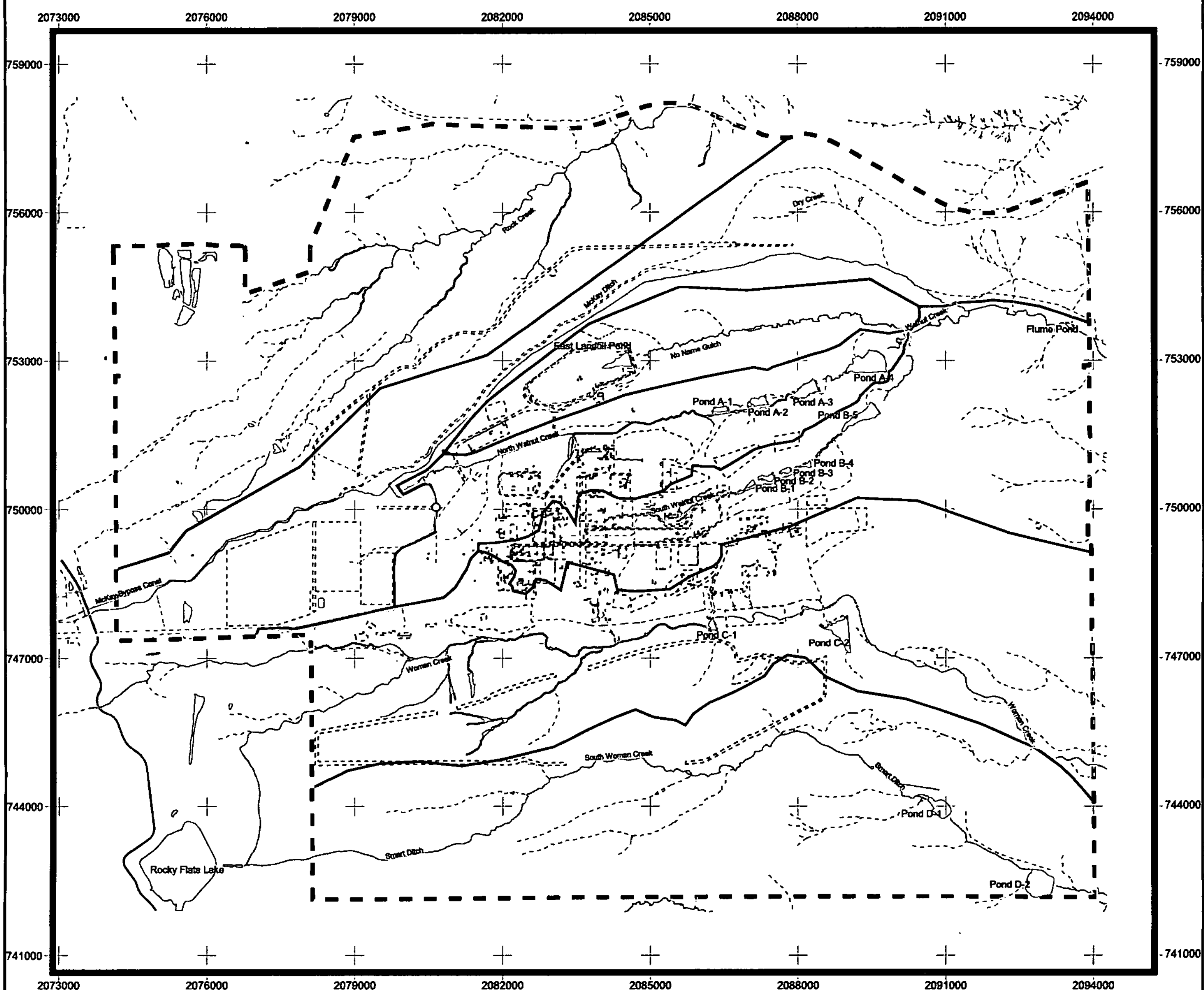

Figure 2.41
McKay Ditch AEU
Sediment Sampling Locations for Fluoride

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 0.01 mg/kg

Standard Map Features
- McKay Ditch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N
W
E
S

0 1000 2000 Feet

Scale 1:36000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

File: W:\Projects\Fy2004\CRA\Volume_15\GIS\RISK_Maps\Final-Risk-Maps.apr

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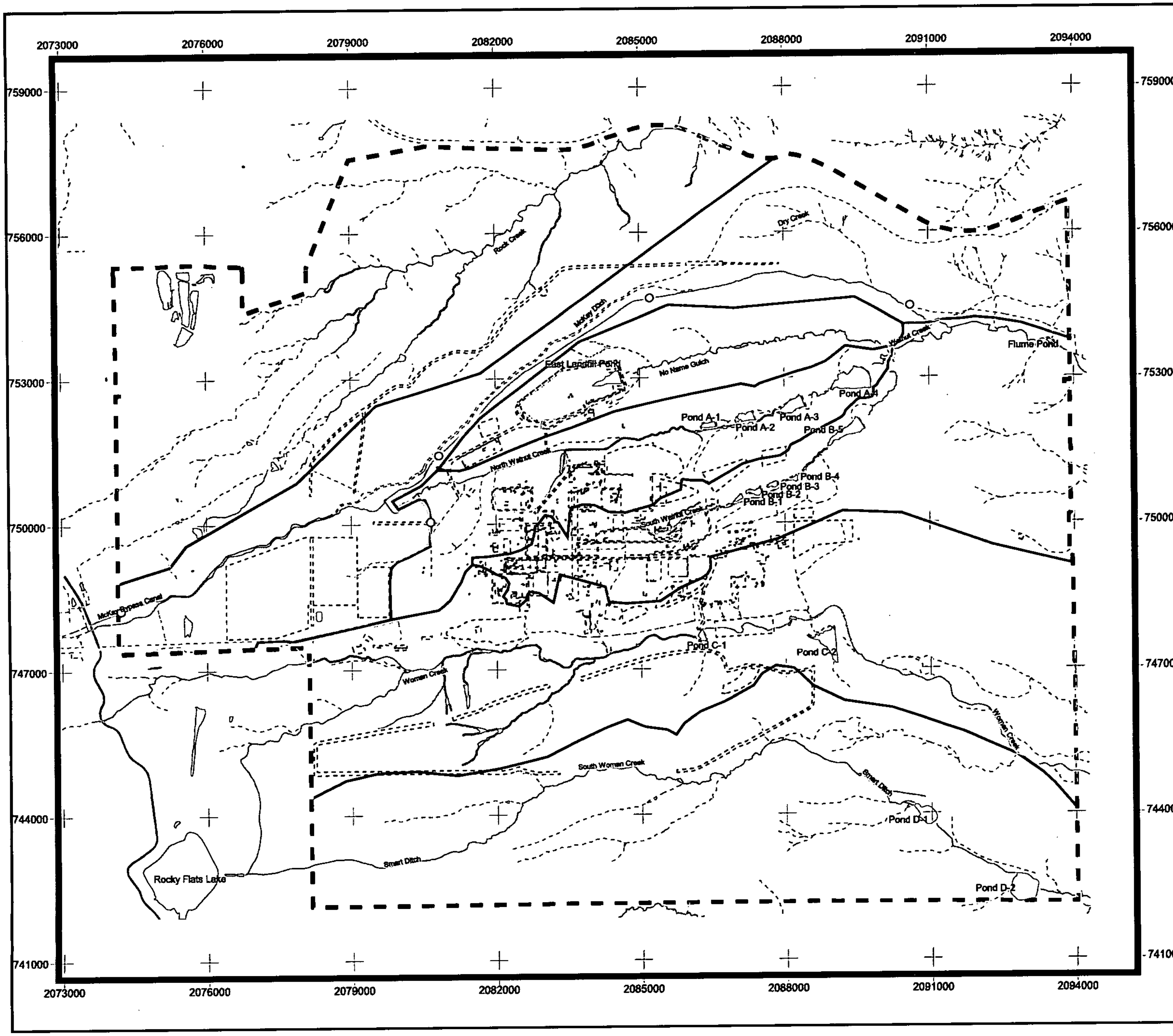

Figure 2.42
McKay Ditch AEU
Sediment Sampling Locations
for Nickel

KEY

Sampling location
- >= ESL
- < ESL
- Nondetect

CRA Methodology ESL = 22.7 mg/kg

Standard Map Features
- McKay Ditch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:36000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Rocky Flats Environmental
Technology Site

File: W:\Projects\Fy2004\CRA\Volume_15\GIS\RISK_Maps\Final-Risk-Maps.apr

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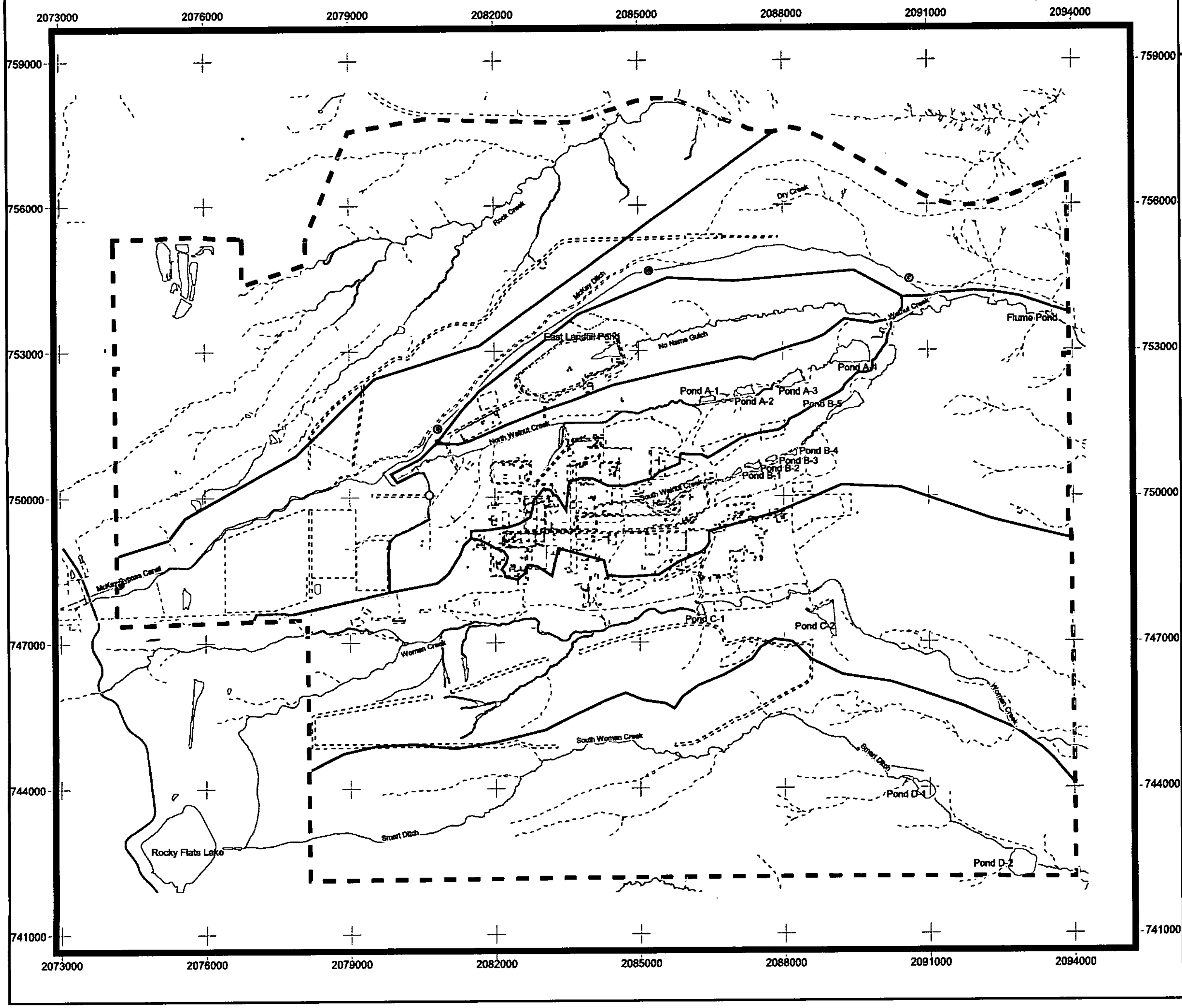

Figure 2.43
McKay Ditch AEU
Sediment Sampling Locations for Selenium

KEY

Sampling location

- O >= ESL
- O < ESL
- Nondetect

CRA Methodology ESL = 0.95 mg/kg

Standard Map Features

- McKay Ditch AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N
W E
S

0 1000 2000 Feet

Scale 1:36000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

File: W:\Projects\Fy2004\CRA\Volume_15\GIS\RISK_Maps\Final-Risk-Maps.apr

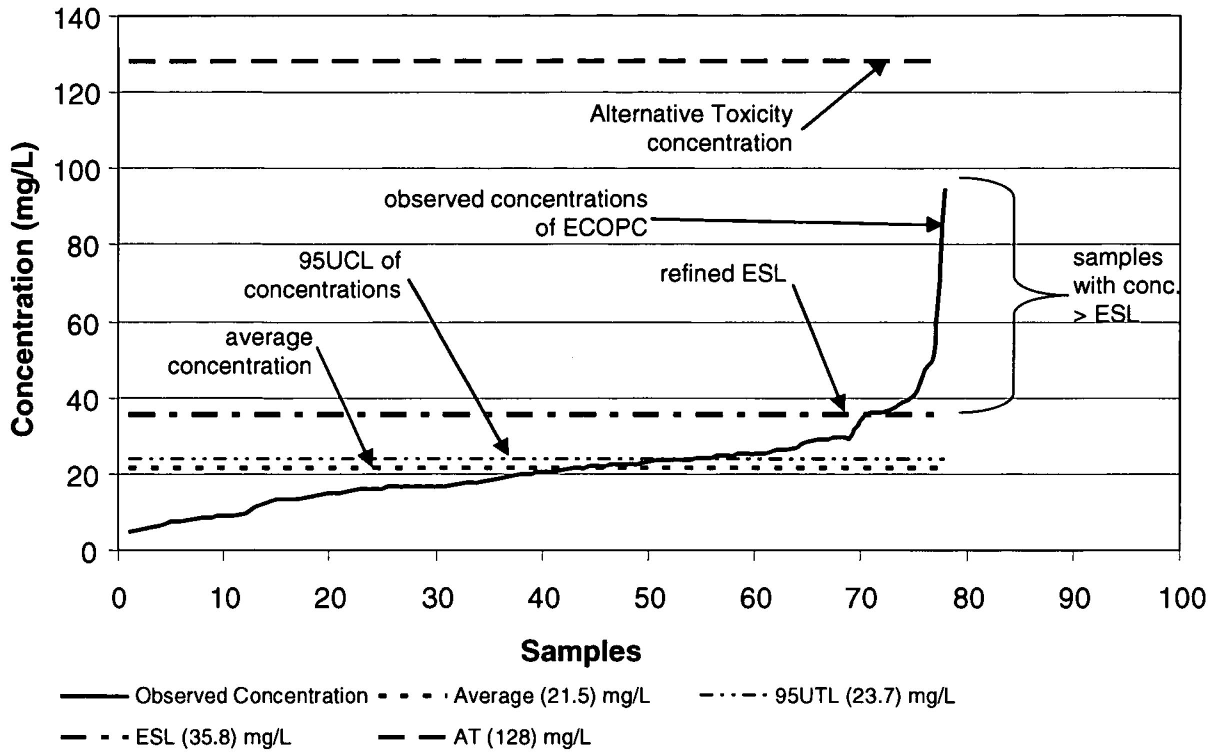

Figure 5.1 Example Data Distribution Curve (Lead in Surface Water)

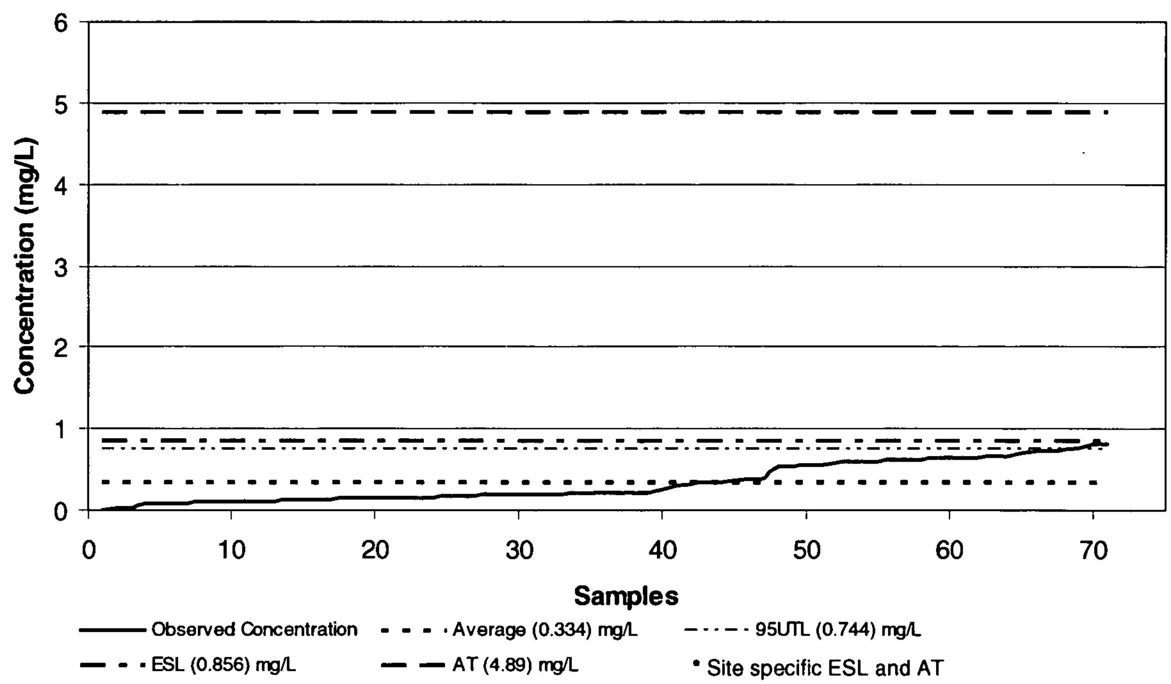

Figure 5.2 Data Distribution for Barium (Total) in NN AEU Surface Water

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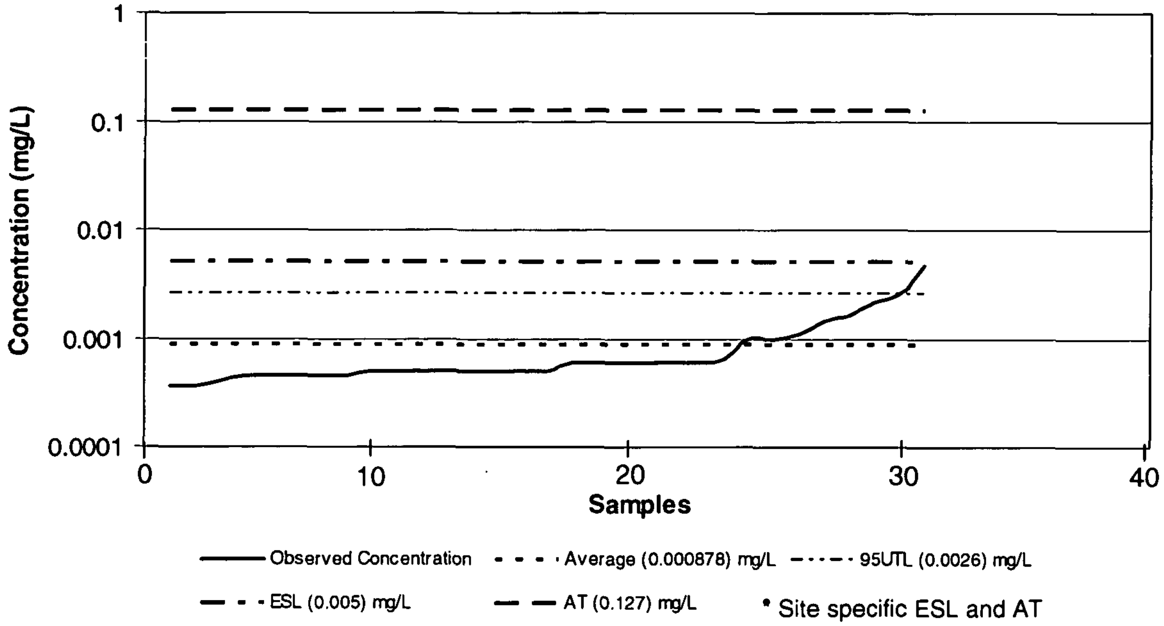

Figure 5.3 Data Distribution for Lead (Dissolved) in NN AEU Surface Water

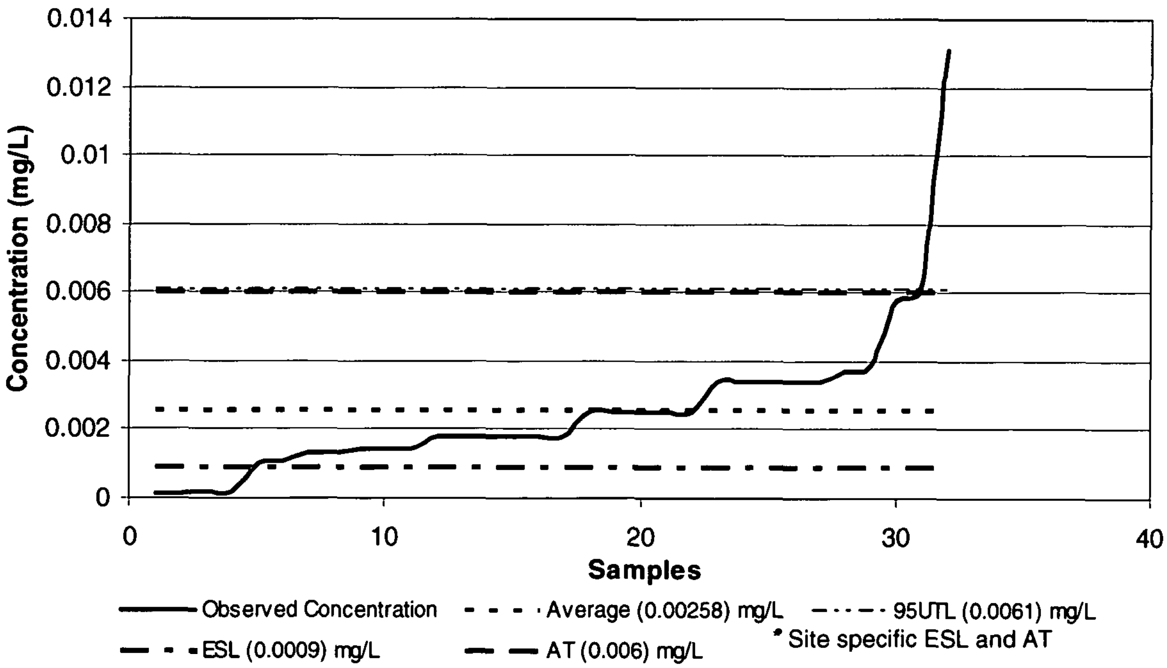

Figure 5.4 Data Distribution for Silver (Dissolved) in NN AEU Surface Water

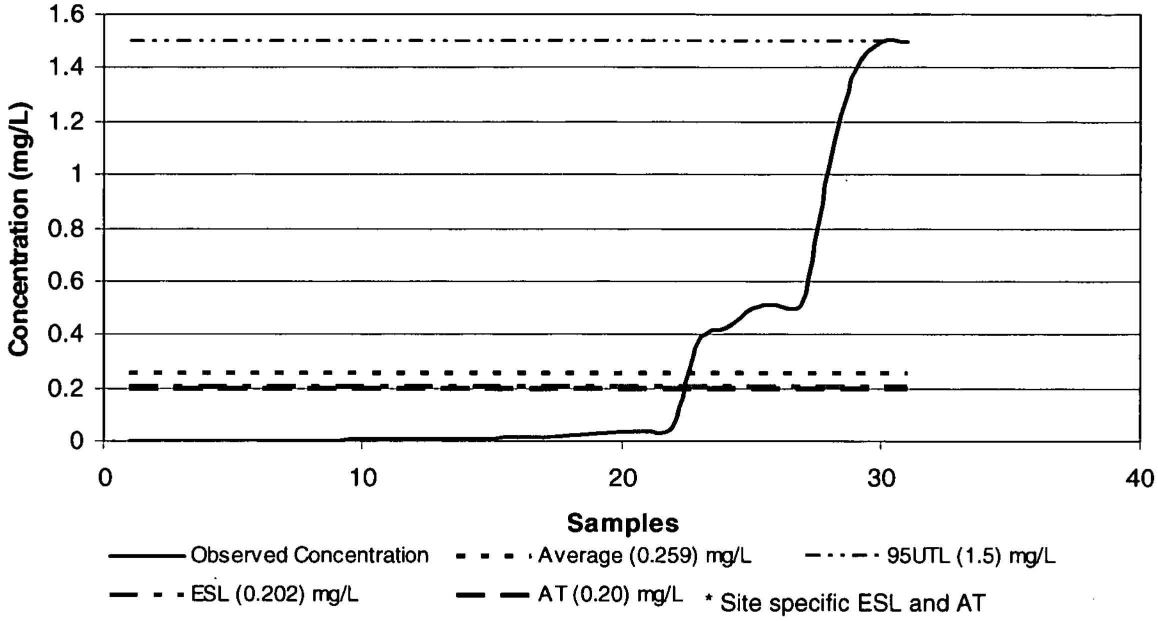

Figure 5.5 Data Distribution for Zinc (Dissolved) in NN AEU Surface Water

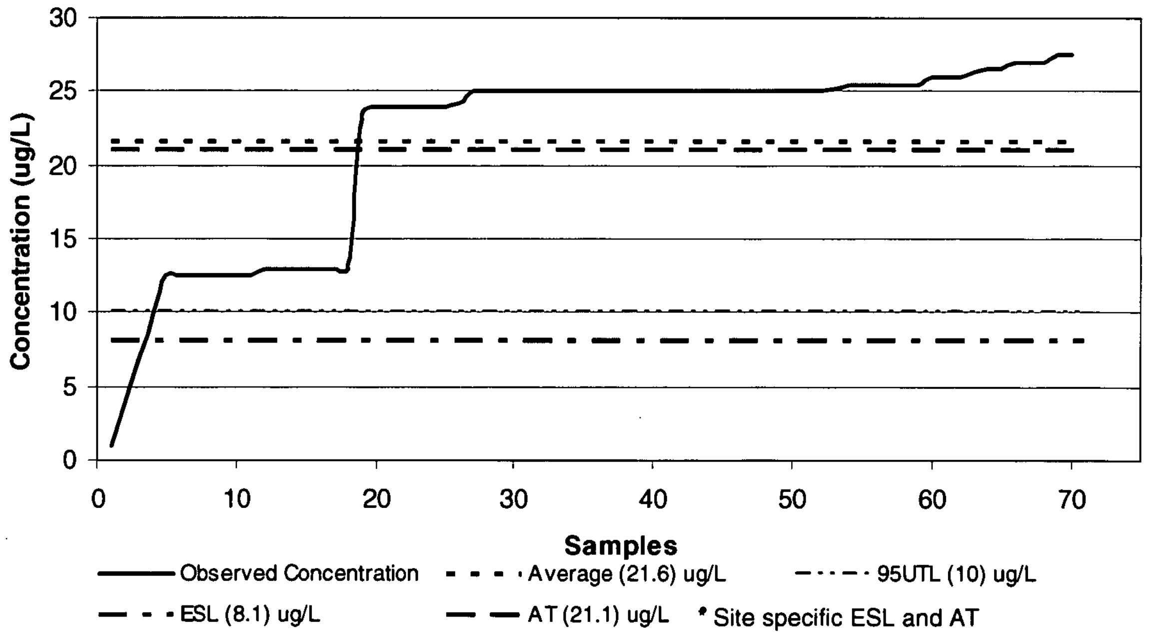

Figure 5.6 Data Distribution for Pentachlorophenol in NN AEU Surface Water

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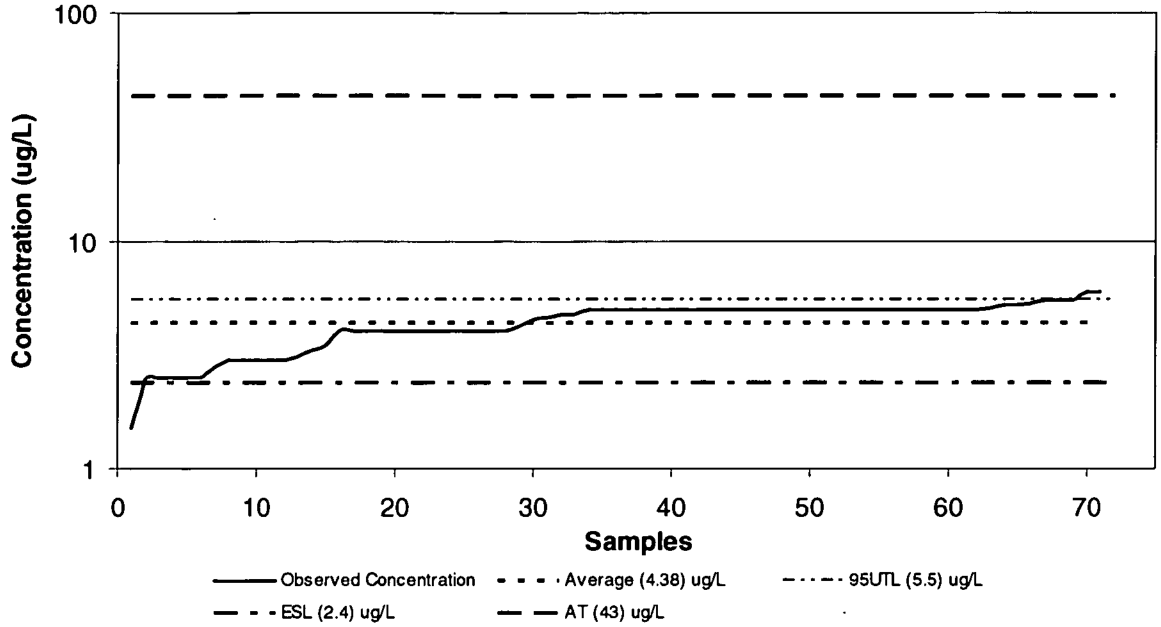

Figure 5.7 Data Distribution for Phenanthrene in NN AEU Surface Water

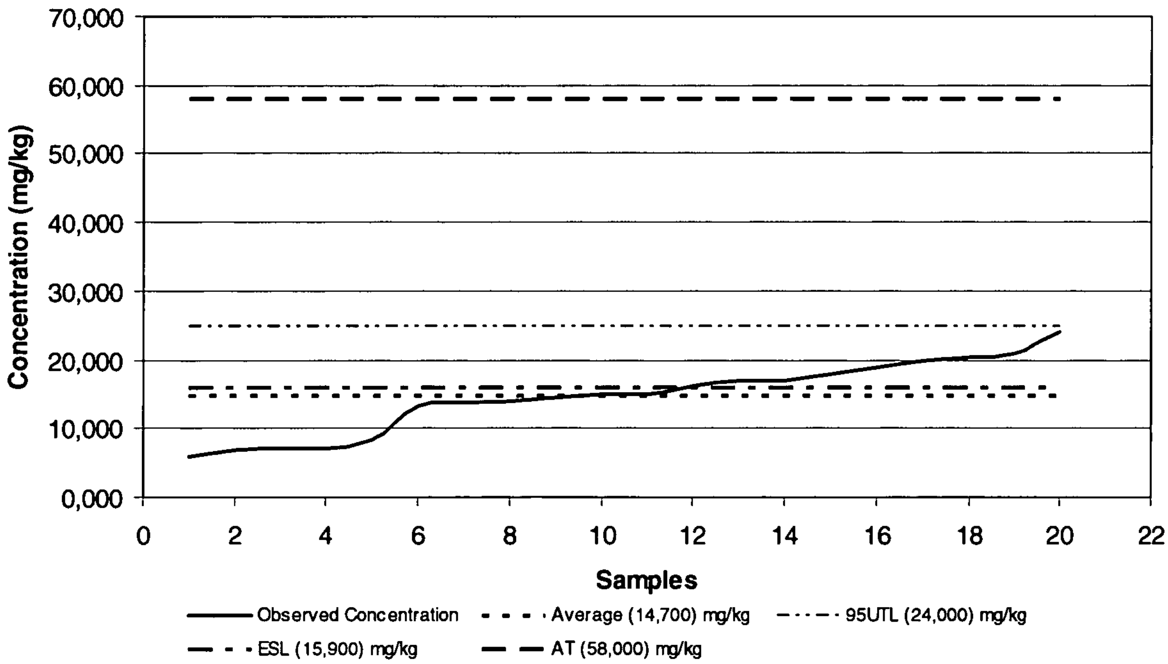

Figure 5.8 Data Distribution for Aluminum in NN AEU Sediment

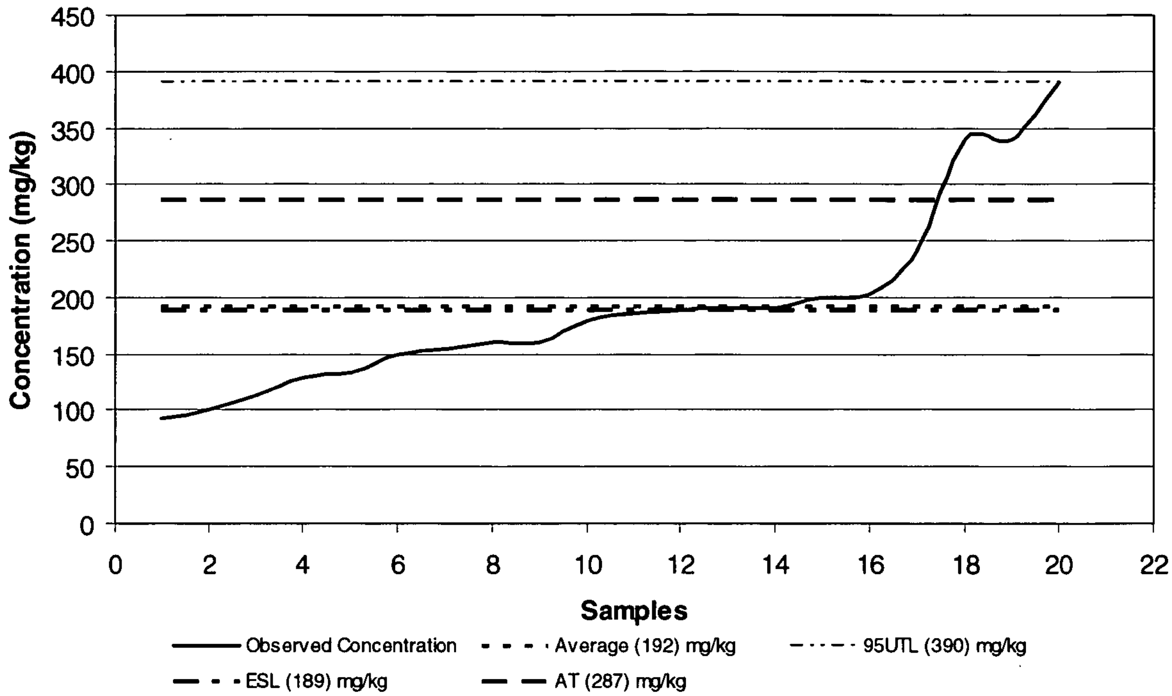

Figure 5.9 Data Distribution for Barium in NN AEU Sediment

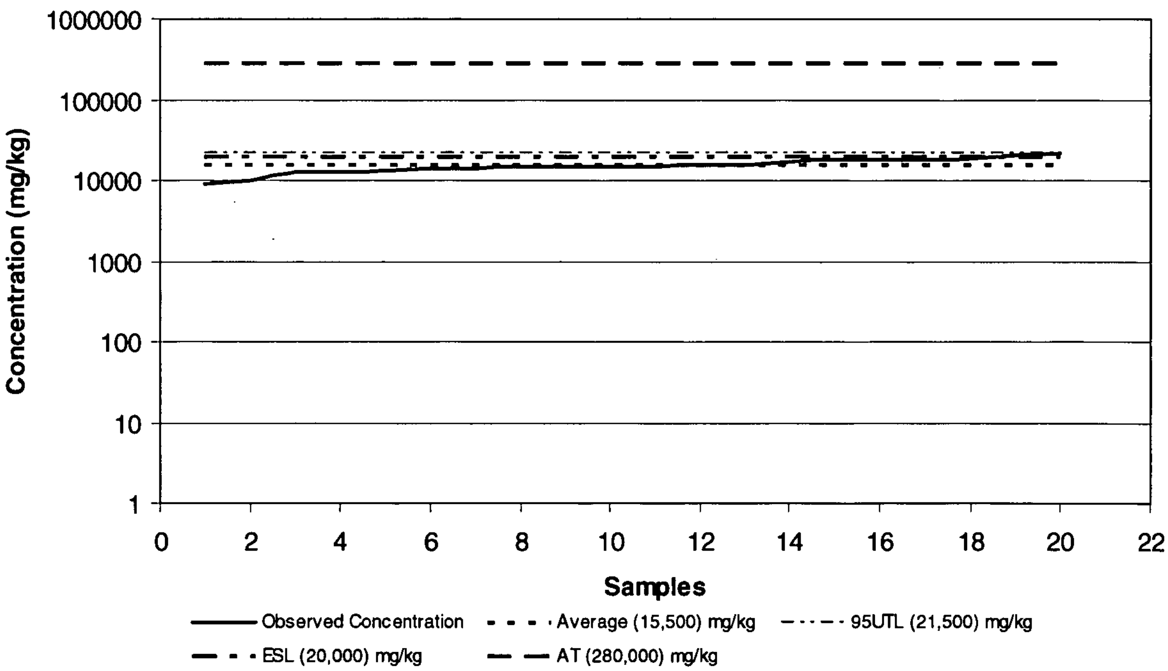

Figure 5.10 Data Distribution for Iron in NN AEU Sediment

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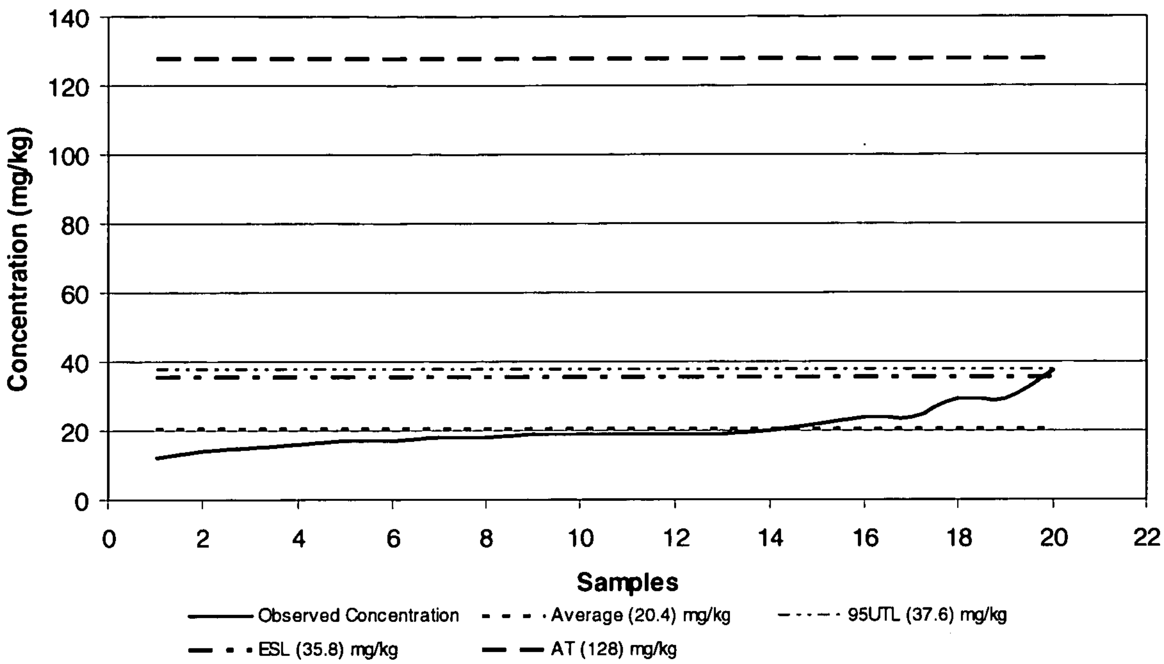

Figure 5.11 Data Distribution for Lead in NN AEU Sediment

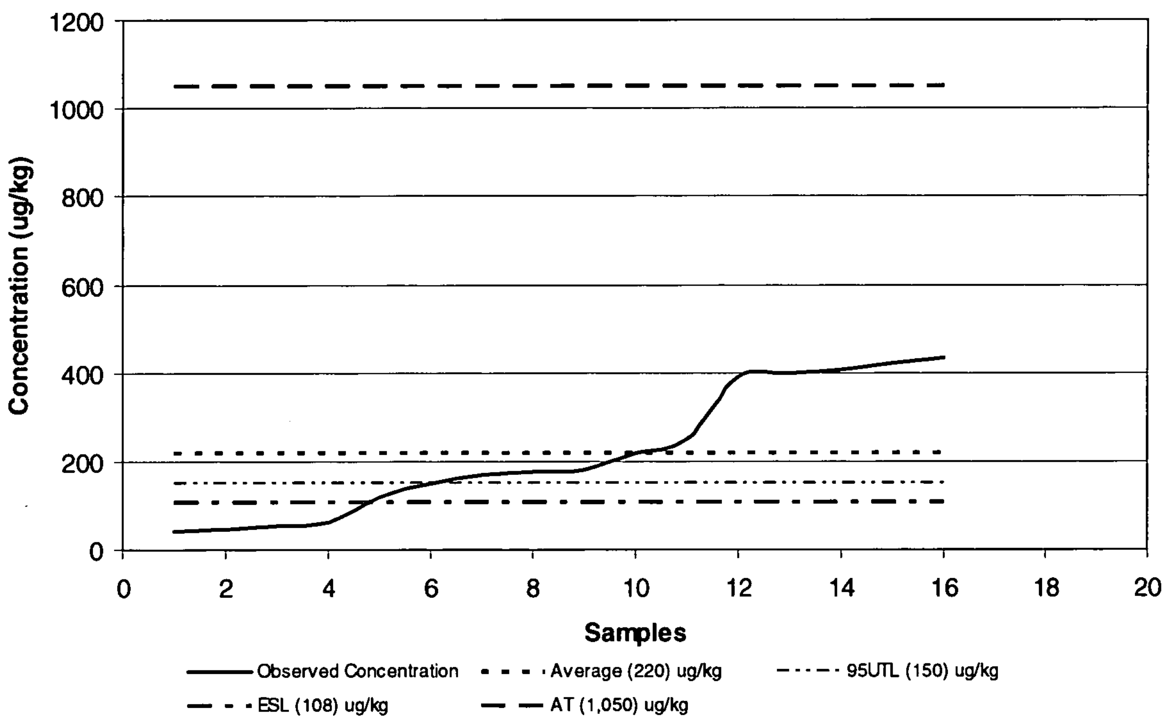

Figure 5.12 Data Distribution for Benzo(a)anthracene in NN AEU Sediment

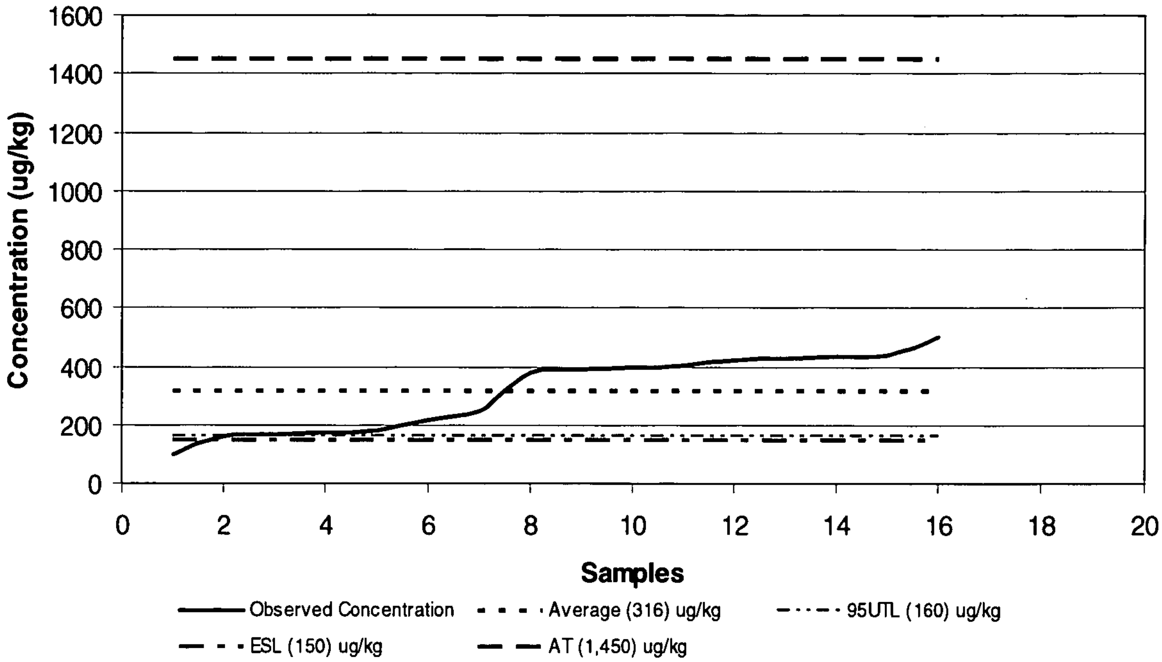

Figure 5.13 Data Distribution for Benzo(a)pyrene in NN AEU Sediment

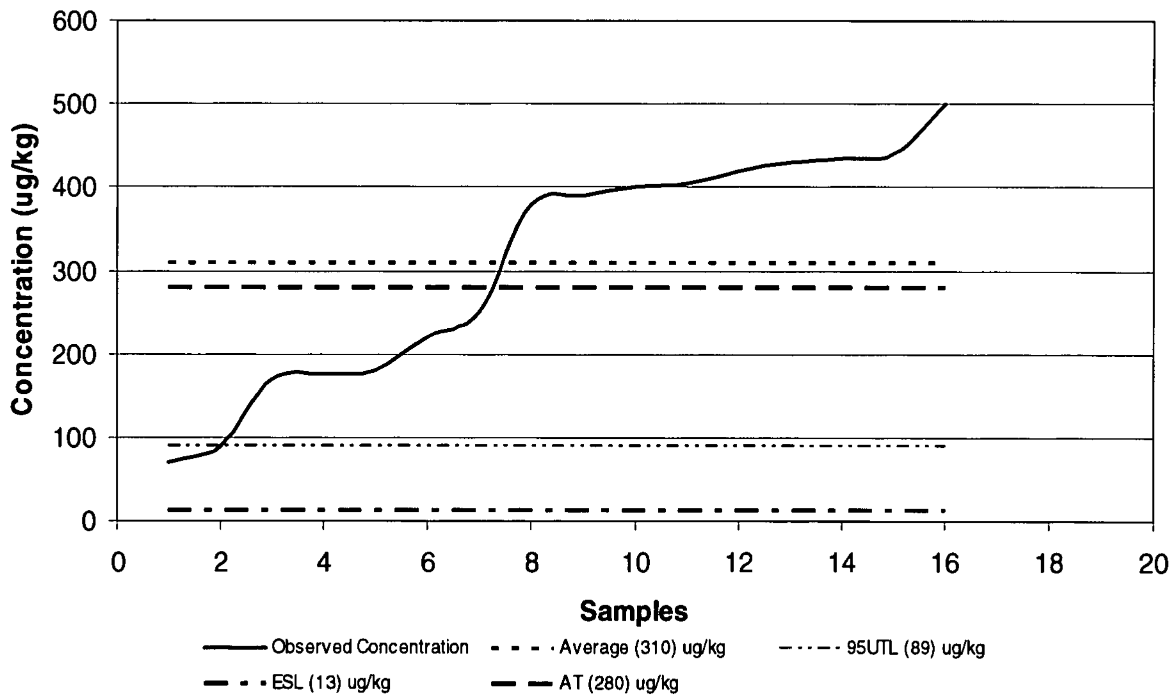

Figure 5.14 Data Distribution for Benzo(g,h,i)perylene in NN AEU Sediment

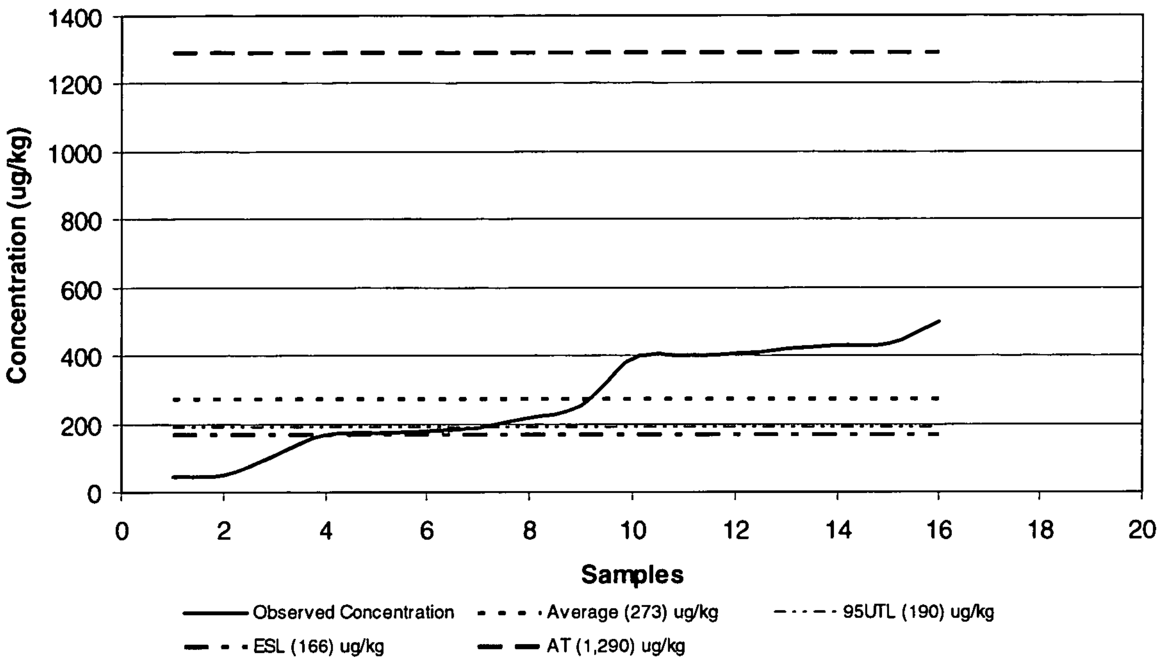

Figure 5.15 Data Distribution for Chrysene in NN AEU Sediment

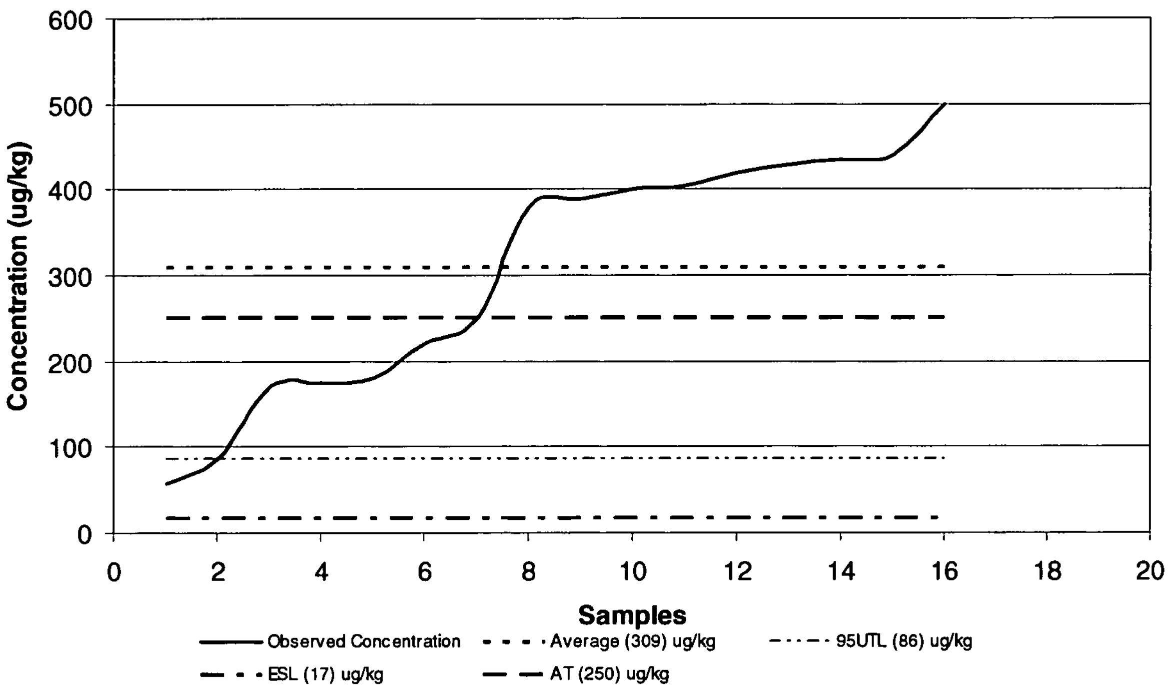

Figure 5.16 Data Distribution for Indeno(1,2,3-cd)pyrene in NN AEU Sediment

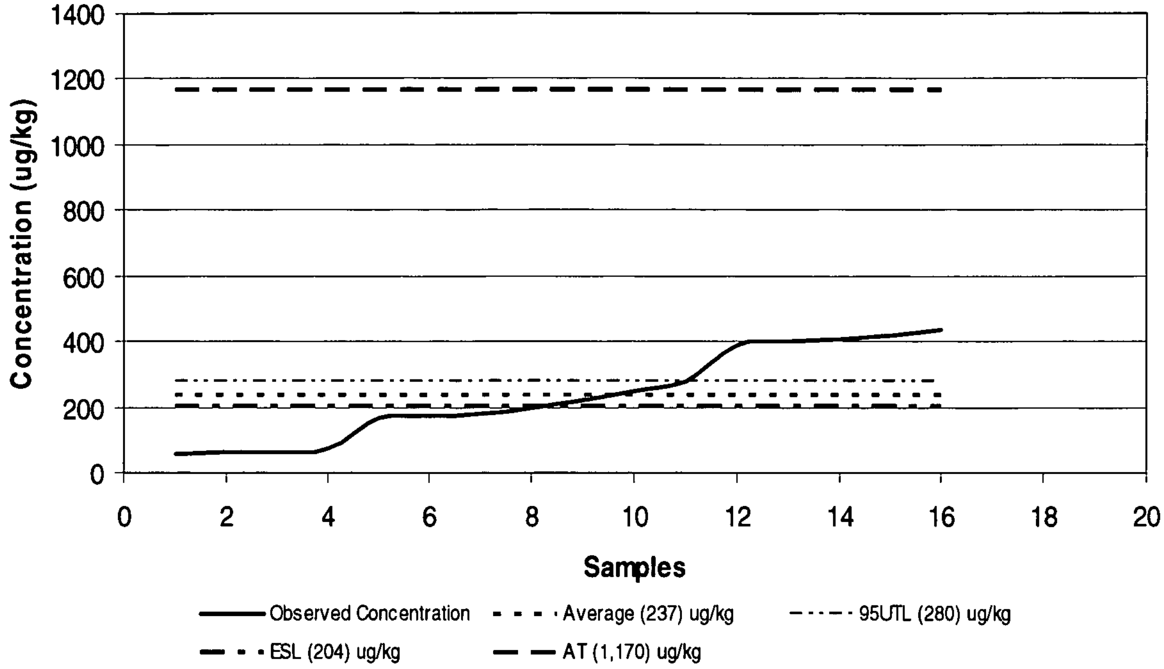

Figure 5.17 Data Distribution for Phenanthrene in NN AEU Sediment

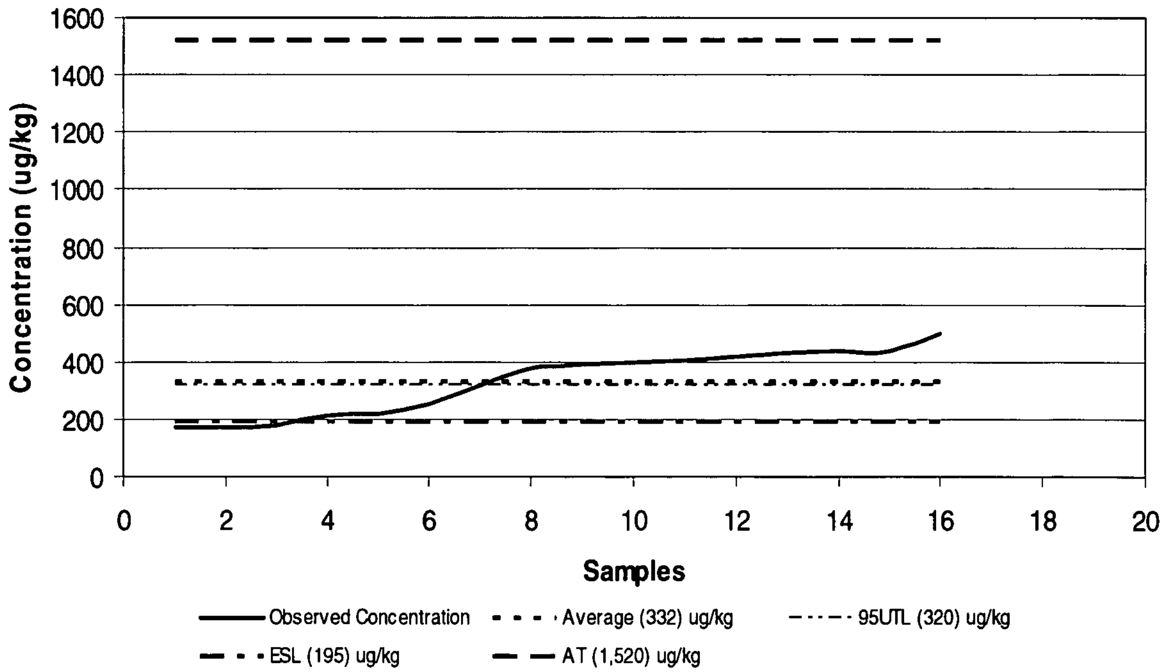

Figure 5.18 Data Distribution for Pyrene in NN AEU Sediment

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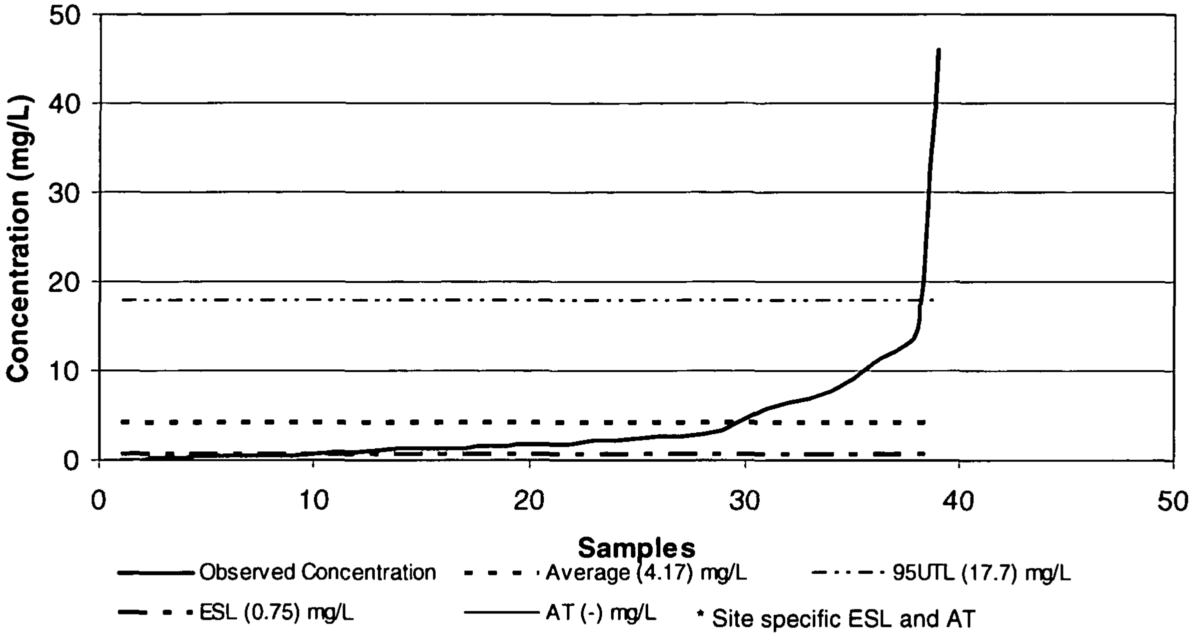

Figure 5.19 Data Distribution for Aluminum (Total) in MK AEU Surface Water

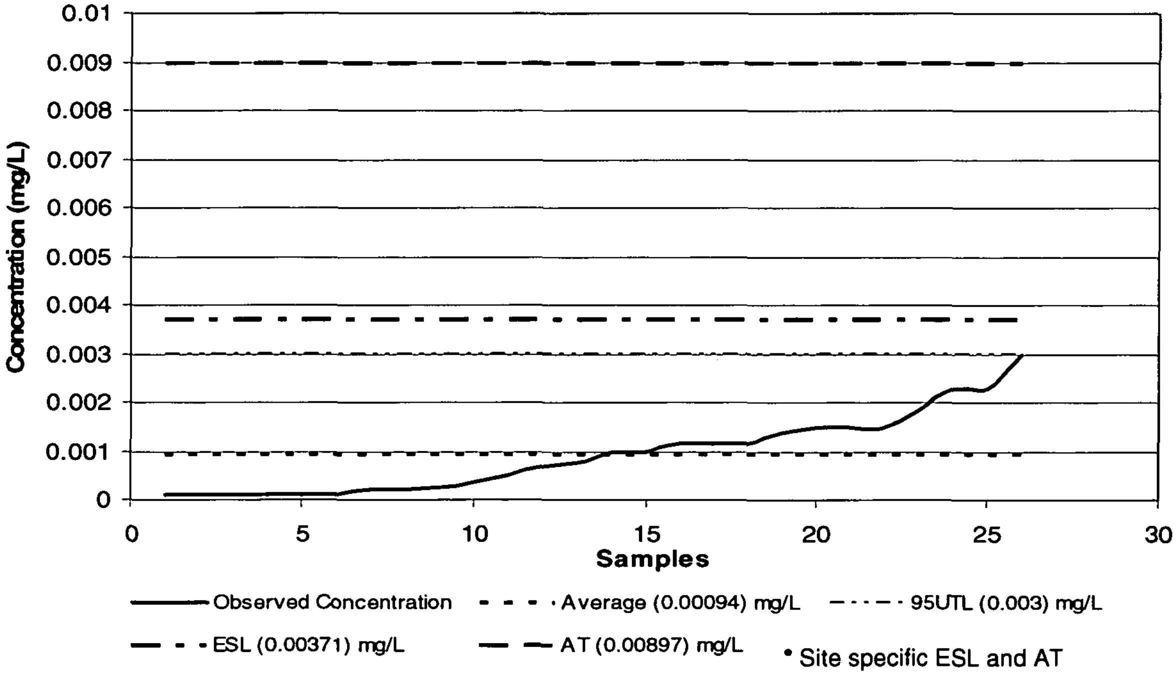

Figure 5.20 Data Distribution for Cadmium (Dissolved) in MK AEU Surface Water

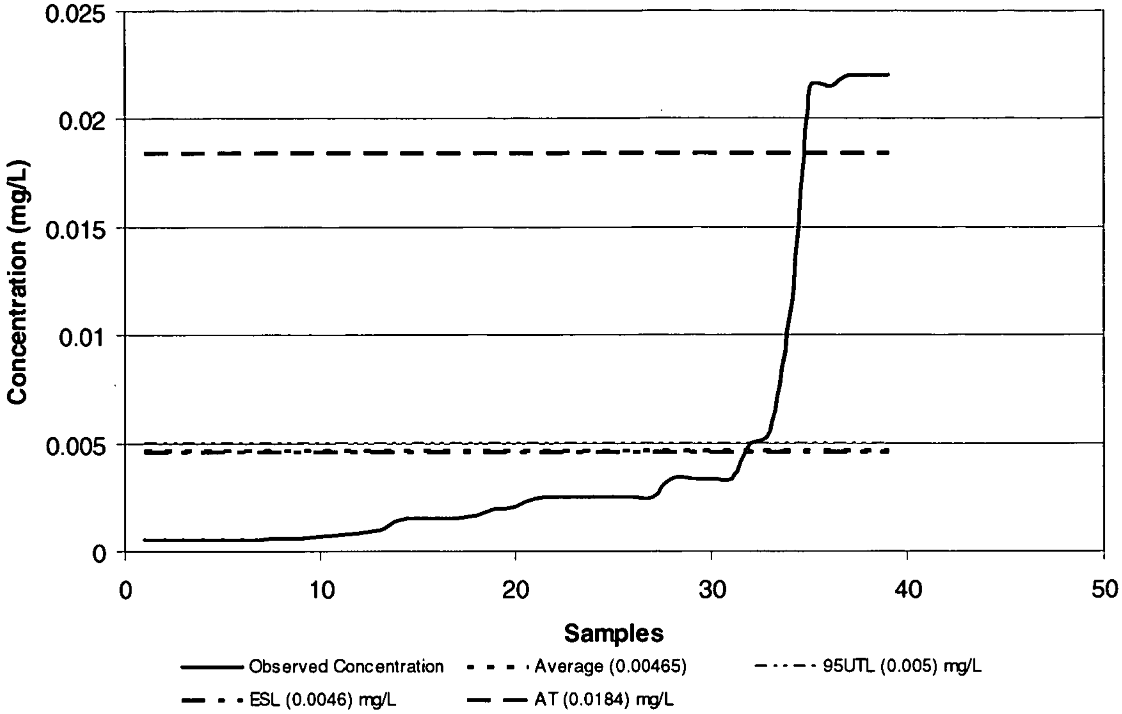

Figure 5.21 Data Distribution for Selenium (Total) in MK AEU Surface Water

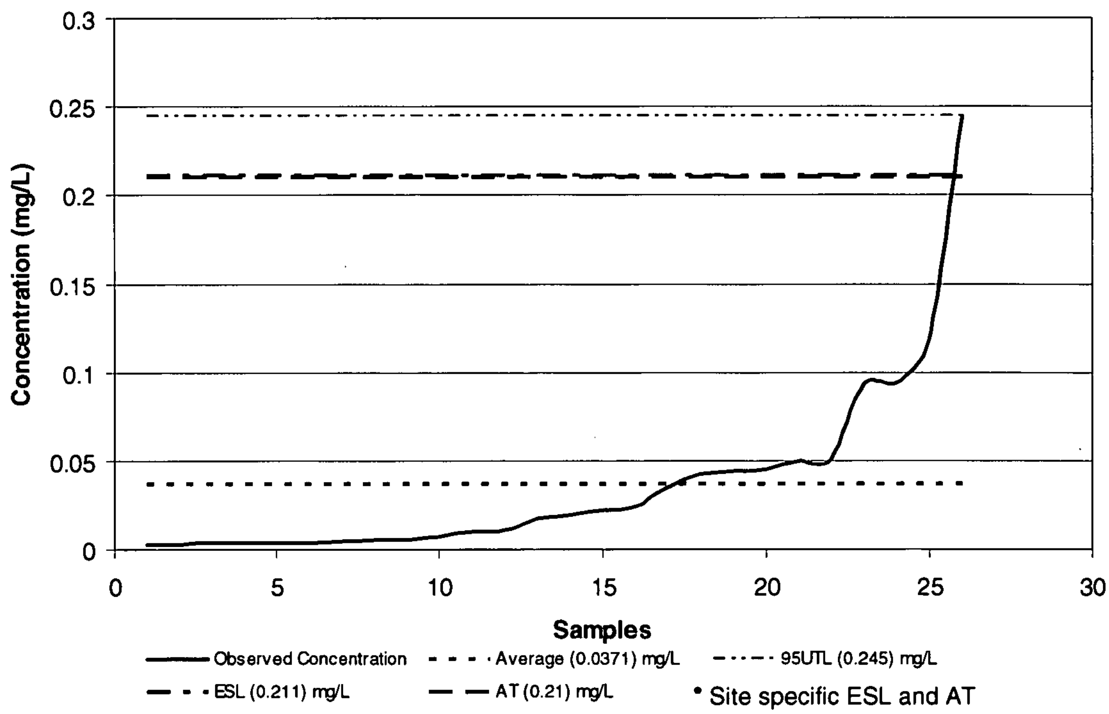

Figure 5.22 Data Distribution for Zinc (Dissolved) in MK AEU Surface Water

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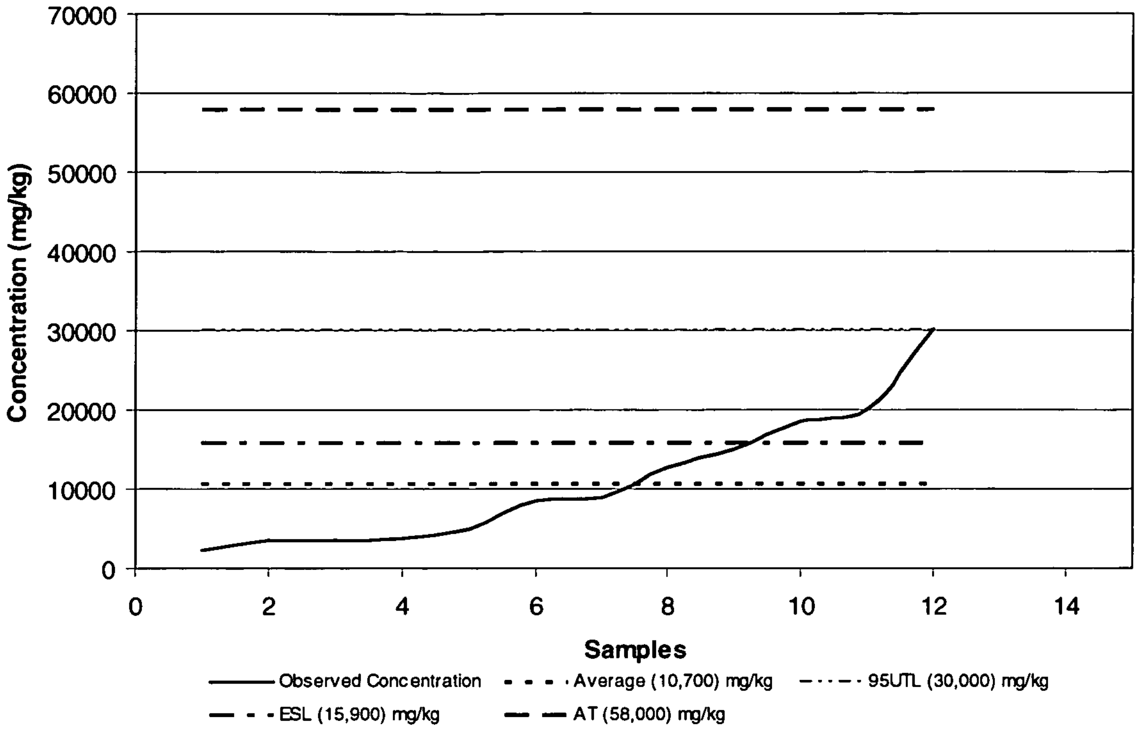

Figure 5.23 Data Distribution for Aluminum in MK AEU Sediment

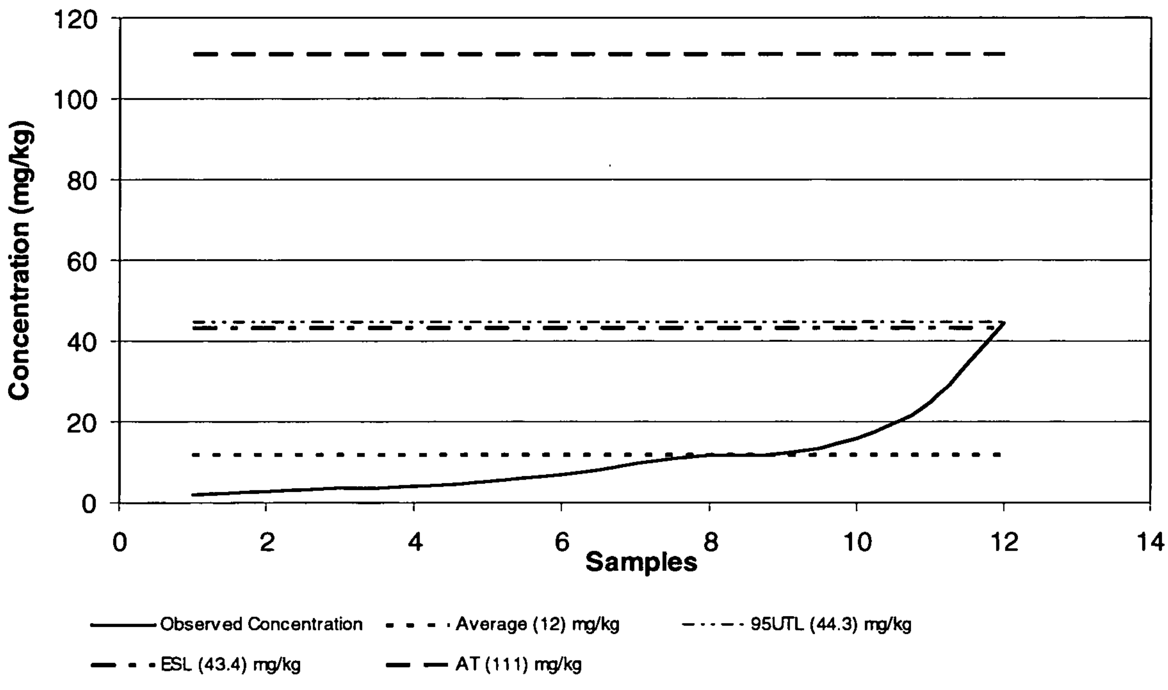

Figure 5.24 Data Distribution for Chromium in MK AEU Sediment

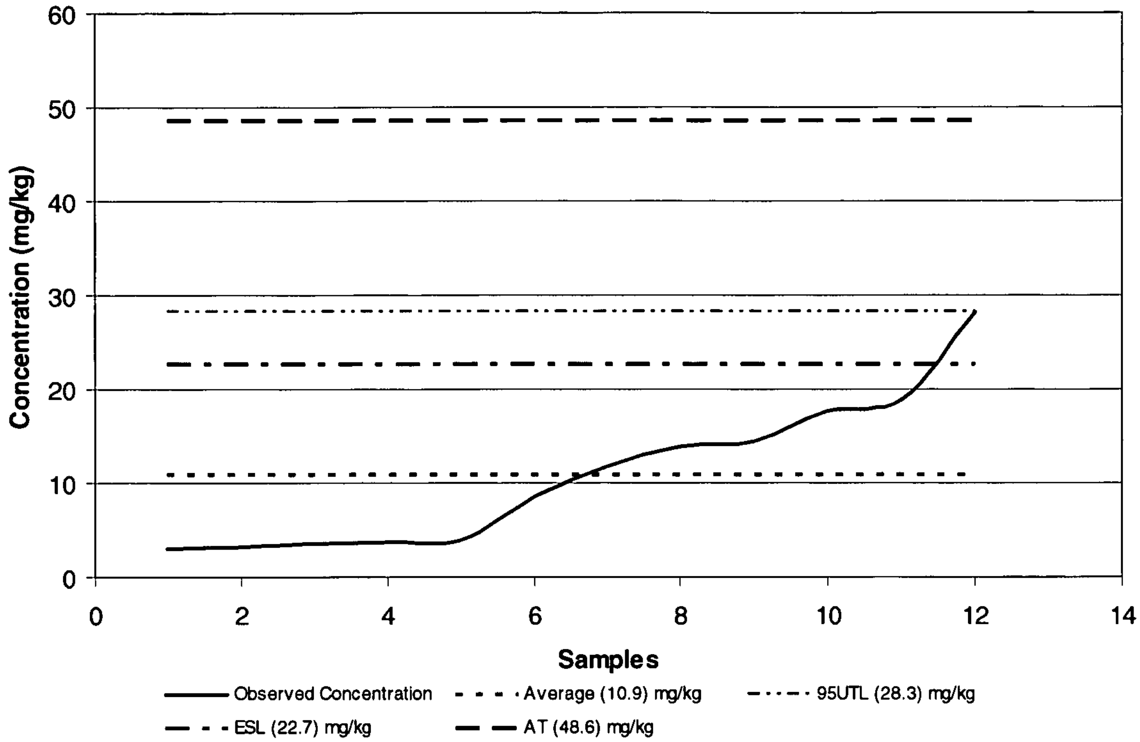

Figure 5.25 Data Distribution for Nickel in MK AEU Sediment

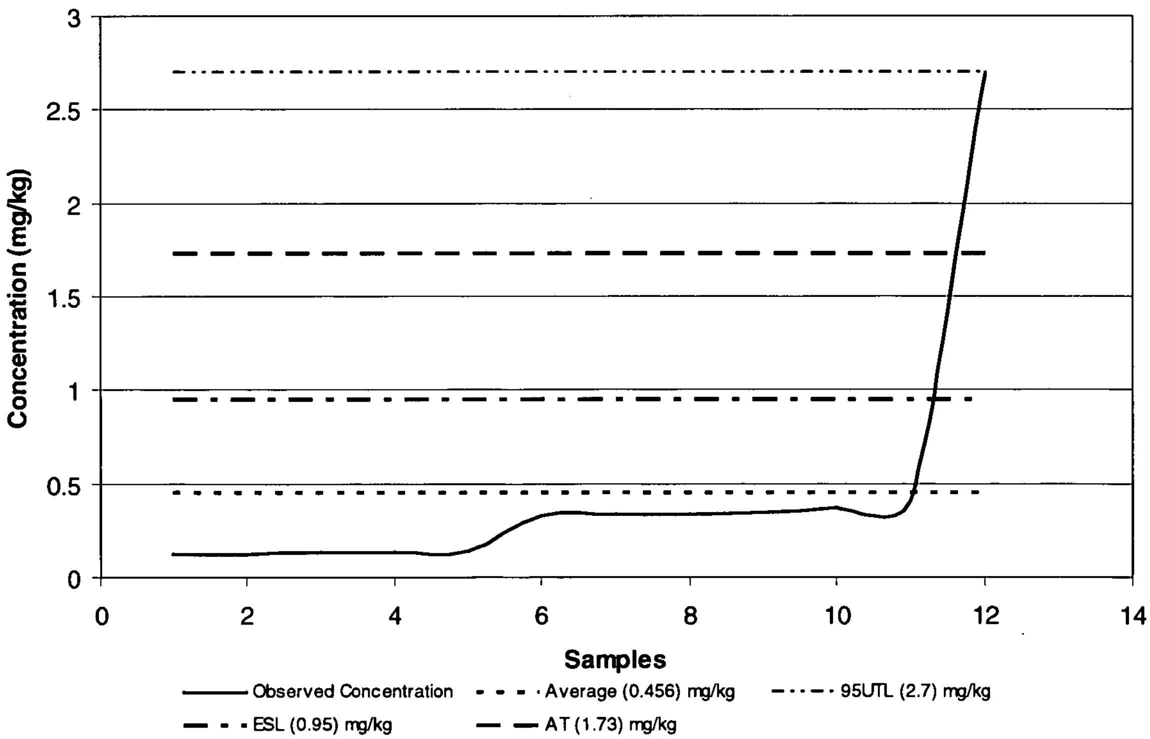

Figure 5.26 Data Distribution for Selenium in MK AEU Sediment

COMPREHENSIVE RISK ASSESSMENT

NO NAME GULCH AQUATIC EXPOSURE UNIT, ROCK CREEK AQUATIC EXPOSURE UNIT, MCKAY DITCH AQUATIC EXPOSURE UNIT, SOUTHEAST AQUATIC EXPOSURE UNIT

VOLUME 15B1: ATTACHMENT 1

Detection Limit Screen

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ACRONYMS AND ABBREVIATIONS

µg/kg	micrograms per kilogram
AEU	Aquatic Exposure Unit
bgs	below ground surface
CD	compact disc
CRA	Comprehensive Risk Assessment
ERA	Ecological Risk Assessment
ESL	ecological screening level
mg/kg	milligram per kilogram
mg/L	milligrams per liter
MK AEU	McKay Ditch Aquatic Exposure Unit
NN AEU	No Name Gulch Aquatic Exposure Unit
RC AEU	Rock Creek Aquatic Exposure Unit
SE AEU	Southeast Aquatic Exposure Unit
TIC	tentatively identified compound

1.0 EVALUATION OF DETECTION LIMITS FOR NONDETECTED ANALYTES AND ANALYTES DETECTED IN LESS THAN 5 PERCENT OF SAMPLES IN THE AQUATIC EXPOSURE UNITS

The detection limits for analytes that are either not detected or detected in less than 5 percent of the samples collected from the media used in the Ecological Risk Assessment (ERA) are reviewed in this attachment. The detection limits for surface water and sediment samples are compared to the minimum ecological screening level (ESL) for a variety of aquatic ecological receptors. The results of these comparisons are presented in the Attachment 1 tables.

Nondetects, analytes detected in less than 5 percent of samples, and the reported detection limits (referred to as "reported result" in the following sections of this attachment) are listed in these tables for each medium in the No Name Gulch Aquatic Exposure Unit (AEU), Rock Creek AEU, McKay Ditch AEU, and Southeast AEU and compared to medium-specific ESLs for a variety of aquatic ecological receptors. Maximum reported results that exceed the respective ESLs are noted and discussed.

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

1.1 Comparison of Maximum Reported Results for Nondetected Analytes and Analytes Detected in Less than 5 percent of Samples to Ecological Screening Levels

1.1.1 No Name Aquatic Exposure Unit (NN AEU)

Surface Water

The maximum reported results for 24 nondetected analytes and six analytes detected in less than 5 percent of samples in surface water are greater than their respective ESLs (Table A1.2.NNAEU.1). Therefore, there is some uncertainty associated with the reported results for these analytes in the NN AEU.

The maximum reported results for three analytes (benzo(a)anthracene, benzo(a)pyrene, and pyrene) exceeded the ESL by four orders of magnitude. The maximum reported result for 4,4'-DDT exceeded the ESL by two orders of magnitude. For the remaining analytes, the maximum reported results exceeded the ESLs by one order of magnitude or less.

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ESLs were not available for several nondetected analytes and analytes detected in less than 5 percent of samples in surface water (Table A1.2.NNAEU.1). However, the maximum reported results for other similar analytes were much lower than their respective ESLs. This, combined with the fact that no identified source exists for these analytes in the surface water at the NN AEU, suggests there is an acceptable level of uncertainty associated with the reported results for these analytes.

Sediment

The maximum reported results for 41 nondetected analytes in sediment are greater than their respective ESLs (Table A1.2.NNAEU.2). Therefore, there is some uncertainty associated with the reported results for these analytes in the NN AEU.

The maximum reported result for benzyl alcohol exceeds the ESL by three orders of magnitude. For the remaining analytes, the maximum reported result exceeds the ESL by one order of magnitude or less.

ESLs were not available for several nondetected analytes in sediment (Table A1.2.NNAEU.2). However, the maximum reported results for other similar analytes were much lower than their respective ESLs. This, combined with the fact that no identified source exists for these analytes in the sediment at the NN AEU, suggests there is an acceptable level of uncertainty associated with the reported results for these nondetected analytes.

1.1.2 Rock Creek Aquatic Exposure Unit (RC AEU)

Surface Water

The maximum reported results for 31 nondetected analytes and two analytes detected in less than 5 percent of samples in surface water are greater than their respective ESLs (Table A1.2.RCAEU.1). Therefore, there is some uncertainty associated with the reported results for these analytes in the RC AEU.

The maximum reported results for four analytes (4,4'-DDT, benzo(a)anthracene, benzo(a)pyrene, and pyrene) exceeded the ESLs by two orders of magnitude. For the remaining analytes, the maximum reported results exceeded the ESLs by one order of magnitude or less.

ESLs were not available for several nondetected analytes in surface water (Table A1.2.RCAEU.1). However, the maximum reported results for other similar analytes were much lower than their respective ESLs. This, combined with the fact that no identified source exists for these analytes in the surface water at the RC AEU, suggests there is an acceptable level of uncertainty associated with the reported results for these nondetected analytes.

Sediment

The maximum reported results for 42 nondetected analytes in sediment are greater than their respective ESLs (Table A1.2.RCAEU.2). Therefore, there is some uncertainty associated with the reported results for these analytes in the RC AEU.

The maximum reported result for benzyl alcohol exceeds the ESL by three orders of magnitude. The maximum reported results for 12 analytes exceed the ESLs by two orders of magnitude. For the remaining analytes, the maximum reported results exceed the ESLs by one order of magnitude or less.

ESLs were not available for several nondetected analytes in sediment (Table A1.2.RCAEU.2). However, the maximum reported results for other similar analytes were much lower than their ESLs. This, combined with the fact that no identified source exists for these analytes in the sediment at the RC AEU, suggests there is an acceptable level of uncertainty associated with the reported results for these nondetected analytes.

1.1.3 McKay Ditch Aquatic Exposure Unit (MK AEU)

Surface Water

The maximum reported results for 32 nondetected analytes and seven analytes detected in less than 5 percent of samples in surface water are greater than their respective ESLs (Table A1.2.MKAEU.1). Therefore, there is some uncertainty associated with the reported results for these analytes in the MK AEU.

The maximum reported results for five analytes (4,4'-DDT, benzo(a)anthracene, benzo(a)pyrene, PCB-1221, and pyrene) exceed the ESLs by two orders of magnitude. For the remaining analytes, the maximum reported results exceed the ESLs by one order of magnitude or less.

ESLs were not available for several nondetected analytes in surface water (Table A1.2.MKAEU.1). However, the maximum reported results for other similar analytes were much lower than their ESLs. This, combined with the fact that no identified source exists for these analytes in the surface water at the MK AEU, suggests there is an acceptable level of uncertainty associated with the reported results for these nondetected analytes.

Sediment

The maximum reported results for 47 nondetected analytes in sediment are greater than their respective ESLs (Table A1.2.MKAEU.2). Therefore, there is some uncertainty associated with the reported results for these analytes in the MK AEU.

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The maximum reported results for four analytes (acenaphthene, acenaphthylene, benzyl alcohol, and heptachlor) exceed the ESLs by two orders of magnitude. For the remaining analytes, the maximum reported results exceed the ESLs by one order of magnitude or less.

ESLs were not available for several nondetected analytes in sediment (Table A1.2.MKAEU.2). However, the maximum reported results for other similar analytes were much lower than their respective ESLs. This, combined with the fact that no identified source exists for these analytes in the sediment at the MK AEU, suggests there is an acceptable level of uncertainty associated with the reported results for these nondetected analytes.

1.1.4 Southeast Aquatic Exposure Unit (SE AEU)

Surface Water

The maximum reported results for 29 nondetected analytes in surface water are greater than their respective ESLs (Table A1.2.SEAEU.1). Therefore, there is some uncertainty associated with the reported results for these analytes in the SE AEU.

The maximum reported result for 4,4'-DDT exceeded the ESL by two orders of magnitude. The maximum reported results for 16 analytes exceed the ESLs between ten times and less than 100 times. For the remaining analytes, the maximum reported results exceed the ESLs by less than ten times.

ESLs were not available for several nondetected analytes in surface water (Table A1.2.SEAEU.1). However, the maximum reported results for other similar analytes were much lower than their respective ESLs. This, combined with the fact that no identified source exists for these analytes in the surface water at the SE AEU, suggests there is an acceptable level of uncertainty associated with the reported results for these nondetected analytes.

Sediment

There were no nondetect analytes or analytes detected in less than 5 percent of samples in sediment for which the maximum reported result exceeded the ESLs (Table A1.2.SEAEU.2). Therefore, there is no uncertainty associated with the reported results for these analytes in the SE AEU.

An ESL was not available for tin in sediment (Table A1.2.SEAEU.2). However, the fact that no identified source exists for this analyte in the sediment at the SE AEU suggests there is an acceptable level of uncertainty associated with the reported result for tin.

TABLES

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Table A1.2.NNAEU.1

Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Water

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[a] > ESL?
Inorganic Total (mg/L)				
Cadmium[b]	**3.0E-05 - 0.005**	**64**	**2.50E-04**	**Yes**
Cesium	0.033 - 0.5	25	N/A	UT
Cyanide	**0 - 0.02**	**22**	**5.00E-04**	**Yes**
Mercury	1.4E-05 - 2.0E-04	62	7.70E-04	No
Ortho-phosphate	0.05 - 0.05	16	N/A	UT
Phosphate	0.02 - 0.05	3	N/A	UT
Sulfide	1 - 1	21	N/A	UT
Thallium	1.5E-04 - 0.012	65	0.0150	No
Uranium[b]	0.002 - 0.039	25	1.50	No
Inorganic Dissolved (mg/L)				
Cadmium[b]	**8.0E-04 - 0.0046**	**31**	**2.50E-04**	**Yes**
Cesium	0.048 - 0.5	20	N/A	UT
Mercury	1.4E-05 - 2.0E-04	32	7.70E-04	No
Thallium	8.8E-04 - 0.015	32	0.0150	No
Uranium[b]	0.0055	1	1.50	No
Organic Total (µg/L)				
1,1,1,2-Tetrachloroethane	0.1 - 10	98	N/A	UT
1,1,1-Trichloroethane[b]	0.1 - 5	137	89	No
1,1,2,2-Tetrachloroethane	0.1 - 5	138	2,400	No
1,1,2-Trichloro-1,2,2-trifluoroethane	0.5 - 5	85	32	No
1,1,2-Trichloroethane	0.1 - 5	138	940	No
1,1-Dichloroethene[b]	0.2 - 5	136	65	No
1,1-Dichloropropene	0.1 - 5	97	N/A	UT
1,2,3-Trichloropropane[b]	0.1 - 10	97	N/A	UT
1,2,4,5-Tetrachlorobenzene	9.5 - 9.5	2	N/A	UT
1,2-Dibromo-3-chloropropane	0.5 - 20	89	N/A	UT
1,2-Dibromoethane	0.5 - 20	98	N/A	UT
1,2-Dichloroethane	0.1 - 5	130	20,000	No
1,2-Diphenylhydrazine	9.5 - 9.5	2	N/A	UT
1,3-Dichloropropane	0.1 - 5	97	N/A	UT
2,2-Dichloropropane	0.5 - 5	97	N/A	UT
2,4,5-T	10	1	N/A	UT
2,4,5-TP (Silvex)	10	1	N/A	UT
2,4,5-Trichlorophenol	9.5 - 330	72	N/A	UT
2,4,6-Trichlorophenol	**5 - 330**	**72**	**5**	**Yes**
2,4-D	10	1	N/A	UT
2,4-DB	10	1	N/A	UT
2,4-Dichlorophenol	5 - 330	72	365	No
2,4-Dinitrophenol	25 - 1,700	72	N/A	UT
2,4-Dinitrotoluene	5 - 330	71	N/A	UT
2,6-Dinitrotoluene	5 - 330	71	N/A	UT
2378-TCDD	5.00E-04	1	N/A	UT
2-Chloronaphthalene	5 - 330	71	630	No
2-Chlorophenol	5 - 330	72	N/A	UT

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Table A1.2.NNAEU.1

Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Water

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[a] > ESL?
2-Chlorotoluene	0.2 - 5	98	N/A	UT
2-Hexanone	1 - 11	118	99	No
2-Methyl-1-propanol	2,000	1	N/A	UT
2-Methylphenol	**5 - 330**	**72**	**82**	**Yes**
2-Nitroaniline	25 - 1,700	71	N/A	UT
2-Nitrophenol[b]	5 - 330	71	N/A	UT
3 & 4-methyl phenol	9.7 - 10.6	7	N/A	UT
3,3'-Dichlorobenzidine	10 - 670	71	N/A	UT
3-Nitroaniline	25 - 1,700	71	N/A	UT
4,4'-DDD	**0.1 - 0.11**	**7**	**0.0600**	**Yes**
4,4'-DDE	0.1 - 0.11	7	105	No
4,4'-DDT	**0.1 - 0.11**	**7**	**0.00100**	**Yes**
4,6-Dinitro-2-methylphenol	9.7 - 1,700	72	N/A	UT
4-Bromophenyl-phenylether[b]	5 - 330	70	N/A	UT
4-Chloro-3-methylphenol	5 - 670	72	N/A	UT
4-Chloroaniline	5 - 670	71	N/A	UT
4-Chlorophenyl-phenyl ether	5 - 330	71	N/A	UT
4-Chlorotoluene[b]	0.2 - 5	97	N/A	UT
4-Methyl-2-pentanone	1 - 11	123	170	No
4-Methylphenol[b]	**5 - 330**	**62**	**25**	**Yes**
4-Nitroaniline	19 - 1,700	71	N/A	UT
4-Nitrophenol	25 - 1,700	71	N/A	UT
Acenaphthylene[b]	5 - 330	70	N/A	UT
Acetonitrile	100	1	N/A	UT
Acrolein	500	1	N/A	UT
Acrylonitrile	100	1	N/A	UT
Aldrin	0.05 - 0.056	7	0.150	No
Allyl Chloride	10	1	N/A	UT
alpha-Chlordane	0.05 - 0.56	7	N/A	UT
Aniline	10	1	N/A	UT
Aroclor-1016	**0.5 - 1**	**7**	**0.0140**	**Yes**
Aroclor-1221	**0.5 - 2**	**7**	**0.0140**	**Yes**
Aroclor-1232	**0.5 - 1**	**7**	**0.0140**	**Yes**
Aroclor-1242	**0.5 - 1**	**7**	**0.0140**	**Yes**
Aroclor-1248	**0.5 - 1**	**7**	**0.0140**	**Yes**
Aroclor-1254	**1 - 1.1**	**7**	**0.0140**	**Yes**
Aroclor-1260	**1 - 1.1**	**7**	**0.0140**	**Yes**
Atrazine	1	1	7.30	No
Benzo(a)anthracene	**5 - 330**	**71**	**0.0270**	**Yes**
Benzo(a)pyrene[b]	**5 - 330**	**70**	**0.0140**	**Yes**
Benzo(b)fluoranthene[b]	5 - 12	55	N/A	UT
Benzo(b,k)fluoroanthene	10 - 330	15	N/A	UT
Benzo(g,h,i)perylene[b]	5 - 330	70	N/A	UT
Benzo(k)fluoranthene[b]	5 - 12	51	N/A	UT
Benzyl Alcohol	**5 - 670**	**70**	**8.60**	**Yes**

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Table A1.2.NNAEU.1

Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Water

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[a] > ESL?
beta-Chlordane	0.05 - 0.05	2	N/A	UT
bis(2-Chloroethoxy) methane	5 - 330	71	N/A	UT
bis(2-Chloroethyl) ether	5 - 330	71	N/A	UT
bis(2-Chloroisopropyl) ether	**5 - 330**	**71**	**29**	**Yes**
Bromobenzene	0.2 - 5	98	N/A	UT
Bromochloromethane	0.5 - 5	98	N/A	UT
Bromodichloromethane	0.2 - 5	139	1,100	No
Bromoform[b]	0.5 - 5	137	320	No
Bromomethane	0.5 - 10	139	35	No
Carbon Disulfide	**1 - 5**	**126**	**0.920**	**Yes**
Carbon Tetrachloride	0.2 - 5	139	3,520	No
Chloroform[b]	0.1 - 5	138	1,240	No
Chloromethane[b]	0.5 - 10	134	N/A	UT
Chrysene	5 - 330	71	N/A	UT
cis-1,3-Dichloropropene	0.1 - 5	138	244	No
Dalapon	10 - 10	1	N/A	UT
Dibenz(a,h)anthracene[b]	5 - 330	70	N/A	UT
Dibromochloromethane	0.2 - 5	139	N/A	UT
Dibromomethane	0.5 - 20	98	N/A	UT
Dicamba	10	1	10	No
Dichloroprop	10	1	N/A	UT
Dieldrin	**0.1 - 0.11**	**7**	**0.0560**	**Yes**
Dimethylphthalate	5 - 330	71	N/A	UT
Di-n-octylphthalate[b]	5 - 330	70	N/A	UT
Dinoseb	**10**	**1**	**0.480**	**Yes**
Diphenylamine	10.6	1	N/A	UT
Endosulfan I	0.05 - 0.056	7	0.0560	No
Endosulfan II	**0.1 - 0.11**	**7**	**0.0560**	**Yes**
Endosulfan sulfate	**0.1 - 0.11**	**7**	**0.0560**	**Yes**
Endrin	**0.1 - 0.11**	**7**	**0.0360**	**Yes**
Endrin aldehyde	**0.1 - 0.1**	**2**	**0.0360**	**Yes**
Endrin ketone	**0.1 - 0.11**	**7**	**0.0360**	**Yes**
Ethyl Methacrylate	20	1	N/A	UT
Fluoranthene	5 - 330	71	398	No
gamma-Chlordane	0.5 - 0.56	5	N/A	UT
Heptachlor epoxide	**0.05 - 0.056**	**7**	**0.00380**	**Yes**
Hexachlorobenzene	5 - 330	71	N/A	UT
Hexachlorobutadiene[b]	**0.1 - 12**	**113**	**9.30**	**Yes**
Hexachlorocyclopentadiene	5 - 330	71	N/A	UT
Hexachlorodibenzofuran	2.00E-04	1	N/A	UT
Hexachlorodibenzo-p-dioxin	4.00E-04	1	N/A	UT
Hexachloroethane[b]	5 - 330	70	540	No
Indeno(1,2,3-cd)pyrene[b]	5 - 330	70	N/A	UT
Iodomethane	10	1	N/A	UT
Isophorone[b]	5 - 330	70	1,300	No

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Table A1.2.NNAEU.1

Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Water

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[a] > ESL?
m,p-Xylene	0.2 - 1	5	35	No
MCPA	10,000	1	N/A	UT
MCPP	10,000	1	N/A	UT
Methoxychlor	0.5 - 0.56	7	N/A	UT
Methyl Acrylonitrile	20	1	N/A	UT
methyl methacrylate	20	1	N/A	UT
Nitrobenzene	5 - 330	71	N/A	UT
N-Nitrosodiethylamine	19 - 19	2	N/A	UT
N-Nitrosodimethylamine	9.5 - 9.5	2	N/A	UT
N-Nitrosodi-n-butylamine	9.5 - 9.5	2	N/A	UT
N-Nitroso-di-n-propylamine	5 - 330	71	N/A	UT
N-nitrosodiphenylamine	5 - 330	70	N/A	UT
o-Xylene	0.2 - 1	6	35	No
Pentachlorobenzene	9.5 - 9.5	2	N/A	UT
Pentachlorodibenzofuran	5.00E-04	1	N/A	UT
Pentachlorodibenzo-p-dioxin	0.001	1	N/A	UT
Pentachloroethane	20	1	N/A	UT
Pyrene[b]	**5 - 330**	**70**	**0.0250**	**Yes**
Pyridine	10 - 10	7	N/A	UT
Simazine	1	1	10	No
Styrene[b]	0.1 - 5	137	160	No
TCDF	7.00E-04	1	N/A	UT
tert-Butylbenzene	0.2 - 5	98	N/A	UT
Tetrachlorodibenzo-p-dioxin	5.00E-04	1	N/A	UT
Tetrachloroethene[b]	0.1 - 5	136	840	No
Toxaphene	1 - 5	7	N/A	UT
trans-1,3-Dichloropropene	0.1 - 5	138	244	No
trans-1,4-Dichlorobutene-2	20	1	N/A	UT
Tributyl phosphate	106	1	N/A	UT
Trichlorofluoromethane[b]	0.5 - 10	95	N/A	UT
Vinyl acetate	2 - 10	39	N/A	UT

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

[b] Analyte has a detection frequency of less than 5 percent.

[c] The value for total xylene is used.

ESL = Ecological screening level.

UT = Uncertain toxicity.

N/A = Not available or not applicable.

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Table A1.2.NNAEU.2
Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency of less than 5 Percent in Sediment[a]

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[b] > ESL?
Inorganic (mg/kg)				
Antimony	**0.59 - 14.7**	**19**	**2**	**Yes**
Uranium	1 - 1.4	10	N/A	UT
Organic (µg/kg)				
1,1,1,2-Tetrachloroethane	5.8 - 7.8	10	N/A	UT
1,1,1-Trichloroethane	5 - 9	16	159	No
1,1,2,2-Tetrachloroethane	5 - 9	16	1,900	No
1,1,2-Trichloro-1,2,2-trifluoroethane	5.8 - 7.8	10	N/A	UT
1,1,2-Trichloroethane	5 - 9	16	N/A	UT
1,1-Dichloroethane	5 - 9	16	N/A	UT
1,1-Dichloroethene	5 - 9	16	N/A	UT
1,1-Dichloropropene	5.8 - 7.8	10	N/A	UT
1,2,3-Trichlorobenzene	5.8 - 7.8	10	58.6	No
1,2,3-Trichloropropane	5.8 - 7.8	10	N/A	UT
1,2,4-Trichlorobenzene	**5.8 - 500**	**16**	**429**	**Yes**
1,2-Dibromo-3-chloropropane	5.8 - 7.8	10	N/A	UT
1,2-Dibromoethane	5.8 - 7.8	10	N/A	UT
1,2-Dichlorobenzene	5.8 - 500	16	N/A	UT
1,2-Dichloroethane	5 - 9	16	N/A	UT
1,2-Dichloroethene	5 - 9	6	N/A	UT
1,2-Dichloropropane	5 - 9	16	N/A	UT
1,3,5-Trimethylbenzene	5.8 - 7.8	10	316	No
1,3-Dichlorobenzene	**5.8 - 500**	**16**	**122**	**Yes**
1,3-Dichloropropane	5.8 - 7.8	10	N/A	UT
1,4-Dichlorobenzene	5.8 - 500	16	N/A	UT
2,2-Dichloropropane	5.8 - 7.8	10	N/A	UT
2,4,5-Trichlorophenol	760 - 2,400	16	N/A	UT
2,4,6-Trichlorophenol	**340 - 1,000**	**16**	**59.3**	**Yes**
2,4-Dichlorophenol	340 - 1,000	16	N/A	UT
2,4-Dimethylphenol	340 - 1,000	16	N/A	UT
2,4-Dinitrophenol	1,700 - 5,100	14	N/A	UT
2,4-Dinitrotoluene	340 - 1,000	16	N/A	UT
2,6-Dinitrotoluene	340 - 1,000	16	N/A	UT
2-Chloronaphthalene	340 - 1,000	16	N/A	UT
2-Chlorophenol	340 - 1,000	16	N/A	UT
2-Chlorotoluene	5.8 - 7.8	10	N/A	UT
2-Hexanone	10 - 31	16	N/A	UT
2-Methylnaphthalene	**340 - 1,000**	**16**	**20.2**	**Yes**
2-Methylphenol	340 - 1,000	16	6,970	No
2-Nitroaniline	1,700 - 5,100	16	N/A	UT
2-Nitrophenol	340 - 1,000	16	N/A	UT
3,3'-Dichlorobenzidine	680 - 2,000	15	N/A	UT
3-Nitroaniline	1,700 - 5,100	15	N/A	UT
4,4'-DDD	**16 - 24**	**6**	**4.88**	**Yes**
4,4'-DDE	**16 - 24**	**6**	**3.16**	**Yes**

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Table A1.2.NNAEU.2
Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency of less than 5 Percent in Sediment[a]

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[b] > ESL?
4,4'-DDT	**16 - 24**	**6**	**4.16**	**Yes**
4,6-Dinitro-2-methylphenol	1,700 - 5,100	14	N/A	UT
4-Bromophenyl-phenylether	**340 - 1,000**	**16**	**166**	**Yes**
4-Chloro-3-methylphenol	340 - 2,000	16	N/A	UT
4-Chloroaniline	340 - 2,000	16	N/A	UT
4-Chlorophenyl-phenyl ether	340 - 1,000	16	N/A	UT
4-Chlorotoluene	5.8 - 7.8	10	N/A	UT
4-Isopropyltoluene	5.8 - 7.8	10	N/A	UT
4-Methyl-2-pentanone	10 - 31	16	N/A	UT
4-Methylphenol	**340 - 1,000**	**16**	**12.3**	**Yes**
4-Nitroaniline	1,700 - 5,100	16	N/A	UT
4-Nitrophenol	1,700 - 5,100	16	N/A	UT
Acenaphthene	**340 - 510**	**16**	**6.71**	**Yes**
Acenaphthylene	**340 - 510**	**16**	**5.87**	**Yes**
Aldrin	**8 - 12**	**6**	**8.25**	**Yes**
alpha-BHC	8 - 12	6	43.9	No
alpha-Chlordane	**80 - 120**	**6**	**3.24**	**Yes**
Aroclor-1016	**80 - 120**	**6**	**40**	**Yes**
Aroclor-1221	**80 - 120**	**6**	**40**	**Yes**
Aroclor-1232	**80 - 120**	**6**	**40**	**Yes**
Aroclor-1242	**80 - 120**	**6**	**40**	**Yes**
Aroclor-1248	**80 - 120**	**6**	**40**	**Yes**
Aroclor-1254	**160 - 240**	**6**	**40**	**Yes**
Aroclor-1260	**160 - 240**	**6**	**40**	**Yes**
Benzene	5 - 9	16	260	No
Benzoic Acid	1,700 - 5,100	15	N/A	UT
Benzyl Alcohol	**340 - 2,000**	**16**	**1.35**	**Yes**
beta-BHC	8 - 12	6	93.6	No
beta-Chlordane	**110 - 120**	**2**	**3.24**	**Yes**
bis(2-Chloroethoxy) methane	340 - 1,000	16	N/A	UT
bis(2-Chloroethyl) ether	340 - 1,000	16	N/A	UT
bis(2-Chloroisopropyl) ether	340 - 1,000	16	N/A	UT
Bromobenzene	5.8 - 7.8	10	N/A	UT
Bromochloromethane	5.8 - 7.8	10	N/A	UT
Bromodichloromethane	5 - 9	16	N/A	UT
Bromoform	5 - 9	16	N/A	UT
Bromomethane	**5.8 - 18**	**16**	**3.43**	**Yes**
Butylbenzylphthalate	340 - 1,000	16	11,400	No
Carbon Disulfide	5 - 9	16	N/A	UT
Carbon Tetrachloride	5 - 9	16	7,890	No
Chlorobenzene	5 - 9	16	N/A	UT
Chloroethane	5.8 - 18	16	N/A	UT
Chloroform	5 - 9	16	N/A	UT
Chloromethane	5.8 - 13	15	N/A	UT
cis-1,2-Dichloroethene	2.9 - 3.9	10	N/A	UT

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Table A1.2.NNAEU.2
Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency of less than 5 Percent in Sediment[a]

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[b] > ESL?
cis-1,3-Dichloropropene	5 - 9	16	N/A	UT
delta-BHC	**8 - 12**	**6**	**2.37**	**Yes**
Dibenz(a,h)anthracene	**340 - 1,000**	**16**	**33**	**Yes**
Dibenzofuran	**340 - 1,000**	**16**	**325**	**Yes**
Dibromochloromethane	5 - 9	16	N/A	UT
Dibromomethane	5.8 - 7.8	10	N/A	UT
Dichlorodifluoromethane	5.8 - 7.8	10	N/A	UT
Dieldrin	**16 - 24**	**6**	**5.94**	**Yes**
Diethylphthalate	**340 - 1,000**	**16**	**108**	**Yes**
Dimethylphthalate	340 - 1,000	16	N/A	UT
Di-n-octylphthalate	340 - 1,000	16	N/A	UT
Endosulfan I	**8 - 12**	**6**	**0.690**	**Yes**
Endosulfan II	**16 - 24**	**6**	**0.690**	**Yes**
Endosulfan sulfate	**16 - 24**	**6**	**0.690**	**Yes**
Endrin	16 - 24	6	N/A	UT
Endrin ketone	16 - 24	6	N/A	UT
Ethylbenzene	5 - 9	16	16,570	No
Fluorene	**340 - 1,000**	**16**	**77.4**	**Yes**
gamma-BHC (Lindane)	**8 - 12**	**6**	**2.37**	**Yes**
gamma-Chlordane	**80 - 97**	**4**	**3.24**	**Yes**
Heptachlor	**8 - 12**	**6**	**0.132**	**Yes**
Heptachlor epoxide	**8 - 12**	**6**	**2.47**	**Yes**
Hexachlorobenzene	340 - 1,000	16	N/A	UT
Hexachlorobutadiene	**5.8 - 500**	**16**	**23**	**Yes**
Hexachlorocyclopentadiene	340 - 1,000	14	N/A	UT
Hexachloroethane	340 - 1,000	16	N/A	UT
Isophorone	340 - 1,000	16	N/A	UT
Isopropylbenzene	5.8 - 7.8	10	N/A	UT
Methoxychlor	**80 - 120**	**6**	**24**	**Yes**
n-Butylbenzene	5.8 - 7.8	10	N/A	UT
Nitrobenzene	340 - 1,000	16	N/A	UT
N-Nitroso-di-n-propylamine	340 - 1,000	16	N/A	UT
N-nitrosodiphenylamine	340 - 1,000	16	N/A	UT
n-Propylbenzene	5.8 - 7.8	10	N/A	UT
Pentachlorophenol	**1,700 - 5,100**	**16**	**255**	**Yes**
Phenol	**340 - 1,000**	**16**	**773**	**Yes**
Pyridine	760 - 1,000	10	N/A	UT
sec-Butylbenzene	5.8 - 7.8	10	N/A	UT
Styrene	5 - 9	16	N/A	UT
tert-Butylbenzene	5.8 - 7.8	10	N/A	UT
Tetrachloroethene	5 - 9	16	3,050	No
Toxaphene	160 - 240	6	N/A	UT
trans-1,2-Dichloroethene	2.9 - 3.9	10	657	No
trans-1,3-Dichloropropene	5 - 9	16	N/A	UT
Trichloroethene	5 - 9	16	22,800	No

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Table A1.2.NNAEU.2
Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency of less than 5 Percent in Sediment[a]

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[b] > ESL?
Trichlorofluoromethane	5.8 - 7.8	10	N/A	UT
Vinyl acetate	10 - 18	6	N/A	UT
Vinyl Chloride	5.8 - 18	16	N/A	UT
Xylene[c]	5 - 9	16	91	No

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

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

[c] The value for total xylene is used.

ESL = Ecological screening level.

UT = Uncertain toxicity.

N/A = Not available or not applicable.

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Table A1.2.RCAEU.1

Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Water

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[a] >ESL?
Inorganic Total (mg/L)				
Beryllium	2.0E-05 - 0.0017	82	0.00240	No
Boron	0.013 - 0.013	3	1.90	No
Mercury[b]	1.3E-05 - 2.0E-04	94	7.70E-04	No
Nitrite[b]	0.02 - 0.1	31	4.47	No
Silver[b]	**4.0E-05 - 0.0068**	**107**	**3.20E-04**	**Yes**
Sulfide	1 - 1	31	N/A	UT
Thallium[b]	1.0E-04 - 0.0052	100	0.0150	No
Tin	**5.2E-04 - 0.136**	**89**	**0.0730**	**Yes**
Inorganic Dissolved (mg/L)				
Beryllium	1.0E-04 - 0.0018	42	0.00240	No
Mercury[b]	1.0E-04 - 2.0E-04	40	7.70E-04	No
Silver[b]	**1.0E-04 - 0.0068**	**41**	**3.20E-04**	**Yes**
Sulfide	1	1	N/A	UT
Thallium[b]	1.0E-04 - 0.0038	39	0.0150	No
Tin	**0.001 - 0.136**	**39**	**0.0730**	**Yes**
Organic Total (µg/L)				
1,1,1,2-Tetrachloroethane	0.5 - 1	9	N/A	UT
1,1,1-Trichloroethane	0.5 - 5	43	89	No
1,1,2,2-Tetrachloroethane	0.5 - 5	43	2,400	No
1,1,2-Trichloro-1,2,2-trifluoroethane	1	1	32	No
1,1,2-Trichloroethane	0.5 - 5	43	940	No
1,1-Dichloroethane	0.5 - 5	43	740	No
1,1-Dichloroethene	0.5 - 5	43	65	No
1,1-Dichloropropene	0.5 - 1	9	N/A	UT
1,2,3-Trichlorobenzene	0.5 - 1	9	8	No
1,2,3-Trichloropropane	1 - 1	9	N/A	UT
1,2,4-Trichlorobenzene	0.5 - 10	12	50	No
1,2,4-Trimethylbenzene	0.5 - 1	9	17	No
1,2-Dibromo-3-chloropropane	1 - 1	9	N/A	UT
1,2-Dibromoethane	0.5 - 1	9	N/A	UT
1,2-Dichlorobenzene	0.5 - 10	12	13	No
1,2-Dichloroethane	0.5 - 5	43	20,000	No
1,2-Dichloroethene	5 - 5	34	1,100	No
1,2-Dichloropropane	0.5 - 5	43	5,700	No
1,3,5-Trimethylbenzene	0.5 - 1	9	45	No
1,3-Dichlorobenzene	0.5 - 10	12	28	No
1,3-Dichloropropane	0.5 - 1	9	N/A	UT
1,4-Dichlorobenzene	0.5 - 10	12	16	No
2,2-Dichloropropane	0.5 - 1	9	N/A	UT
2,4,5-Trichlorophenol	50 - 52	3	N/A	UT
2,4,6-Trichlorophenol	**10 - 10**	**3**	**5**	**Yes**
2,4-Dichlorophenol	10 - 10	3	365	No
2,4-Dimethylphenol	10 - 10	3	212	No
2,4-Dinitrophenol	50 - 52	3	N/A	UT
2,4-Dinitrotoluene	10 - 10	3	N/A	UT
2,6-Dinitrotoluene	10 - 10	3	N/A	UT
2-Butanone	10 - 10	32	2,200	No

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Table A1.2.RCAEU.1
Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Water

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[a] >ESL?
2-Chloronaphthalene	10 - 10	3	630	No
2-Chlorophenol	10 - 10	3	N/A	UT
2-Chlorotoluene	0.5 - 1	9	N/A	UT
2-Hexanone	10 - 10	35	99	No
2-Methylnaphthalene	10 - 10	3	N/A	UT
2-Methylphenol	10 - 10	3	82	No
2-Nitroaniline	50 - 52	3	N/A	UT
2-Nitrophenol	10 - 10	3	N/A	UT
3,3'-Dichlorobenzidine	20 - 21	3	N/A	UT
3-Nitroaniline	50 - 52	3	N/A	UT
4,4'-DDD	**0.1 - 0.1**	**3**	**0.0600**	**Yes**
4,4'-DDE	0.1 - 0.1	3	105	No
4,4'-DDT	**0.1 - 0.1**	**3**	**0.00100**	**Yes**
4,6-Dinitro-2-methylphenol	50 - 52	3	N/A	UT
4-Bromophenyl-phenylether	10 - 10	3	N/A	UT
4-Chloro-3-methylphenol	10 - 10	3	N/A	UT
4-Chloroaniline	10 - 10	3	N/A	UT
4-Chlorophenyl-phenyl ether	10 - 10	3	N/A	UT
4-Chlorotoluene	0.5 - 1	9	N/A	UT
4-Isopropyltoluene	0.5 - 1	9	N/A	UT
4-Methyl-2-pentanone	10 - 10	31	170	No
4-Methylphenol	10 - 10	3	25	No
4-Nitroaniline	50 - 52	3	N/A	UT
4-Nitrophenol	50 - 52	3	N/A	UT
Acenaphthene	10 - 10	3	520	No
Acenaphthylene	10 - 10	3	N/A	UT
Aldrin	0.05 - 0.052	3	0.150	No
alpha-BHC	0.05 - 0.052	3	2.20	No
alpha-Chlordane	0.5 - 0.52	3	N/A	UT
Anthracene	**10 - 10**	**3**	**0.730**	**Yes**
Aroclor-1016	**0.5 - 0.52**	**3**	**0.0140**	**Yes**
Aroclor-1221	**0.5 - 0.52**	**3**	**0.0140**	**Yes**
Aroclor-1232	**0.5 - 0.52**	**3**	**0.0140**	**Yes**
Aroclor-1242	**0.5 - 0.52**	**3**	**0.0140**	**Yes**
Aroclor-1248	**0.5 - 0.52**	**3**	**0.0140**	**Yes**
Aroclor-1254	**1 - 1**	**3**	**0.0140**	**Yes**
Aroclor-1260	**1 - 1**	**3**	**0.0140**	**Yes**
Benzene	0.5 - 5	43	530	No
Benzo(a)anthracene	**10 - 10**	**3**	**0.0270**	**Yes**
Benzo(a)pyrene	**10 - 10**	**3**	**0.0140**	**Yes**
Benzo(b)fluoranthene	10 - 10	3	N/A	UT
Benzo(g,h,i)perylene	10 - 10	3	N/A	UT
Benzo(k)fluoranthene	10 - 10	3	N/A	UT
Benzoic Acid	**50 - 52**	**3**	**42**	**Yes**
Benzyl Alcohol	**10 - 10**	**3**	**8.60**	**Yes**
beta-BHC	0.05 - 0.052	3	2.20	No
bis(2-Chloroethoxy) methane	10 - 10	3	N/A	UT
bis(2-Chloroethyl) ether	10 - 10	3	N/A	UT
bis(2-Chloroisopropyl) ether	10 - 10	3	29	No
bis(2-ethylhexyl)phthalate	10 - 10	3	28.5	No

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Table A1.2.RCAEU.1
Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Water

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[a] > ESL?
Bromobenzene	0.5 - 1	9	N/A	UT
Bromochloromethane	0.5 - 1	9	N/A	UT
Bromodichloromethane	0.5 - 5	43	1,100	No
Bromoform	0.5 - 5	43	320	No
Bromomethane	1 - 10	43	35	No
Butylbenzylphthalate	10 - 10	3	67	No
Carbon Disulfide	**1 - 5**	**34**	**0.920**	**Yes**
Carbon Tetrachloride	0.5 - 5	43	3,520	No
Chlorobenzene[b]	0.5 - 5	42	47	No
Chloroethane	1 - 10	43	N/A	UT
Chloroform[b]	0.5 - 5	41	1,240	No
Chloromethane	1 - 10	41	N/A	UT
Chrysene	10 - 10	3	N/A	UT
cis-1,2-Dichloroethene	0.5 - 1	9	620	No
cis-1,3-Dichloropropene	0.5 - 5	43	244	No
delta-BHC	0.05 - 0.052	3	2.20	No
Dibenz(a,h)anthracene	10 - 10	3	N/A	UT
Dibenzofuran	**10 - 10**	**3**	**4**	**Yes**
Dibromochloromethane	0.5 - 5	43	N/A	UT
Dibromomethane	0.5 - 1	9	N/A	UT
Dichlorodifluoromethane	1 - 1	9	N/A	UT
Dieldrin	**0.1 - 0.1**	**3**	**0.0560**	**Yes**
Diethylphthalate	10 - 10	3	110	No
Dimethylphthalate	10 - 10	3	N/A	UT
Di-n-butylphthalate	**10 - 10**	**3**	**9.70**	**Yes**
Di-n-octylphthalate	10 - 10	3	N/A	UT
Endosulfan I	0.05 - 0.052	3	0.0560	No
Endosulfan II	**0.1 - 0.1**	**3**	**0.0560**	**Yes**
Endosulfan sulfate	**0.1 - 0.1**	**3**	**0.0560**	**Yes**
Endrin	**0.1 - 0.1**	**3**	**0.0360**	**Yes**
Endrin ketone	**0.1 - 0.1**	**3**	**0.0360**	**Yes**
Ethylbenzene	0.5 - 5	43	3,200	No
Fluoranthene	10 - 10	3	398	No
Fluorene	10 - 10	3	12	No
gamma-BHC (Lindane)	0.05 - 0.052	3	0.0800	No
gamma-Chlordane	0.5 - 0.52	3	N/A	UT
Heptachlor	**0.05 - 0.052**	**3**	**0.00380**	**Yes**
Heptachlor epoxide	**0.05 - 0.052**	**3**	**0.00380**	**Yes**
Hexachlorobenzene	10 - 10	3	N/A	UT
Hexachlorobutadiene	**0.5 - 10**	**12**	**9.30**	**Yes**
Hexachlorocyclopentadiene	10 - 10	3	N/A	UT
Hexachloroethane	10 - 10	3	540	No
Indeno(1,2,3-cd)pyrene	10 - 10	3	N/A	UT
Isophorone	10 - 10	3	1,300	No
Isopropylbenzene	0.5 - 1	9	N/A	UT
Methoxychlor	0.5 - 0.52	3	N/A	UT
Naphthalene	0.5 - 10	12	620	No
n-Butylbenzene	0.5 - 1	9	N/A	UT
Nitrobenzene	10 - 10	3	N/A	UT

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Table A1.2.RCAEU.1
Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Water

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[a] > ESL?
N-Nitroso-di-n-propylamine	10 - 10	3	N/A	UT
N-nitrosodiphenylamine	10 - 10	3	N/A	UT
n-Propylbenzene	0.5 - 1	9	N/A	UT
Pentachlorophenol	**50 - 52**	**3**	**6.73**	**Yes**
Phenanthrene	**10 - 10**	**3**	**2.40**	**Yes**
Phenol	10 - 10	3	2,560	No
Pyrene	**10 - 10**	**3**	**0.0250**	**Yes**
sec-Butylbenzene	0.5 - 1	9	N/A	UT
Styrene	0.5 - 5	43	160	No
tert-Butylbenzene	0.5 - 1	9	N/A	UT
Tetrachloroethene[b]	0.5 - 5	42	840	No
Toluene	0.5 - 5	43	1,750	No
Toxaphene	1 - 1	3	N/A	UT
trans-1,2-Dichloroethene	0.5 - 1	9	1,500	No
trans-1,3-Dichloropropene	0.5 - 5	43	244	No
Trichloroethene	0.5 - 5	43	21,900	No
Trichlorofluoromethane	0.5 - 1	9	N/A	UT
Vinyl acetate	10 - 10	33	N/A	UT
Vinyl Chloride	1 - 10	43	930	No
Xylene[c]	0.5 - 5	43	35	No

[a] Value is the maximum reported result for nondetected analytes.
[b] Analyte has a detection frequency of less than 5 percent.
[c] The value for total xylene is used.
ESL = Ecological screening level.
UT = Uncertain toxicity.
N/A = Not available or not applicable.

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Table A1.2.RCAEU.2

Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency of less than 5 Percent in Sediment[a]

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[b] > ESL?
Inorganic (mg/kg)				
Nitrite	0.3 - 0.5	2	N/A	UT
Organic (µg/kg)				
1,1,2,2-Tetrachloroethane	5 - 14	10	1,900	No
1,1,2-Trichloroethane	5 - 14	11	N/A	UT
1,1-Dichloroethane	5 - 14	12	N/A	UT
1,1-Dichloroethene	5 - 14	12	N/A	UT
1,2,4-Trichlorobenzene	**330 - 2,500**	**19**	**429**	**Yes**
1,2-Dichlorobenzene	330 - 1,600	14	N/A	UT
1,2-Dichloroethane	5 - 14	12	N/A	UT
1,2-Dichloroethene	5 - 14	12	N/A	UT
1,2-Dichloropropane	5 - 14	11	N/A	UT
1,3-Dichlorobenzene	**330 - 2,500**	**19**	**122**	**Yes**
1,4-Dichlorobenzene	330 - 1,600	14	N/A	UT
2,4,5-Trichlorophenol	890 - 8,000	19	N/A	UT
2,4,6-Trichlorophenol	**330 - 2,500**	**19**	**59.3**	**Yes**
2,4-Dichlorophenol	330 - 2,500	19	N/A	UT
2,4-Dimethylphenol	330 - 2,500	19	N/A	UT
2,4-Dinitrophenol	1,700 - 13,000	17	N/A	UT
2,4-Dinitrotoluene	330 - 2,500	19	N/A	UT
2,6-Dinitrotoluene	330 - 2,500	19	N/A	UT
2-Chloronaphthalene	330 - 2,500	19	N/A	UT
2-Chlorophenol	330 - 2,500	19	N/A	UT
2-Hexanone	10 - 29	10	N/A	UT
2-Methylnaphthalene	**330 - 2,500**	**19**	**20.2**	**Yes**
2-Methylphenol	330 - 2,500	19	6,970	No
2-Nitroaniline	1,700 - 13,000	19	N/A	UT
2-Nitrophenol	330 - 2,500	19	N/A	UT
3,3'-Dichlorobenzidine	660 - 5,000	16	N/A	UT
3-Nitroaniline	1,700 - 13,000	17	N/A	UT
4,4'-DDD	**20 - 82**	**13**	**4.88**	**Yes**
4,4'-DDE	**20 - 82**	**13**	**3.16**	**Yes**
4,4'-DDT	**20 - 82**	**13**	**4.16**	**Yes**
4-Bromophenyl-phenylether	**330 - 2,500**	**19**	**166**	**Yes**
4-Chloro-3-methylphenol	330 - 5,000	19	N/A	UT
4-Chloroaniline	330 - 5,000	18	N/A	UT
4-Chlorophenyl-phenyl ether	330 - 2,500	19	N/A	UT
4-Methyl-2-pentanone	10 - 29	10	N/A	UT
4-Nitroaniline	1,700 - 13,000	17	N/A	UT
Acenaphthene	**330 - 1,600**	**19**	**6.71**	**Yes**
Acenaphthylene	**330 - 1,600**	**19**	**5.87**	**Yes**
Aldrin	**10 - 41**	**13**	**8.25**	**Yes**
alpha-BHC	10 - 41	13	43.9	No
alpha-Chlordane	**100 - 410**	**13**	**3.24**	**Yes**
Anthracene	**330 - 1,600**	**19**	**57.2**	**Yes**

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Table A1.2.RCAEU.2

Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency of less than 5 Percent in Sediment[a]

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[b] > ESL?
Aroclor-1016	**100 - 410**	**13**	**40**	**Yes**
Aroclor-1221	**100 - 410**	**13**	**40**	**Yes**
Aroclor-1232	**100 - 410**	**13**	**40**	**Yes**
Aroclor-1242	**100 - 410**	**13**	**40**	**Yes**
Aroclor-1248	**100 - 410**	**13**	**40**	**Yes**
Aroclor-1254	**200 - 820**	**13**	**40**	**Yes**
Aroclor-1260	**200 - 820**	**13**	**40**	**Yes**
Benzene	5 - 14	11	260	No
Benzo(b)fluoranthene	330 - 2,500	18	N/A	UT
Benzo(g,h,i)perylene	**330 - 2,500**	**16**	**13**	**Yes**
Benzo(k)fluoranthene	**330 - 2,500**	**18**	**240**	**Yes**
Benzyl Alcohol	**330 - 5,000**	**19**	**1.35**	**Yes**
beta-BHC	10 - 41	13	93.6	No
beta-Chlordane	**100 - 400**	**3**	**3.24**	**Yes**
bis(2-Chloroethoxy) methane	330 - 2,500	19	N/A	UT
bis(2-Chloroethyl) ether	330 - 2,500	19	N/A	UT
bis(2-Chloroisopropyl) ether	330 - 2,500	19	N/A	UT
Bromodichloromethane	5 - 14	11	N/A	UT
Bromoform	5 - 14	11	N/A	UT
Bromomethane	**10 - 29**	**11**	**3.43**	**Yes**
Butylbenzylphthalate	330 - 2,500	18	11,400	No
Carbon Disulfide	5 - 14	12	N/A	UT
Carbon Tetrachloride	5 - 14	11	7,890	No
Chlorobenzene	5 - 14	10	N/A	UT
Chloroethane	10 - 29	11	N/A	UT
Chloroform	5 - 14	12	N/A	UT
Chloromethane	10 - 29	12	N/A	UT
cis-1,3-Dichloropropene	5 - 14	11	N/A	UT
delta-BHC	**10 - 41**	**13**	**2.37**	**Yes**
Dibenz(a,h)anthracene	**330 - 2,500**	**18**	**33**	**Yes**
Dibenzofuran	**330 - 2,500**	**19**	**325**	**Yes**
Dibromochloromethane	5 - 14	11	N/A	UT
Dieldrin	**20 - 82**	**13**	**5.94**	**Yes**
Diethylphthalate	**330 - 2,500**	**19**	**108**	**Yes**
Dimethylphthalate	330 - 2,500	19	N/A	UT
Di-n-octylphthalate	330 - 2,500	18	N/A	UT
Endosulfan I	**10 - 41**	**13**	**0.690**	**Yes**
Endosulfan II	**20 - 82**	**13**	**0.690**	**Yes**
Endosulfan sulfate	**20 - 82**	**13**	**0.690**	**Yes**
Endrin	20 - 82	13	N/A	UT
Endrin ketone	20 - 82	13	N/A	UT
Ethylbenzene	5 - 14	10	16,570	No
Fluorene	**330 - 2,500**	**19**	**77.4**	**Yes**
gamma-BHC (Lindane)	**10 - 41**	**13**	**2.37**	**Yes**
gamma-Chlordane	**130 - 410**	**10**	**3.24**	**Yes**

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Table A1.2.RCAEU.2

Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency of less than 5 Percent in Sediment[a]

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[b] > ESL?
Heptachlor	**10 - 41**	**13**	**0.132**	**Yes**
Heptachlor epoxide	**10 - 41**	**13**	**2.47**	**Yes**
Hexachlorobenzene	330 - 2,500	19	N/A	UT
Hexachlorobutadiene	**330 - 2,500**	**19**	**23**	**Yes**
Hexachlorocyclopentadiene	330 - 2,500	17	N/A	UT
Hexachloroethane	330 - 2,500	19	N/A	UT
Indeno(1,2,3-cd)pyrene	**330 - 2,500**	**16**	**17**	**Yes**
Isophorone	330 - 2,500	19	N/A	UT
Methoxychlor	**100 - 410**	**13**	**24**	**Yes**
Naphthalene	**330 - 2,500**	**19**	**176**	**Yes**
Nitrobenzene	330 - 2,500	19	N/A	UT
N-Nitroso-di-n-propylamine	330 - 2,500	19	N/A	UT
N-nitrosodiphenylamine	330 - 2,500	19	N/A	UT
Pyridine	890 - 2,500	5	N/A	UT
Styrene	5 - 14	10	N/A	UT
Toxaphene	200 - 820	13	N/A	UT
trans-1,3-Dichloropropene	5 - 14	11	N/A	UT
Vinyl acetate	10 - 29	11	N/A	UT
Vinyl Chloride	10 - 29	12	N/A	UT

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

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

ESL = Ecological screening level.

UT = Uncertain toxicity.

N/A = Not available or not applicable.

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Table A1.2.MKAEU.1
Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Water

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[a] > ESL?
Inorganic Total (mg/L)				
Ammonia	**0.1 - 0.2**	**5**	**0.0200**	**Yes**
Antimony[b]	4.4E-04 - 0.05	38	0.240	No
Beryllium[b]	**1.0E-04 - 0.005**	**39**	**0.00240**	**Yes**
Cadmium[b]	**1.0E-04 - 0.005**	**38**	**2.50E-04**	**Yes**
Cyanide	**0 - 0.02**	**12**	**5.00E-04**	**Yes**
Mercury[b]	4.4E-05 - 2.0E-04	32	7.70E-04	No
Molybdenum[b]	2.6E-04 - 0.015	33	0.800	No
Silver[b]	**1.0E-04 - 0.0068**	**37**	**3.20E-04**	**Yes**
Sulfide	1 - 1	12	N/A	UT
Thallium[b]	**1.0E-04 - 0.109**	**38**	**0.0150**	**Yes**
Tin[b]	0.001 - 0.05	33	0.0730	No
Inorganic Dissolved (mg/L)				
Antimony[b]	4.4E-04 - 0.0422	20	0.240	No
Beryllium[b]	1.0E-04 - 0.001	25	0.00240	No
Cadmium[b]	**2.0E-04 - 0.0046**	**21**	**2.50E-04**	**Yes**
Mercury[b]	2.0E-04 - 2.0E-04	22	7.70E-04	No
Molybdenum[b]	2.2E-04 - 0.014	24	0.800	No
Silver[b]	**1.0E-04 - 0.0068**	**25**	**3.20E-04**	**Yes**
Thallium[b]	**1.0E-04 - 0.109**	**24**	**0.0150**	**Yes**
Tin[b]	0.001 - 0.0389	25	0.0730	No
Organic Total (µg/L)				
1,1,1-Trichloroethane	5 - 10	13	89	No
1,1,2,2-Tetrachloroethane	5 - 10	13	2,400	No
1,1,2-Trichloroethane	5 - 10	13	940	No
1,1-Dichloroethane	5 - 10	13	740	No
1,1-Dichloroethene	5 - 10	13	65	No
1,2,4-Trichlorobenzene	10 - 11	2	50	No
1,2-Dichlorobenzene	10 - 11	2	13	No
1,2-Dichloroethane	5 - 10	13	20,000	No
1,2-Dichloroethene	5 - 10	13	1,100	No
1,2-Dichloropropane	5 - 10	13	5,700	No
1,3-Dichlorobenzene	10 - 11	2	28	No
1,4-Dichlorobenzene	10 - 11	2	16	No
2,4,5-Trichlorophenol	28	1	N/A	UT
2,4,6-Trichlorophenol	**11**	**1**	**5**	**Yes**
2,4-Dichlorophenol	11	1	365	No
2,4-Dimethylphenol	11	1	212	No
2,4-Dinitrophenol	28	1	N/A	UT
2,4-Dinitrotoluene	10 - 11	2	N/A	UT
2,6-Dinitrotoluene	10 - 11	2	N/A	UT
2-Chloronaphthalene	10 - 11	2	630	No

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Table A1.2.MKAEU.1

Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Water

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[a] > ESL?
2-Chlorophenol	11	1	N/A	UT
2-Hexanone	10 - 10	13	99	No
2-Methylnaphthalene	10 - 11	2	N/A	UT
2-Methylphenol	11	1	82	No
2-Nitroaniline	28 - 50	2	N/A	UT
2-Nitrophenol	11	1	N/A	UT
3,3'-Dichlorobenzidine	11 - 20	2	N/A	UT
3-Nitroaniline	28 - 50	2	N/A	UT
4,4'-DDD	**0.1 - 0.12**	**3**	**0.0600**	**Yes**
4,4'-DDE	0.1 - 0.12	3	105	No
4,4'-DDT	**0.1 - 0.12**	**3**	**0.00100**	**Yes**
4,6-Dinitro-2-methylphenol	28	1	N/A	UT
4-Bromophenyl-phenylether	10 - 11	2	N/A	UT
4-Chloro-3-methylphenol	11	1	N/A	UT
4-Chloroaniline	10 - 11	2	N/A	UT
4-Chlorophenyl-phenyl ether	10 - 11	2	N/A	UT
4-Methyl-2-pentanone	10 - 10	13	170	No
4-Methylphenol	11	1	25	No
4-Nitroaniline	28 - 50	2	N/A	UT
4-Nitrophenol	28	1	N/A	UT
Acenaphthene	10 - 11	2	520	No
Acenaphthylene	10 - 11	2	N/A	UT
Acetone	10 - 26	13	1,500	No
Aldrin	0.05 - 0.058	3	0.150	No
alpha-BHC	0.05 - 0.058	3	2.20	No
alpha-Chlordane	0.05 - 0.5	3	N/A	UT
Anthracene	**10 - 11**	**2**	**0.730**	**Yes**
Benzene	5 - 10	13	530	No
Benzo(a)anthracene	**10 - 11**	**2**	**0.0270**	**Yes**
Benzo(a)pyrene	**10 - 11**	**2**	**0.0140**	**Yes**
Benzo(b)fluoranthene	10 - 11	2	N/A	UT
Benzo(g,h,i)perylene	10 - 11	2	N/A	UT
Benzo(k)fluoranthene	10 - 11	2	N/A	UT
beta-BHC	0.05 - 0.058	3	2.20	No
beta-Chlordane	0.05 - 0.5	3	N/A	UT
bis(2-Chloroethoxy) methane	10 - 11	2	N/A	UT
bis(2-Chloroethyl) ether	10 - 11	2	N/A	UT
bis(2-Chloroisopropyl) ether	10 - 11	2	29	No
Bromodichloromethane	5 - 10	13	1,100	No
Bromoform	5 - 10	13	320	No
Bromomethane	10 - 10	13	35	No
Butylbenzylphthalate	10 - 11	2	67	No
Carbazole	**11**	**1**	**4**	**Yes**
Carbon Disulfide	**5 - 10**	**13**	**0.920**	**Yes**
Carbon Tetrachloride	5 - 10	13	3,520	No
Chlorobenzene	5 - 10	13	47	No

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Table A1.2.MKAEU.1
Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Water

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[a] > ESL?
Chloroethane	10 - 10	13	N/A	UT
Chloroform	5 - 10	13	1,240	No
Chloromethane	10 - 10	12	N/A	UT
Chrysene	10 - 11	2	N/A	UT
cis-1,3-Dichloropropene	5 - 10	13	244	No
delta-BHC	0.05 - 0.058	3	2.20	No
Dibenz(a,h)anthracene	10 - 11	2	N/A	UT
Dibenzofuran	**10 - 11**	**2**	**4**	**Yes**
Dibromochloromethane	5 - 10	13	N/A	UT
Dieldrin	**0.1 - 0.12**	**3**	**0.0560**	**Yes**
Diethylphthalate	10 - 11	2	110	No
Dimethylphthalate	10 - 11	2	N/A	UT
Di-n-butylphthalate	**10 - 11**	**2**	**9.70**	**Yes**
Di-n-octylphthalate	10 - 11	2	N/A	UT
Endosulfan I	**0.05 - 0.058**	**3**	**0.0560**	**Yes**
Endosulfan II	**0.1 - 0.12**	**3**	**0.0560**	**Yes**
Endosulfan sulfate	**0.1 - 0.12**	**3**	**0.0560**	**Yes**
Endrin	**0.1 - 0.12**	**3**	**0.0360**	**Yes**
Endrin aldehyde	**0.1 - 0.12**	**2**	**0.0360**	**Yes**
Endrin ketone	**0.1 - 0.12**	**3**	**0.0360**	**Yes**
Ethylbenzene	5 - 10	13	3,200	No
Fluoranthene	10 - 11	2	398	No
Fluorene	10 - 11	2	12	No
gamma-BHC (Lindane)	0.05 - 0.058	3	0.0800	No
Heptachlor	**0.05 - 0.058**	**3**	**0.00380**	**Yes**
Heptachlor epoxide	**0.05 - 0.058**	**3**	**0.00380**	**Yes**
Hexachlorobenzene	10 - 11	2	N/A	UT
Hexachlorobutadiene	**10 - 11**	**2**	**9.30**	**Yes**
Hexachlorocyclopentadiene	10 - 11	2	N/A	UT
Hexachloroethane	10 - 11	2	540	No
Indeno(1,2,3-cd)pyrene	10 - 11	2	N/A	UT
Isophorone	10 - 11	2	1,300	No
Methoxychlor	0.5 - 0.58	3	N/A	UT
Naphthalene	10 - 11	2	620	No
Nitrobenzene	10 - 11	2	N/A	UT
N-Nitroso-di-n-propylamine	10 - 11	2	N/A	UT
N-nitrosodiphenylamine	10 - 11	2	N/A	UT
Aroclor-1016	**0.5 - 1.2**	**3**	**0.0140**	**Yes**
Aroclor-1221	**0.5 - 2.3**	**3**	**0.0140**	**Yes**
Aroclor-1232	**0.5 - 1.2**	**3**	**0.0140**	**Yes**
Aroclor-1242	**0.5 - 1.2**	**3**	**0.0140**	**Yes**
Aroclor-1248	**0.5 - 1.2**	**3**	**0.0140**	**Yes**
Aroclor-1254	**1 - 1.2**	**3**	**0.0140**	**Yes**
Aroclor-1260	**1 - 1.2**	**3**	**0.0140**	**Yes**
Pentachlorophenol	**28**	**1**	**6.73**	**Yes**
Phenanthrene	**10 - 11**	**2**	**2.40**	**Yes**

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Table A1.2.MKAEU.1

Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Water

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[a] > ESL?
Phenol	11	1	2,560	No
Pyrene	**10 - 11**	**2**	**0.0250**	**Yes**
Styrene	5 - 10	13	160	No
Toluene	5 - 10	13	1,750	No
Toxaphene	1 - 5.8	3	N/A	UT
trans-1,3-Dichloropropene	5 - 10	13	244	No
Vinyl acetate	10 - 10	12	N/A	UT
Vinyl Chloride	10 - 10	13	930	No
Xylene[c]	5 - 10	13	35	No

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

[b] Analyte has a detection frequency of less than 5 percent.

[c] The value for total xylene is used.

ESL = Ecological screening level.

UT = Uncertain toxicity.

N/A = Not available or not applicable.

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Table A1.2.MKAEU.2
Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency of less than 5 Percent in Sediment[a]

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[b] > ESL?
Inorganic (mg/kg)				
Nitrite	0.4 - 0.4	1	N/A	UT
Silver	**0.078 - 1.94**	**12**	**1**	**Yes**
Organic (µg/kg)				
1,1,1-Trichloroethane	5 - 27	8	159	No
1,1,2,2-Tetrachloroethane	5 - 27	8	1,900	No
1,1,2-Trichloroethane	5 - 27	8	N/A	UT
1,1-Dichloroethane	5 - 27	8	N/A	UT
1,1-Dichloroethene	5 - 27	8	N/A	UT
1,2,4-Trichlorobenzene	**340 - 1,200**	**8**	**429**	**Yes**
1,2-Dichlorobenzene	340 - 1,200	8	N/A	UT
1,2-Dichloroethane	5 - 27	8	N/A	UT
1,2-Dichloroethene	5 - 27	8	N/A	UT
1,2-Dichloropropane	5 - 27	8	N/A	UT
1,3-Dichlorobenzene	**340 - 1,200**	**8**	**122**	**Yes**
1,4-Dichlorobenzene	340 - 1,200	8	N/A	UT
2,4,5-Trichlorophenol	1,700 - 5,600	8	N/A	UT
2,4,6-Trichlorophenol	**340 - 1,200**	**8**	**59.3**	**Yes**
2,4-Dichlorophenol	340 - 1,200	8	N/A	UT
2,4-Dimethylphenol	340 - 1,200	8	N/A	UT
2,4-Dinitrophenol	1,700 - 5,600	8	N/A	UT
2,4-Dinitrotoluene	340 - 1,200	8	N/A	UT
2,6-Dinitrotoluene	340 - 1,200	8	N/A	UT
2-Chloronaphthalene	340 - 1,200	8	N/A	UT
2-Chlorophenol	340 - 1,200	8	N/A	UT
2-Hexanone	10 - 27	7	N/A	UT
2-Methylnaphthalene	**340 - 1,200**	**8**	**20.2**	**Yes**
2-Methylphenol	340 - 1,200	8	6,970	No
2-Nitroaniline	1,700 - 5,600	8	N/A	UT
2-Nitrophenol	340 - 1,200	8	N/A	UT
3,3'-Dichlorobenzidine	680 - 1,800	7	N/A	UT
3-Nitroaniline	1,700 - 5,600	7	N/A	UT
4,4'-DDD	**9 - 56**	**8**	**4.88**	**Yes**
4,4'-DDE	**9 - 56**	**8**	**3.16**	**Yes**
4,4'-DDT	**9 - 56**	**8**	**4.16**	**Yes**
4,6-Dinitro-2-methylphenol	1,700 - 5,600	8	N/A	UT
4-Bromophenyl-phenylether	**340 - 1,200**	**8**	**166**	**Yes**
4-Chloro-3-methylphenol	340 - 1,200	8	N/A	UT
4-Chloroaniline	340 - 1,200	8	N/A	UT
4-Chlorophenyl-phenyl ether	340 - 1,200	8	N/A	UT
4-Methyl-2-pentanone	10 - 27	8	N/A	UT
4-Nitroaniline	1,700 - 4,300	7	N/A	UT
4-Nitrophenol	1,700 - 5,600	8	N/A	UT
Acenaphthene	**340 - 1,200**	**8**	**6.71**	**Yes**
Acenaphthylene	**340 - 1,200**	**8**	**5.87**	**Yes**

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Table A1.2.MKAEU.2
Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency of less than 5 Percent in Sediment[a]

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[b] > ESL?
Acetone	13 - 210	8	N/A	UT
Aldrin	**4.5 - 28**	**8**	**8.25**	**Yes**
alpha-BHC	4.5 - 28	8	43.9	No
alpha-Chlordane	**4.5 - 280**	**8**	**3.24**	**Yes**
Anthracene	**340 - 1,200**	**8**	**57.2**	**Yes**
Aroclor-1016	**81 - 280**	**8**	**40**	**Yes**
Aroclor-1221	**81 - 280**	**8**	**40**	**Yes**
Aroclor-1232	**81 - 280**	**8**	**40**	**Yes**
Aroclor-1242	**81 - 280**	**8**	**40**	**Yes**
Aroclor-1248	**81 - 280**	**8**	**40**	**Yes**
Aroclor-1254	**90 - 560**	**8**	**40**	**Yes**
Aroclor-1260	**90 - 560**	**8**	**40**	**Yes**
Benzene	5 - 27	8	260	No
Benzo(a)anthracene	**340 - 1,200**	**8**	**108**	**Yes**
Benzo(a)pyrene	**340 - 1,200**	**8**	**150**	**Yes**
Benzo(b)fluoranthene	340 - 1,200	8	N/A	UT
Benzo(g,h,i)perylene	**340 - 1,200**	**7**	**13**	**Yes**
Benzo(k)fluoranthene	**340 - 1,200**	**8**	**240**	**Yes**
Benzyl Alcohol	**340 - 1,200**	**7**	**1.35**	**Yes**
beta-BHC	4.5 - 28	8	93.6	No
beta-Chlordane	**4.5 - 280**	**4**	**3.24**	**Yes**
bis(2-Chloroethoxy) methane	340 - 1,200	8	N/A	UT
bis(2-Chloroethyl) ether	340 - 1,200	8	N/A	UT
bis(2-Chloroisopropyl) ether	340 - 1,200	8	N/A	UT
Bromodichloromethane	5 - 27	8	N/A	UT
Bromoform	5 - 27	8	N/A	UT
Bromomethane	**10 - 27**	**8**	**3.43**	**Yes**
Butylbenzylphthalate	340 - 1,200	8	11,400	No
Carbazole	**890**	**1**	**25.2**	**Yes**
Carbon Disulfide	5 - 27	8	N/A	UT
Carbon Tetrachloride	5 - 27	8	7,890	No
Chlorobenzene	5 - 27	8	N/A	UT
Chloroethane	10 - 27	8	N/A	UT
Chloroform	5 - 27	8	N/A	UT
Chloromethane	10 - 27	8	N/A	UT
cis-1,3-Dichloropropene	5 - 27	8	N/A	UT
delta-BHC	**4.5 - 28**	**8**	**2.37**	**Yes**
Dibenz(a,h)anthracene	**340 - 1,200**	**8**	**33**	**Yes**
Dibenzofuran	**340 - 1,200**	**8**	**325**	**Yes**
Dibromochloromethane	5 - 27	8	N/A	UT
Dieldrin	**9 - 56**	**8**	**5.94**	**Yes**
Diethylphthalate	**340 - 1,200**	**8**	**108**	**Yes**
Dimethylphthalate	340 - 1,200	8	N/A	UT
Di-n-octylphthalate	340 - 1,200	8	N/A	UT
Endosulfan I	**4.5 - 28**	**8**	**0.690**	**Yes**

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Table A1.2.MKAEU.2
Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency of less than 5 Percent in Sediment[a]

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[b] > ESL?
Endosulfan II	**9 - 56**	**8**	**0.690**	**Yes**
Endosulfan sulfate	**9 - 56**	**8**	**0.690**	**Yes**
Endrin	9 - 56	8	N/A	UT
Endrin aldehyde	9	1	N/A	UT
Endrin ketone	9 - 56	8	N/A	UT
Ethylbenzene	5 - 27	8	16,570	No
Fluorene	**340 - 1,200**	**8**	**77.4**	**Yes**
gamma-BHC (Lindane)	**4.5 - 28**	**8**	**2.37**	**Yes**
gamma-Chlordane	**81 - 220**	**4**	**3.24**	**Yes**
Heptachlor	**4.5 - 28**	**8**	**0.132**	**Yes**
Heptachlor epoxide	**4.5 - 28**	**8**	**2.47**	**Yes**
Hexachlorobenzene	340 - 1,200	8	N/A	UT
Hexachlorobutadiene	**340 - 1,200**	**8**	**23**	**Yes**
Hexachlorocyclopentadiene	340 - 1,200	8	N/A	UT
Hexachloroethane	340 - 1,200	8	N/A	UT
Indeno(1,2,3-cd)pyrene	**340 - 1,200**	**8**	**17**	**Yes**
Isophorone	340 - 1,200	8	N/A	UT
Methoxychlor	**45 - 280**	**8**	**24**	**Yes**
Methylene Chloride	6 - 28	8	N/A	UT
Naphthalene	340 - 1,200	8	176	UT
Nitrobenzene	340 - 1,200	8	N/A	UT
N-Nitroso-di-n-propylamine	340 - 1,200	8	N/A	UT
N-nitrosodiphenylamine	340 - 1,200	8	N/A	UT
Pentachlorophenol	**1,700 - 5,600**	**8**	**255**	**Yes**
Phenol	**340 - 1,200**	**8**	**773**	**Yes**
Styrene	5 - 27	8	N/A	UT
Tetrachloroethene	5 - 27	8	3,050	No
Toxaphene	160 - 560	8	N/A	UT
trans-1,3-Dichloropropene	5 - 27	8	N/A	UT
Trichloroethene	5 - 27	8	22,800	No
Vinyl acetate	10 - 18	7	N/A	UT
Vinyl Chloride	10 - 27	8	N/A	UT
Xylene[c]	5 - 27	8	91	No

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

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

[c] The value for total xylene is used.

ESL = Ecological screening level.

UT = Uncertain toxicity.

N/A = Not available or not applicable.

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Table A1.2.SEAEU.1
Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Water[a]

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[b] > ESL?
Inorganic Total (mg/L)				
Arsenic	7.0E-04 - 0.0037	9	0.150	No
Beryllium	5.0E-04 - 0.001	12	0.00240	No
Cadmium	**3.8E-04 - 0.0046**	**11**	**2.50E-04**	**Yes**
Chromium	0.0012 - 0.0055	12	0.0740	No
Cobalt	9.1E-04 - 0.0073	12	0.100	No
Cyanide	**0.001 - 0.01**	**7**	**5.00E-04**	**Yes**
Mercury	4.4E-05 - 2.0E-04	12	7.70E-04	No
Nitrite	0.02 - 0.05	7	4.47	No
Ortho-phosphate	0.05 - 0.05	2	N/A	UT
Thallium	0.001 - 0.0043	12	0.0150	No
Uranium	0.0078 - 0.03	4	1.50	No
Vanadium	0.002 - 0.0065	12	0.0120	No
Inorganic Dissolved (mg/L)				
Arsenic	7.0E-04 - 0.002	6	0.150	No
Beryllium	5.0E-04 - 0.001	5	0.00240	No
Cadmium	**0.001 - 0.0046**	**7**	**2.50E-04**	**Yes**
Chromium	0.002 - 0.0055	7	0.0740	No
Cobalt	0.002 - 0.0073	6	0.100	No
Mercury	1.0E-04 - 2.0E-04	7	7.70E-04	No
Thallium	0.001 - 0.002	6	0.0150	No
Vanadium	0.002 - 0.0065	7	0.0120	No
Organic Total (µg/L)				
1,1,1,2-Tetrachloroethane	0.1	1	N/A	UT
1,1,1-Trichloroethane	0.1 - 5	7	89	No
1,1,2,2-Tetrachloroethane	0.1 - 5	7	2,400	No
1,1,2-Trichloroethane	0.1 - 5	7	940	No
1,1-Dichloroethane	0.2 - 5	7	740	No
1,1-Dichloroethene	0.2 - 5	7	65	No
1,1-Dichloropropene	0.1	1	N/A	UT
1,2,3-Trichlorobenzene	0.1	1	8	No
1,2,3-Trichloropropane	0.1	1	N/A	UT
1,2,4-Trichlorobenzene	0.1	1	50	No
1,2,4-Trimethylbenzene	0.1	1	17	No
1,2-Dibromo-3-chloropropane	2	1	N/A	UT
1,2-Dibromoethane	0.5	1	N/A	UT
1,2-Dichlorobenzene	0.1	1	13	No
1,2-Dichloroethane	0.1 - 5	7	20,000	No
1,2-Dichloroethene	5 - 5	7	1,100	No
1,2-Dichloropropane	0.1 - 5	7	5,700	No
1,3,5-Trimethylbenzene	0.1	1	45	No
1,3-Dichlorobenzene	0.1	1	28	No
1,3-Dichloropropane	0.1	1	N/A	UT
1,4-Dichlorobenzene	0.1	1	16	No
2,4,5-TP (Silvex)	0.46	1	N/A	UT
2,4,5-Trichlorophenol	50	1	N/A	UT

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Table A1.2.SEAEU.1
Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Water[a]

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[b] > ESL?
2,4,6-Trichlorophenol	**10**	**1**	**5**	**Yes**
2,4-D	0.46	1	N/A	UT
2,4-Dichlorophenol	10	1	365	No
2,4-Dimethylphenol	10	1	212	No
2,4-Dinitrophenol	50	1	N/A	UT
2,4-Dinitrotoluene	10	1	N/A	UT
2,6-Dinitrotoluene	10	1	N/A	UT
2378-TCDD	0.0012	1	N/A	UT
2-Butanone	10 - 10	6	2,200	No
2-Chloronaphthalene	10	1	630	No
2-Chlorophenol	10	1	N/A	UT
2-Chlorotoluene	0.2	1	N/A	UT
2-Hexanone	10 - 10	7	99	No
2-Methylnaphthalene	10	1	N/A	UT
2-Methylphenol	10	1	82	No
2-Nitroaniline	50	1	N/A	UT
2-Nitrophenol	10	1	N/A	UT
3,3'-Dichlorobenzidine	20	1	N/A	UT
3-Nitroaniline	50	1	N/A	UT
4,4'-DDD	**0.1**	**1**	**0.0600**	**Yes**
4,4'-DDE	0.1	1	105	No
4,4'-DDT	**0.1**	**1**	**0.00100**	**Yes**
4,6-Dinitro-2-methylphenol	50	1	N/A	UT
4-Bromophenyl-phenylether	10	1	N/A	UT
4-Chloro-3-methylphenol	10	1	N/A	UT
4-Chloroaniline	10	1	N/A	UT
4-Chlorophenyl-phenyl ether	10	1	N/A	UT
4-Chlorotoluene	0.2	1	N/A	UT
4-Isopropyltoluene	0.2	1	N/A	UT
4-Methyl-2-pentanone	10 - 10	6	170	No
4-Methylphenol	10	1	25	No
4-Nitroaniline	50	1	N/A	UT
4-Nitrophenol	50	1	N/A	UT
Acenaphthene	10	1	520	No
Acenaphthylene	5.92	1	N/A	UT
Acetone	10 - 10	6	1,500	No
Aldrin	0.051	1	0.150	No
alpha-BHC	0.051	1	2.20	No
alpha-Chlordane	0.51	1	N/A	UT
Ametryne	0.61	1	N/A	UT
Anthracene	0.0306	1	0.730	No
Aroclor-1016	**0.51**	**1**	**0.0140**	**Yes**
Aroclor-1221	**0.51**	**1**	**0.0140**	**Yes**
Aroclor-1232	**0.51**	**1**	**0.0140**	**Yes**
Aroclor-1242	**0.51**	**1**	**0.0140**	**Yes**
Aroclor-1248	**0.51**	**1**	**0.0140**	**Yes**

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Table A1.2.SEAEU.1
Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Water[a]

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[b] > ESL?
Aroclor-1254	**1**	**1**	**0.0140**	**Yes**
Aroclor-1260	**1**	**1**	**0.0140**	**Yes**
Atraton	0.61	1	N/A	UT
Atrazine	0.51	1	7.30	No
Benzene	0.2 - 5	7	530	No
Benzo(a)anthracene	**0.347**	**1**	**0.0270**	**Yes**
Benzo(a)pyrene	**0.143**	**1**	**0.0140**	**Yes**
Benzo(b)fluoranthene	0.153	1	N/A	UT
Benzo(g,h,i)perylene	1.53	1	N/A	UT
Benzo(k)fluoranthene	0.0816	1	N/A	UT
Benzoic Acid	**50**	**1**	**42**	**Yes**
Benzyl Alcohol	**10**	**1**	**8.60**	**Yes**
beta-BHC	0.051	1	2.20	No
bis(2-Chloroethoxy) methane	10	1	N/A	UT
bis(2-Chloroethyl) ether	10	1	N/A	UT
bis(2-Chloroisopropyl) ether	10	1	29	No
bis(2-ethylhexyl)phthalate	10	1	28.5	No
Bromobenzene	0.2	1	N/A	UT
Bromochloromethane	0.5	1	N/A	UT
Bromodichloromethane	0.2 - 5	7	1,100	No
Bromoform	0.5 - 5	7	320	No
Bromomethane	1 - 10	7	35	No
Butylbenzylphthalate	10	1	67	No
Carbon Disulfide	**5 - 5**	**7**	**0.920**	**Yes**
Carbon Tetrachloride	0.2 - 5	7	3,520	No
Chlorobenzene	0.1 - 5	7	47	No
Chloroethane	0.5 - 10	7	N/A	UT
Chloroform	0.1 - 5	7	1,240	No
Chloromethane	0.5 - 10	7	N/A	UT
Chrysene	0.53	1	N/A	UT
cis-1,2-Dichloroethene	0.1	1	620	No
cis-1,3-Dichloropropene	0.1 - 5	7	244	No
delta-BHC	0.051	1	2.20	No
Dibenz(a,h)anthracene	2.45	1	N/A	UT
Dibenzofuran	**10**	**1**	**4**	**Yes**
Dibromochloromethane	0.2 - 5	7	N/A	UT
Dibromomethane	0.5	1	N/A	UT
Dichlorodifluoromethane	0.5	1	N/A	UT
Dieldrin	**0.1**	**1**	**0.0560**	**Yes**
Diethylphthalate	10	1	110	No
Dimethylphthalate	10	1	N/A	UT
Di-n-butylphthalate	**10**	**1**	**9.70**	**Yes**
Di-n-octylphthalate	10	1	N/A	UT
Endosulfan I	0.051	1	0.0560	No
Endosulfan II	**0.1**	**1**	**0.0560**	**Yes**
Endosulfan sulfate	**0.1**	**1**	**0.0560**	**Yes**

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Table A1.2.SEAEU.1
Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Water[a]

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[b] > ESL?
Endrin	**0.1**	**1**	**0.0360**	**Yes**
Endrin ketone	**0.1**	**1**	**0.0360**	**Yes**
Ethylbenzene	0.2 - 5	7	3,200	No
Fluoranthene	0.632	1	398	No
Fluorene	0.898	1	12	No
gamma-BHC (Lindane)	0.051	1	0.0800	No
gamma-Chlordane	0.51	1	N/A	UT
Heptachlor	**0.051**	**1**	**0.00380**	**Yes**
Heptachlor epoxide	**0.051**	**1**	**0.00380**	**Yes**
Hexachlorobenzene	10	1	N/A	UT
Hexachlorobutadiene	0.1	1	9.30	No
Hexachlorocyclopentadiene	10	1	N/A	UT
Hexachloroethane	10	1	540	No
Indeno(1,2,3-cd)pyrene	0.785	1	N/A	UT
Isophorone	10	1	1,300	No
Isopropylbenzene	0.2	1	N/A	UT
m,p-Xylene	0.2	1	35	No
Methoxychlor	0.51	1	N/A	UT
Naphthalene	3.88	1	620	No
n-Butylbenzene	0.2	1	N/A	UT
Nitrobenzene	10	1	N/A	UT
N-Nitroso-di-n-propylamine	10	1	N/A	UT
N-nitrosodiphenylamine	10	1	N/A	UT
n-Propylbenzene	0.2	1	N/A	UT
o-Xylene	0.2	1	35	No
Pentachlorophenol	**50**	**1**	**6.73**	**Yes**
Phenanthrene	0.714	1	2.40	No
Phenol	10	1	2,560	No
Prometon	0.31	1	N/A	UT
Prometryn	0.61	1	N/A	UT
Propazine	0.31	1	N/A	UT
Pyrene	**1.84**	**1**	**0.0250**	**Yes**
sec-Butylbenzene	0.2	1	N/A	UT
Simazine	0.61	1	10	No
Simetryn	0.71	1	N/A	UT
Styrene	0.1 - 5	7	160	No
Terbutryn	0.51	1	N/A	UT
Terbutylazine	0.31	1	N/A	UT
tert-Butylbenzene	0.2	1	N/A	UT
Tetrachloroethene	0.1 - 5	7	840	No
Toluene	0.2 - 5	7	1,750	No
Toxaphene	1	1	N/A	UT
trans-1,2-Dichloroethene	0.1	1	1,500	No
trans-1,3-Dichloropropene	0.1 - 5	7	244	No
Trichloroethene	0.1 - 5	7	21,900	No
Trichlorofluoromethane	0.5	1	N/A	UT

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Table A1.2.SEAEU.1
Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency less than 5 Percent in Surface Water[a]

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[b] > ESL?
Vinyl acetate	10 - 10	6	N/A	UT
Vinyl Chloride	0.2 - 10	7	930	No
Xylene[c]	5 - 5	7	35	No

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

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Table A1.2.SEAEU.2
Evaluation of Maximum Reported Results for Nondetected Analytes and Analytes with a Detection Frequency of less than 5 Percent in Sediment[a]

Analyte	Range of Reported Results	Total Number of Results	Lowest ESL	Maximum Reported Result[b] > ESL?
Inorganic (mg/kg)				
Antimony	0.7 - 1.7	7	2	No
Silver	0.09 - 0.42	7	1	No
Tin	1 - 4	7	N/A	UT

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

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COMPREHENSIVE RISK ASSESSMENT

NO NAME AQUATIC EXPOSURE UNIT, ROCK CREEK AQUATIC EXPOSURE UNIT, MCKAY DITCH AQUATIC EXPOSURE UNIT, SOUTHEAST AQUATIC EXPOSURE UNIT

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Data Quality Assessment

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ACRONYMS AND ABBREVIATIONS

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

MSD	matrix spike duplicate
NIST	National Institute of Standards Technology
NN AEU	No Name Gulch Aquatic Exposure Unit
NW AEU	North Walnut Creek Aquatic Exposure Unit
PARCC	precision, accuracy, representativeness, completeness, and comparability
PPT	pipette
PCB	polychlorinated biphenyl
QC	quality control
RC AEU	Rock Creek Aquatic Exposure Unit
RDL	required detection limit
RFEDS	Rocky Flats Environmental Data System
RFETS	Rocky Flats Environmental Technology Site
RI/FS	Remedial Investigation/Feasibility Study
RL	reporting limit
RPD	relative percent difference
SDP	standard data package
SE AEU	Southeast Aquatic Exposure Unit
SOW	Statement of Work
SVOC	semi-volatile organic compound
SW AEU	South Walnut Creek Aquatic Exposure Unit
SWD	Soil Water Database
TCLP	Toxicity Characteristic Leaching Procedure
TIC	tentatively identified compound
V&V	verification and validation

VOC	volatile organic compound
WC AEU	Woman Creek Aquatic Exposure Unit

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EXECUTIVE SUMMARY

This document provides an assessment of the quality of the data for four of the seven the Aquatic Exposure Units (AEUs) used in the Comprehensive Risk Assessment (CRA) at the Rocky Flats Environmental Technology Site (RFETS). As such, this Data Quality Assessment (DQA) focuses on all elements of quality control (QC) including both laboratory and sample-specific QC data.

Depending on the specific AEU, anywhere from 79 to 94 percent of the data have been verified and/or validated by a validator from the Analytical Services Division (ASD) at RFETS (or from an outside subcontractor) using verification and validation (V&V) guidelines for each analytical method developed for RFETS. V&V data are identified in the RFETS Soil Water Database (SWD) by a data qualifier flag and reason code(s) that provide an explanation for the qualifier flag. All rejected data have been removed from the AEU data sets used in the CRA because the validator has determined the data are unusable. The other qualifier flags indicate the data are valid, estimated, or undetected, and are used in the CRA. The percentage of the V&V data qualified as estimated and/or undetected ranged from 14 percent in the No Name AEU (NN AEU) to nearly 23 percent in the McKay Ditch AEU (MK AEU). Less than 5 percent of the data reported as detected by the laboratory for all AEUs were qualified as undetected due to blank contamination. Data qualified as estimated or undetected are a result of various minor issues identified by the validators, but are insufficient to render the data unusable.

A review of the AEU V&V data indicates that the data meet the data quality objectives (DQOs) outlined in the Final CRA Work Plan and Methodology (K-H 2004) (hereafter referred to as the CRA Methodology). A review of the most common observations found in the V&V data determined that a minimal amount, less than one percent, of the non-V&V data may have been qualified if a review had been performed. Based on this DQA, data for the AEUs discussed here are of sufficient quality for use in the CRA.

1.0 INTRODUCTION

This document provides an assessment of the quality of the data for each of the seven the Aquatic Exposure Units (AEUs) used in the Comprehensive Risk Assessment (CRA) at the Rocky Flats Environmental Technology Site (RFETS). As such, this Data Quality Assessment (DQA) focuses on all elements of quality control (QC) including both laboratory and sample-specific QC data.

The AEU CRA for RFETS has been prepared in accordance with the CRA Methodology. The CRA Methodology was developed jointly with the regulatory agencies using the consultative process, and was approved by the agencies on September 28, 2004. Consistent with the CRA Methodology, data quality was assessed using a standard precision, accuracy, representativeness, completeness, and comparability (PARCC) parameter analysis (EPA 2002), and both laboratory and field quality control (QC) were evaluated.

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

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

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

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  - LCS data, calibration verification data, internal standard data, and instrument tune parameters (laboratory accuracy); and
  - Surrogate recoveries, MSs, and sample preparation (sample-specific accuracy).
- Representativeness of the data was verified through review of:
  - Laboratory blank data;
  - Sample preservation/storage;
  - Adherence to sample holding times;
  - Documentation issues;
  - Contract noncompliance issues; and
  - Laboratory activities affecting ability to properly identify compounds.
- Completeness is a data adequacy criterion and is addressed in Appendix A, Volume 2 of the Remedial Investigation/Feasibility Study (RI/FS) Report. It refers to the spatial and temporal distribution of the data, and their adequacy for estimating exposure point concentrations (EPCs) for the CRA.
- Comparability of the data was verified through evaluation of:
  - Analytical procedures, and whether they were standard U.S. Environmental Protection Agency (EPA)- and RFETS-approved procedures;
  - Instrument types and maintenance, sample preparation techniques, and standard units for reporting; and
  - MS and surrogate samples, ensuring accuracy within acceptable ranges.

2.0 ANALYTICAL DATA

The majority of the data (79 to 94 percent depending on the specific AEU) used in the AEU CRA have undergone verification and validation (V&V). The specific fraction of the data that was verified and/or validated is discussed in Section 3.0 for each AEU by analyte group/matrix combination. These data were reviewed by validators and their observations and comments are captured in the Soil Water Database (SWD). All of the data that have been flagged due to V&V findings (except "R"-flagged data) and data that have no flags as a result of V&V are used in the AEU CRA. The small amount of data that has not undergone V&V is used as provided by the laboratories. The most common errors found during V&V such as transcription errors, calculation errors, and excluded records that were later added by the validator were reviewed to determine the possible effect on non-V&V data. Assuming that the percentage of data qualified as a result of these issues are representative of similar observations in the non-V&V data, less than one percent of each AEU dataset is at risk for such un-acknowledged and therefore un-corrected errors.

Data V&V involves an in-depth review of the data packages from the laboratory to assess compliance with contract requirements. In general, data validation includes all of the activities of verification as well as additional QC checks and review of some raw laboratory instrument data and calculations. After V&V, a data qualifier flag and/or reason code(s) are assigned to the data record (Tables A2.1 and A2.2). The reason codes provide an explanation for the qualifier flag, thereby making it possible to determine which of the PARCC parameters is affected by the observation (Table A2.3). Qualifier flags are discussed in this DQA as those V&V flags that note issues in the data. V&V flags "V", "V1", and "1" represent data that were reviewed by validators, but no issues were observed. The amount of V&V data that falls into this category ranges from 74 percent in the MK AEU to 84 percent in the NN AEU. Additional qualifier flags such as "A", "E", and "Z" were also applied. These validation qualifiers are notations that do not indicate estimation or a change in the status of detection. The data are valid and useable as reported by the laboratory. The specific definitions of these additional V&V flags are presented in Table A2.1. Data with noted issues are presented in the tables per AEU, analyte group, and matrix and are discussed in detail in Section 3.0.

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

V&V data records contain a field with V&V reason codes (5, 18/52, 200, 99/101/701, and so forth), or the field is null. These reason codes represent observations related to assessment of precision, accuracy, and representativeness. For example, the reason code 110 definition (see Table A2.2) is "LCS recovery criteria were not met," which is an observation is related to data accuracy.

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

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

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(Table A2.3). The reason codes were then summarized by AEU for each medium and analyte group within each QC category, applying the standardized definition to the summarized codes. The summaries are presented in Section 3.0.

Rejected data (data qualifier flag "R") have been removed from the data used in the AEU CRA because the validator has determined the data to be unusable. The fraction of the data that was rejected during validation and/or verification is also presented in the tables by AEU, analyte group, and matrix and discussed in Section 3.0.

Finally, evaluating the RPD (DER for radionuclides) between a target sample and the associated field duplicate is not a QC parameter performed during V&V, but is still an important analysis when determining data precision. Because this analysis was not performed during V&V, the target sample/field duplicate RPD and DER calculations are presented in the tables, also by AEU, analyte group, and matrix and discussed in Section 3.0.

3.0 AQUATIC EXPOSURE UNITS

The percentages of V&V data, rejected data, data qualified as usable, estimated or undetected, and the percentage of laboratory detected data qualified as undetected due to blank contamination are presented below for each of the seven AEUs. V&V observations affecting the CRA data set are also summarized for each AEU by analyte group/matrix/QC category/reason code. The RPDs (DERs for radionuclides) between target sample/field duplicate analyte pairs are presented by analyte group and matrix as the number of pairs exceeding control criteria.

The quality of the laboratory results were evaluated for compliance with the CRA Methodology DQOs through an overall review of PARCC parameters. Although many of the elements of QC that are reviewed in this document affect more than one PARCC parameter, the general discussions below summarize the data quality per the validation reason codes affecting each specific PARCC parameter. Several V&V reason codes have no real impact on data quality because they represent issues that were noted but corrected, or represent observations related to missing documentation that was not required for data assessment. These "Other" reason codes do not affect any of the PARCC parameters and are only presented in this report for the purpose of completeness.

3.1 North Walnut Creek Aquatic Exposure Unit (NW AEU)

This section is presented in Volume 15B12 of this CRA.

3.2 South Walnut Creek Aquatic Exposure Unit (SW AEU)

This section is presented in Volume 15B12 of this CRA.

3.3 Woman Creek Aquatic Exposure Unit (WC AEU)

This section is presented in Volume 15B12 of this CRA.

3.4 No Name Gulch Aquatic Exposure Unit (NN AEU)

Depending on the analyte group/matrix combination, anywhere from 67 to 100 percent of the data were validated and/or verified, with an overall 83 percent of the NN AEU data set having undergone V&V (Table A2.3.4.1). Of that 83 percent, approximately 84 percent was qualified as having no issues and 14 percent was qualified as either estimated or undetected due to minor laboratory noncompliance issues (Table A2.3.4.2). The remaining two percent of the V&V data are made up of records qualified with additional flags indicating acceptable data such as "A", "E", or "P".

Less than 3 percent of the data reported as detected by the laboratory were flagged as undetected by the validators due to blank contamination (Table A2.3.4.3).

Approximately 4.4 percent of the entire NN AEU data set was rejected during V&V. The percent of rejected data is presented by analyte group and matrix in Table A2.3.4.4, and is discussed in the subsequent sections below when greater than 10 percent of the associated data were rejected.

The RPDs (DERs for radionuclides) between a target sample and the field duplicate are presented in Table A2.3.4.5 and only discussed in further detail when exceedances of control criteria are greater than 10 percent for any given analyte group/matrix combination.

V&V observations affecting the NN AEU data set are summarized by analyte group and matrix in Table A2.3.4.6. The detected and nondetected results are summarized separately to give the reader a better idea of the impact on data usability. Observations noted in large percentages (generally greater than five percent) of the data that possibly affect data quality are discussed below in further detail.

3.4.1 Dioxins and Furans – Water

Calibration and documentation issues resulted in data V&V qualifications related to this analyte group/matrix combination. Although 100 percent of the data were qualified, this included only seven analytical results. It is important to note that the associated data were qualified as usable, although estimated.

3.4.2 Herbicides – Soil

Holding time and matrix issues resulted in data V&V qualifications related to this analyte group/matrix combination. Although the percentage of qualified data is high, it is important to note that the data were qualified as usable, although estimated.

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3.4.3 Herbicides – Water

Calibration, documentation, holding time, LCS, matrix, sample preparation, surrogate, and other issues resulted in data V&V qualifications related to this analyte group/matrix combination. The percentage of qualified data is low with few exceptions. The omissions or errors noted in the data package do not impact data quality as the omitted data was not required for V&V. Similar documentation issues such as a lack of original documentation also do not impact data usability as all observations have previously been evaluated and corrected. Although issues related to allowed sample holding times and surrogate recoveries should not be overlooked, it is important to note that the data associated with these observations were qualified as usable, although estimated.

3.4.4 Metals – Soil

Blank, documentation, instrument set-up, LCS, matrix, and other observations resulted in data V&V qualifications related to this analyte group/matrix combination.
The percentage of observations is low with the exception of those records qualified for expired instrument detection limit (IDL) studies and predigestion MS recovery criteria exceedances. Although the importance of predigestion MSs and quarterly IDL studies should not be underestimated, it is also important to note that the data were qualified as usable, although estimated.

3.4.5 Metals – Water

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

3.4.6 Polychlorinated Biphenyls (PCBs) – Soil

Issues with surrogates resulted in data V&V observations related to this analyte group/matrix combination. While the percentage of observations related to surrogate recoveries is high, it is important to note that the data were qualified as usable, although estimated.

3.4.7 Polychlorinated Biphenyls – Water

None of the data associated with this analyte group and matrix were flagged with V&V observations. The amount of data that was rejected during V&V, however, is notable. Almost 17 percent of the V&V data for this analyte group/matrix combination were rejected. Taking into account that only 71 percent of all associated data underwent V&V, approximately five percent of this dataset may have been rejected if a review had been performed, but only two samples did not have V&V performed.

3.4.8 Pesticides – Soil

Holding time, matrix, and surrogate observations resulted in data V&V qualifications related to this analyte group/matrix combination. While the percentage of issues related to MS/MSD precision and surrogate recoveries is high, it is important to note that the data were qualified as usable, although estimated.

3.4.9 Pesticides – Water

Calibration, documentation, holding time, matrix, sample preparation, and other observations resulted in data V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records qualified due to issues with continuing calibration verifications and documentation. The omissions or errors noted in the data package do not impact data quality as the omitted data was not required for V&V. While the importance of continuing calibration verifications should not be underestimated, it is also important to note that the data were qualified as usable, although estimated. Approximately 15 percent of the V&V data for this analyte group/matrix combination were rejected. Taking into account that only 67 percent of the CRA data associated with this analyte group and matrix was either validated and/or verified, as much as five percent of the data used in the CRA may have been rejected if a review had been performed.

3.4.10 Radionuclides – Soil

Blank, calculation error, calibration, documentation, holding time, instrument set-up, LCS, matrix, sensitivity, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with few exceptions. Insufficient documentation indicates that a complete V&V evaluation may not have been performed, but it is important to note that the data were qualified as usable, although estimated. Transcription errors and validator-calculated minimum detectable activities (MDAs) have no effect on data quality as all issues have previously been evaluated and corrected. While the importance of meeting the detector efficiency requirements should not be overlooked, it is also important to note that all associated data were qualified as usable, although estimated. Although approximately 22 percent of the V&V data for this analyte group/matrix combination was rejected, 99 percent of all associated data underwent V&V. This leaves less than one percent of the data related to this analyte group/matrix combination that may have been rejected if a review had been performed.

3.4.11 Radionuclides – Water

Blank, calculation error, calibration, documentation, holding time, LCS, matrix, sensitivity, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with few exceptions. Insufficient documentation indicates that a complete V&V evaluation may not have been performed, but it is important to note that the data were qualified as usable, although estimated. Validator-calculated MDAs have no effect on data quality as all issues have previously been evaluated and corrected. The majority of the data with validation flags directing the data user to the hard copy validation report for further explanation of the observation were also qualified as estimated. The CRA is performed with this uncertainty in mind and no further effort was made to identify these observations. While the importance of QC parameters such as blank and MS/MSD analyses and sample holding times should not be overlooked, it is also important to note that the data were qualified as usable, although estimated. Finally, approximately 22 percent of the V&V data for this analyte group/matrix combination were rejected. Taking into account that only 83 percent of all associated data underwent V&V, approximately four percent of this dataset may have been rejected if a review had been performed.

3.4.12 Semi-Volatile Organic Compounds (SVOCs) – Soil

Blank, calibration, holding time, and matrix observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records noted because the allowed sample holding time was exceeded or because the MS/MSD precision criteria were not met. Although the importance of these two QC parameters should not be overlooked, it is also important to note that the data were qualified as usable, although estimated.

3.4.13 Semi-Volatile Organic Compounds – Water

Blank, calibration, documentation, holding time, instrument setup, LCS, matrix, sample preparation, surrogate, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with few exceptions. The omissions or errors noted in the data package do not impact data quality as the omitted data was not required for V&V. Similar documentation issues such as a lack of original documentation also do not impact data usability as all observations have previously been evaluated and corrected. While the importance of observing allowed sample holding times should not be overlooked, it is also important to note that the data were qualified as usable, although estimated.

3.4.14 Volatile Organic Compounds (VOCs) – Soil

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

3.4.15 Volatile Organic Compounds – Water

Blank, calculation error, calibration, documentation, holding time, instrument set-up, internal standard, LCS, matrix, sample preparation, surrogate, and other issues resulted in

V&V observations related to this analyte group/matrix combination. With the exception of those records noted for documentation issues, the percentage of observations is low and within method expectations. The omissions or errors noted in the data package do not impact data quality as the omitted data was not required for V&V. Similar documentation issues such as a lack of original documentation also do not impact data usability as all observations have previously been evaluated and corrected.

3.4.16 Wet Chemistry Parameters – Soil

Holding time and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records noted for expired IDL studies. While the importance of quarterly IDL studies should not be overlooked, it is also important to note that this analyte group contains many general chemistry parameters having little impact on site characterization.

3.4.17 Wet Chemistry Parameters – Water

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

3.4.18 Discussion

Approximately 35 percent of the NN AEU CRA data set was flagged with "Other" validation reason codes that do not affect any of the PARCC parameters.

- Precision: Of the V&V data, approximately six percent was noted for observations related to precision. All of the data qualified for precision-related issues were qualified for issues related to sample matrices. No confirmation, LCS, instrument set-up or sensitivity issues related to precision were noted.

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

- Accuracy: Of the V&V data, 28 percent was noted for accuracy-related observations. Of that 28 percent, approximately 72 percent was noted for laboratory practice-related observations. Sample-specific accuracy observations comprise the other 28 percent of the qualified data. Although the percentage of the data with noted accuracy issues is slightly elevated, it is important to note that most of the data flagged with these accuracy-related observations are also flagged as estimated and the CRA is performed with this uncertainty in mind.

- Representativeness: Of the V&V data, approximately 39 percent was noted for observations related to representativeness. Of that 39 percent, 43 percent was qualified for blank observations, 38 percent for failure to observe allowed holding times, 10 percent for issues related to sample preparation, and approximately eight percent for documentation issues. LCS and other observations related to sample representativeness make up the other one percent.

  Reportable levels of target analytes were not routinely detected in the laboratory blanks greater than the laboratory RLs except for relatively isolated incidences. Overall, blank contamination was indicative of normal laboratory operations and did not impact the sample data as reported.

  Sample data are representative of the site conditions at the time of sample collection. Some transcription errors and documentation issues were observed that impacted sample results; however, the majority of such issues were corrected in the database. Samples were generally stored and preserved properly. Overall, these elements of QC exceedances are indicative of normal laboratory operations.

- Comparability of the data was reviewed and no systematic errors were noted.

  - The use of standard EPA- and RFETS-approved analytical procedures;
  - Instrument types and maintenance, sample preparation techniques, and standard units for reporting; and
  - Evaluation of MS and surrogate samples, ensuring accuracy within acceptable ranges.

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

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

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

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

3.5 Rock Creek Aquatic Exposure Unit (RC AEU)

Depending on the analyte group/matrix combination, anywhere from 64 to 100 percent of the data were validated and/or verified, with an overall 87 percent of the RC AEU data set having undergone V&V (Table A2.3.5.1). Of that 87 percent, approximately

78 percent was qualified as having no issues and 19 percent was qualified as either estimated or undetected due to minor laboratory noncompliance issues (Table A2.3.5.2). The remaining three percent of the V&V data are made up of records qualified with additional flags indicating acceptable data such as "A", "E", or "P".

Four percent of the data reported as detected by the laboratory was flagged as undetected by the validators due to blank contamination (Table A2.3.5.3).

Approximately nine percent of the entire RC AEU data set was rejected during V&V. The percent of rejected data is presented by analyte group and matrix in Table A2.3.5.4, and is discussed in the subsequent sections below when greater than 10 percent of the associated data were rejected.

The RPDs (DERs for radionuclides) between a target sample and the field duplicate are presented in Table A2.3.5.5 and only discussed in further detail when exceedances of control criteria are greater than 10 percent for any given analyte group/matrix combination.

V&V observations affecting the RC AEU data set are summarized by analyte group and matrix in Table A2.3.5.6. The detected and nondetected results are summarized separately to give the reader a better idea of the impact on data usability. Observations noted in large percentages (generally greater than five percent) of the data that possibly affect data quality are discussed below in further detail.

3.5.1 Herbicides - Soil

Issues with surrogates resulted in data V&V observations related to this analyte group/matrix combination. While the percentage of observations is high, it is important to note that the data were qualified as usable, although estimated. Twenty percent of the V&V data for this analyte group/matrix combination were rejected, but 100 percent of all associated data underwent V&V. Consequently there is no possibility that any rejected data related to this analyte group and matrix were used in CRA.

3.5.2 Metals – Soil

Blank, calibration, documentation, LCS, matrix, and other observations resulted in data V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records noted because the samples contained less than 30 percent solid material and those noted for LCS recoveries criteria exceedances. While the importance of these QC criteria should not be underestimated, it is also important to note that the data were qualified as usable, although estimated.

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3.5.3 Metals – Water

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

3.5.4 Polychlorinated Biphenyls (PCBs) – Soil

Documentation, surrogate, and other issues resulted in data V&V observations related to this analyte group/matrix combination. While the percentage of all observations is high, it is important to note that the data were qualified as usable, although estimated. Although approximately 22 percent of the V&V data for this analyte group/matrix combination were rejected, 92 percent of all associated data underwent V&V. This leaves only approximately two percent of the data associated with this analyte group and matrix that may have been rejected if a review had been performed.

3.5.5 Pesticides – Soil

Surrogate and other issues resulted in data V&V observations related to this analyte group/matrix combination. While the percentage of observations is high, it is important to note that the data were qualified as usable, although estimated. Although approximately 22 percent of the V&V data for this analyte group/matrix combination were rejected, 93 percent of all associated data underwent V&V. This leaves only approximately two percent of the data associated with this analyte group and matrix that may have been rejected if a review had been performed.

3.5.6 Radionuclides – Soil

Blank, calculation error, calibration, documentation, holding time, instrument set-up, LCS, matrix, sensitivity, and other observations resulted in data V&V qualifications related to the analyte group/matrix combination. The percentage of observations is low, with few exceptions. Insufficient documentation indicates that a complete V&V evaluation may not have been performed, but it is important to note that the data were qualified as usable, although estimated. Transcription errors and validator-calculated MDAs have no effect on data quality as all issues have previously been evaluated and corrected. While the importance of blank analyses should not be overlooked, it is also important to note that all associated data were qualified as usable, although estimated. The majority of the data with validation flags directing the data user to the hard copy validation report for further explanation of the observation was also qualified as estimated. The CRA is performed with this uncertainty in mind and no further effort was made to identify these observations. Although 19 percent of the V&V data for this analyte group/matrix combination was rejected, 98 percent of all associated data underwent V&V. This leaves less than one percent of the data related to this analyte group/matrix combination that may have been rejected if a review had been performed.

3.5.7 Radionuclides – Water

Blank, calibration, documentation, holding time, LCS, matrix, sensitivity, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with few exceptions. Insufficient documentation indicates that a complete V&V evaluation may not have been performed, but it is important to note that the data were qualified as usable, although estimated. Transcription errors and validator-calculated MDAs have no effect on data quality as all issues have previously been evaluated and corrected. While the importance of QC parameters such as blank and MS/MSD analyses and continuing calibration verifications should not be overlooked, it is also important to note that all associated data were qualified as usable, although estimated. The majority of the data with validation flags directing the data user to the hard copy validation report for further explanation of the observation was also qualified as estimated. The CRA is performed with this uncertainty in mind and no further effort was made to identify these observations. Although 35 percent of the V&V data for this analyte group/matrix combination was rejected, 98 percent of all associated data underwent V&V. This leaves less than one percent of the data related to this analyte group/matrix combination that may have been rejected if a review had been performed.

3.5.8 Semi-Volatile Organic Compounds (SVOCs) – Soil

Blank, calibration, internal standard, matrix, and surrogate observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of all observations is low and within method expectations. Although 15 percent of the V&V data for this analyte group/matrix combination was rejected, almost all (99.6 percent) associated data underwent V&V. This leaves less than one percent of the data related to this analyte group/matrix combination that may have been rejected if a review had been performed.

3.5.9 Semi-Volatile Organic Compounds – Water

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

3.5.10 Volatile Organic Compounds (VOCs) – Soil

Blank, calibration, documentation, internal standard, matrix, and surrogate observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records noted for issues with internal standards. While the importance of internal standard analyses should not be overlooked, it is also important to note that the data were qualified as usable, although estimated. Approximately 24 percent of the V&V data for this analyte group/matrix combination were rejected, but 100 percent of all associated data underwent V&V.

Consequently there is no possibility that any rejected data related to this analyte group and matrix were used in CRA.

3.5.11 Volatile Organic Compounds – Water

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

3.5.12 Wet Chemistry Parameters – Soil

Documentation, holding time, and matrix issues resulted in V&V observations related to this analyte group/matrix combination. While the percentage of the data noted for matrix-related issues and because the allowed sample holding time was grossly exceeded is high, it is important to note that this analyte group contains many general chemistry parameters having little impact on site characterization.

3.5.13 Wet Chemistry Parameters – Water

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

3.5.14 Discussion

Approximately 12 percent of the RC AEU CRA data set was flagged with "Other" validation reason codes that do not affect any of the PARCC parameters.

- Precision: Of the V&V data, approximately two percent was noted for observations related to precision. All of the data qualified for precision-related issues were qualified for issues related to sample matrices. No confirmation, LCS, instrument setup or sensitivity issues related to precision were noted.

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

- Accuracy: Of the V&V data, 35 percent was noted for accuracy-related observations. Of that 35 percent, approximately 70 percent was noted for laboratory practice-related observations. Sample-specific accuracy observations make up the other 30 percent of the qualified data. Although the percentage of the data with noted accuracy issues is slightly elevated, it is important to note that most of the data flagged with these accuracy-related observations are also flagged as estimated and the CRA is performed with this uncertainty in mind.

- Representativeness: Of the V&V data, approximately 41 percent was noted for observations related to representativeness. Of that 41 percent, 82 percent was qualified for blank observations, 4 percent for documentation issues relating to representativeness, 6 percent for failure to observe allowed holding times, two percent for issues with sample matrices, three percent for sample preparation issues, and one percent each for sensitivity and LCS observations. The remaining one percent of the data qualified with issues related to sample representativeness is made up of instrument set-up and other, miscellaneous observations.

  Reportable levels of target analytes were not routinely detected in the laboratory blanks greater than the laboratory RLs except for relatively isolated incidences. Overall, blank contamination was indicative of normal laboratory operations and did not impact the sample data as reported.

  Sample data are representative of the site conditions at the time of sample collection. Some transcription errors and documentation issues were observed that impacted sample results; however, the majority of such issues were corrected in the database. Samples were generally stored and preserved properly. Overall, these elements of QC exceedances are indicative of normal laboratory operations.

- Comparability of the data was reviewed and no systematic errors were noted.

  - The use of standard EPA- and RFETS-approved analytical procedures;
  - Instrument types and maintenance, sample preparation techniques, and standard units for reporting; and
  - Evaluation of MS and surrogate samples, ensuring accuracy within acceptable ranges.

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

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

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

  Because greater than 90 percent of the overall data were qualified as usable, the use of non-V&V data for the RC AEU CRA does not contribute to any completeness issues.

3.6 McKay Ditch Aquatic Exposure Unit (MK AEU)

Depending on the analyte group/matrix combination, anywhere from 48 to 100 percent of the data were validated and/or verified, with an overall 79 percent of the MK AEU data set having undergone V&V (Table A2.3.6.1). Of that 79 percent, approximately 74 percent was qualified as having no issues and 23 percent as either estimated or undetected due to minor laboratory noncompliance issues (Table A2.3.6.2). The remaining 3 percent of the V&V data are made up of records qualified with additional flags indicating acceptable data such as "A", "E," or "P".

Less than two percent of the data reported as detected by the laboratory were flagged as undetected by the validators due to blank contamination (Table A2.3.6.3).

Approximately six percent of the entire MK AEU data set was rejected during V&V. The percent of rejected data is presented by analyte group and matrix in Table A2.3.6.4, and is discussed in the subsequent sections below when greater than 10 percent of the associated data were rejected.

The RPDs (DERs for radionuclides) between a target sample and the field duplicate are presented in Table A2.3.6.5 and are only discussed in further detail when exceedances of control criteria are greater than 10 percent for any given analyte group/matrix combination.

V&V observations affecting the MK AEU data set are summarized by analyte group and matrix in Table A2.3.6.6. The detected and nondetected results are summarized separately to give the reader a better idea of the impact on data usability. Observations noted in large percentages (generally greater than five percent) of the data that possibly affect data quality are discussed below in further detail.

3.6.1 Herbicide - Water

None of the data associated with this analyte group and matrix were flagged with V&V observations. The amount of data that was rejected during V&V, however, is notable. Approximately 25 percent of the V&V data for this analyte group/matrix combination were rejected, but 100 percent of all associated data underwent V&V. Consequently there is no possibility that any rejected data related to this analyte group and matrix were used in CRA.

3.6.2 Metals – Soil

Blank, calibration, documentation, LCS, matrix, sensitivity, and other observations resulted in data V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records noted for low LCS recoveries and other issues more fully explained in the hard copy of the validation report. While the importance of LCS analyses should not be underestimated, it is important to note that the data were qualified as usable, although estimated. The majority of the data with validation flags directing the data user to the hard copy validation report for further explanation of the observation was also qualified as estimated. The CRA is performed with this uncertainty in mind and no further effort was made to identify these observations.

3.6.3 Metals – Water

Blank, calibration, documentation, holding time, LCS, matrix, sensitivity, and other observations resulted in V&V qualifications associated with this analyte group/matrix combination. The percentage of observations is low with the exception of those data noted for LCS recovery criteria exceedances. While the importance of LCS analyses should not be overlooked, it is important to note that the data were qualified as usable, although estimated.

3.6.4 Polychlorinated Biphenyls (PCBs) – Soil

Issues with surrogates resulted in data V&V observations related to this analyte group/matrix combination. While the percentage of observations is high, it is important to note that the data were qualified as usable, although estimated.

3.6.5 Polychlorinated Biphenyls – Water

Issues with surrogates resulted in data V&V observations related to this analyte group/matrix combination. While the percentage of observations is high, it is important to note that the data were qualified as usable, although estimated.

3.6.6 Pesticides – Soil

Issues with surrogates resulted in data V&V observations related to this analyte group/matrix combination. While the percentage of observations is high, it is important to note that the data were qualified as usable, although estimated.

3.6.7 Pesticides – Water

Issues with calibration and surrogates resulted in data V&V observations related to this analyte group/matrix combination. While the percentage of surrogate observations is high, it is important to note that the data were qualified as usable, although estimated.

3.6.8 Radionuclides – Soil

Blank, calculation error, calibration, documentation, instrument set-up, LCS, matrix, sensitivity, sample preparation, and other observations resulted in data V&V qualifications related to the analyte group/matrix combination. The percentage of observations is low with few exceptions. Insufficient documentation indicates that a complete V&V evaluation may not have been performed, but it is important to note that the data were qualified as usable, although estimated. Transcription errors and validator-calculated MDAs have no effect on data quality as all issues have previously been evaluated and corrected. While the importance of QC parameters such as blank, LCS, and MS/MSD analyses should not be overlooked, it is also important to note that all associated data were qualified as usable, although estimated. The majority of the data with validation flags directing the data user to the hard copy validation report for further explanation of the observation was also qualified as estimated. The CRA is performed with this uncertainty in mind and no further effort was made to identify these observations. Although 16 percent of the V&V data for this analyte group/matrix combination was rejected, 88 percent of all associated data underwent V&V. This leaves only about two percent of the data related to this analyte group/matrix combination that may have been rejected if a review had been performed.

3.6.9 Radionuclides – Water

Blank, calibration, documentation, holding time, LCS, matrix, sensitivity, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with few exceptions. Insufficient documentation indicates that a complete V&V evaluation may not have been performed, but it is important to note that the data were qualified as usable, although estimated. Transcription errors and validator-calculated MDAs have no effect on data quality as all issues have previously been evaluated and corrected. While the importance continuing calibration verifications should not be overlooked, it is also important to note that the data were qualified as usable, although estimated. The majority of the data with validation flags directing the data user to the hard copy validation report for further explanation of the observation was also qualified as estimated. The CRA is performed with this uncertainty in mind and no further effort was made to identify these observations. Approximately 43 percent of the V&V data for this analyte group/matrix combination were rejected. Taking into account that only 48 percent of the CRA data associated with this analyte group and matrix was either validated and/or verified, as much as 24 percent (125 records) of the data used in the CRA may have been rejected if a review had been performed. These exceedances, however, were noted is a small dataset, where only a few issues can greatly skew statistics.

3.6.10 Semi-Volatile Organic Compounds (SVOCs) – Soil

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

3.6.11 Semi-Volatile Organic Compounds – Water

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

3.6.12 Volatile Organic Compounds (VOCs) – Soil

Blank, calibration, internal standard, and surrogate observations resulted in V&V qualifications related to this analyte group/matrix combination. While the percentage of surrogate observations is high, it is important to note that the data were qualified as usable, although estimated.

3.6.13 Volatile Organic Compounds – Water

Blank, calibration, and documentation issues resulted in V&V observations related to this analyte group/matrix combination. With the exception of those record qualified due to documentation issues, the percentage of observations is low and within method expectations. Validator-added records, however, have no impact on data usability as all issues have previously been evaluated and corrected.

3.6.14 Wet Chemistry Parameters – Soil

Holding time and matrix issues resulted in V&V observations related to this analyte group/matrix combination. While the percentage of all observations is high, including the percent of rejected data, it is important to note that this analyte group contains many general chemistry parameters having little impact on site characterization.

3.6.15 Wet Chemistry Parameters – Water

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

3.6.16 Discussion

Approximately 12 percent of the MK AEU CRA data set was flagged with "Other" validation reason codes that do not affect any of the PARCC parameters.

- Precision: Of the V&V data, approximately two percent was noted for observations related to precision. All of the data qualified for precision-related issues were qualified for issues related to sample matrices. No confirmation, LCS, instrument setup, or sensitivity issues related to precision were noted.

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

- Accuracy: Of the V&V data, 47 percent was noted for accuracy-related observations. Of that 47 percent, approximately 74 percent was noted for laboratory practice-related observations. Sample-specific accuracy observations make up the other 26 percent of the qualified data. Although the percentage of the data with noted accuracy issues is slightly elevated, it is important to note that most of the data flagged with these accuracy-related observations are also flagged as estimated and the CRA is performed with this uncertainty in mind.

- Representativeness: Of the V&V data, 38 percent was noted for observations related to representativeness. Of that 38 percent, approximately 90 percent was qualified for blank observations, seven percent for failure to observe allowed holding times, and two percent for documentation issues. LCS, sensitivity, and other, miscellaneous observations make up the remaining one percent of the data qualified for issues related to sample representativeness.

  Reportable levels of target analytes were not routinely detected in the laboratory blanks greater than the laboratory RLs except for relatively isolated incidences. Overall, blank contamination was indicative of normal laboratory operations and did not impact the sample data as reported.

  Sample data are representative of the site conditions at the time of sample collection. Some transcription errors and documentation issues were observed that impacted sample results; however, the majority of such issues were corrected in the database. Samples were generally stored and preserved properly. Overall, these elements of QC exceedances are indicative of normal laboratory operations.

- Comparability of the data was reviewed and no systematic errors were noted.

  - The use of standard EPA- and RFETS-approved analytical procedures;

  - Instrument types and maintenance, sample preparation techniques, and standard units for reporting; and

  - Evaluation of MS and surrogate samples, ensuring accuracy within acceptable ranges.

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

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

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

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

3.7 Southeast Aquatic Exposure Unit (SE AEU)

Depending on the analyte group/matrix combination, anywhere from 86 to 100 percent of the data were validated and/or verified, with an overall 94 percent of the SE AEU data set having undergone V&V (Table A2.3.7.1). Of that 94 percent, approximately 79 percent was qualified as having no issues and 17 percent as either estimated or undetected due to minor laboratory noncompliance issues (Table A2.3.7.2). The remaining 4 percent of the V&V data is made up of records qualified with additional flags indicating acceptable data such as "A", "E", or "P".

Approximately 4 percent of the data reported as detected by the laboratory were flagged as undetected by the validators due to blank contamination (Table A2.3.7.3).

Three percent of the entire SE AEU data set was rejected during V&V. The percent of rejected data is presented by analyte group and matrix in Table A2.3.7.4, and is discussed in the subsequent sections below when greater than 10 percent of the associated data were rejected.

The RPDs (DERs for radionuclides) between a target sample and the field duplicate are presented in Table A2.3.7.5 and are only discussed in further detail when exceedances of control criteria are greater than 10 percent for any given analyte group/matrix combination.

V&V observations affecting the SE AEU data set are summarized by analyte group and matrix in Table A2.3.7.6. The detected and nondetected results are summarized separately to give the reader a better idea of the impact on data usability. Observations noted in large percentages (generally greater than five percent) of the data that possibly affect data quality are discussed below in further detail.

3.7.1 Dioxins and Furans – Water

Documentation issues resulted in data V&V qualifications related to this analyte group/matrix combination. Although 100 percent of the data were qualified, this included only one analytical result. Data quality is not impacted because all documentation issues have previously been evaluated and corrected.

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3.7.2 Herbicides – Water

Calibration issues resulted in data V&V qualifications related to this analyte group/matrix combination. Although the percentage of the data noted with issues related to continuing calibration verifications is high, it is important to note that the data were qualified as usable, although estimated.

3.7.3 Metals – Soil

Blank, LCS, matrix, and other observations resulted in data V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with few exceptions. Although the importance of calibration verification blanks, predigestion MS analyses, and quarterly IDL studies should not be underestimated, it is also important to note that the data was qualified as usable, although estimated. Although 40 percent of the target sample/field duplicate analyte pairs exceeded RPD criteria, it is important to note that all exceedances were noted in the same target sample/field duplicate pair. This is more indicative of matrix interference at that location than an overall precision issue.

3.7.4 Metals – Water

Blank, calibration, documentation, LCS, matrix, and other observations resulted in V&V qualifications associated with this analyte group/matrix combination. The percentage of all observations is low with the exception of those records qualified due to blank contamination and expired IDL studies. While the importance these QC parameters should not be overlooked, it is also important to note that the data were qualified as usable, although estimated.

3.7.5 Pesticides – Water

Issues with calibration and documentation resulted in data V&V observations related to this analyte group/matrix combination. While the percentage of continuing calibration verification issues is high, it is important to note that the data were qualified as usable, although estimated.

3.7.6 Radionuclides – Water

Blank, calibration, documentation, holding time, instrument set-up, LCS, matrix, sensitivity, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with few exceptions. Insufficient documentation indicates that a complete V&V evaluation may not have been performed, but it is important to note that the data were qualified as usable, although estimated. Transcription errors and validator-calculated MDAs have no effect on data quality as all issues have previously been evaluated and corrected. While the importance instrument calibration and LCS analyses should not be overlooked, it is also important to note that the data were qualified as usable, although estimated. The majority of the data with validation flags directing the data user to the hard copy validation report for further explanation of the observation was also qualified as estimated. The CRA is performed with this uncertainty in mind and no further effort was made to identify these observations. Approximately 21 percent of the V&V data for this analyte group/matrix combination were rejected, but 100 percent of all associated data underwent V&V. Consequently there is no possibility that any rejected data related to this analyte group and matrix were used in CRA.

3.7.7 Semi-Volatile Organic Compounds (SVOCs) – Water

Documentation, holding time, and other observations resulted in V&V qualifications related to this analyte group/matrix combination. The percentage of observations is low with the exception of those records noted with validation flags directing the data user to the hard copy validation report for further explanation of the observation. The majority of these records are qualified as estimated and the CRA is performed with this uncertainty in mind. No further effort to identify these observations was made.

3.7.8 Volatile Organic Compounds (VOCs) – Water

Blank, calibration, documentation, holding time, and other issues resulted in V&V observations related to this analyte group/matrix combination. With the exception of those records noted for documentation issues and exceeding allowed sample holding times, the percentage of observations is low and within method expectations. Transcription errors and validator-added records have no impact on data quality as all issues have previously been evaluated and corrected. While observing allowed sample holding times is important, it is also important to note that the data were qualified as usable, although estimated.

3.7.9 Wet Chemistry Parameters – Soil

Matrix and other issues resulted in V&V observations related to this analyte group/matrix combination. While the percentage of observations is high, it is important to note that this analyte group contains many general chemistry parameters having little impact on site characterization.

3.7.10 Wet Chemistry Parameters – Water

Calibration, documentation, holding time, matrix, and other issues resulted in V&V observations related to this analyte group/matrix combination. While the percentages of several of the observation are high, it is important to note that this analyte group contains several general chemistry parameters having little to do with site characterization.

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3.7.11 Discussion

Approximately 18 percent of the SE AEU CRA data set was flagged with "Other" validation reason codes that do not affect any of the PARCC parameters.

- Precision: Of the V&V data, approximately one percent was noted for observations related to precision. All of the data qualified for precision-related issues were qualified for issues related to sample matrices. No confirmation, LCS, instrument setup, or sensitivity issues related to precision were noted.

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

- Accuracy: Of the V&V data, 47 percent was noted for accuracy-related observations. Of that 47 percent, approximately 80 percent was noted for laboratory practice-related observations. Sample-specific accuracy observations make up the other 20 percent of the qualified data. Although the percentage of the data with noted accuracy issues is slightly elevated, it is important to note that most of the data flagged with these accuracy-related observations are also flagged as estimated and the CRA is performed with this uncertainty in mind.

- Representativeness: Of the V&V data, approximately 44 percent was noted for observations related to representativeness. Of that 44 percent, 74 percent was qualified for blank observations, 22 percent for failure to observe allowed holding times, two percent for documentation issues, and one percent for observations related to instrument sensitivity. Instrument set-up and other, miscellaneous issues make up the remaining one percent of the data qualified for observations related to sample representativeness.

  Reportable levels of target analytes were not routinely detected in the laboratory blanks greater than the laboratory RLs except for relatively isolated incidences. Overall, blank contamination was indicative of normal laboratory operations and did not impact the sample data as reported.

  Sample data are representative of the site conditions at the time of sample collection. Some transcription errors and documentation issues were observed that impacted sample results; however, the majority of such issues were corrected in the database. Samples were generally stored and preserved properly. Overall, these elements of QC exceedances are indicative of normal laboratory operations.

- Comparability of the data was reviewed and no systematic errors were noted.

  - The use of standard EPA- and RFETS-approved analytical procedures;

- Instrument types and maintenance, sample preparation techniques, and standard units for reporting; and
- Evaluation of MS and surrogate samples, ensuring accuracy within acceptable ranges.

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

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

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

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

4.0 CONCLUSIONS

The quality of the data used in the AEU CRA was summarized and evaluated according to the PARCC parameters for each AEU. The vast majority of V&V data were qualified as usable, having no QC issues. The data with noted V&V observations were determined to have minimal impact on data precision, accuracy and representativeness. The percentage of rejected data is not high enough to cause concern as to completeness of the data set. The data for all AEUs are generally acceptable and it is determined that the CRA DQOs have been met.

Data qualified as estimated or undetected are a result of various minor issues identified by the validators, but are insufficient to render the data unusable. All analyses indicate the data meet the data quality objectives (DQOs) outlined in the Final CRA Work Plan and Methodology (K-H 2004) (hereafter referred to as the CRA Methodology) and, therefore, are adequate for use in the CRA.

5.0 REFERENCES

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

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

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TABLES

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Table A2.1
V&V Qualifier Flag Definitions

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

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Table A2.2
V&V Reason Code Definitions

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

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Table A2.2
V&V Reason Code Definitions

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

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Table A2.2
V&V Reason Code Definitions

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

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Table A2.2
V&V Reason Code Definitions

Validation Reason Code	Description
213	Instrument detection limit is > the associated RDL
214	IDL is older than 3 months from date of analysis
215	Blank results were not reported to the IDL/MDL
216	Post-digestion spike recoveries outside of 85-115 percent criteria
217	Post-digestion spike recoveries were < 10 percent
218	Sample COC was not verifiable (attributed to laboratory)
219	Standards have expired or are not valid
220	TCLP sample percent solids < 0.5 percent
222	TCLP particle size was not performed
224	Incomplete TCLP extraction data
225	Insufficient TCLP extraction time
226	TIC misidentification
227	No documentation regarding deviations from methods or SOW
228	Calibration recoveries affecting data quality have not been met
229	Element not analyzed in ICP interference check sample
230	QC sample/analyte (e.g., spike, duplicate, LCS) not analyzed
231	MS/MSD criteria not met
232	Control limits not assigned correctly
233	Sample matrix QC does not represent samples analyzed
234	QC sample does not meet method requirement
235	Duplicate sample control limits do not pass
236	LCS control limits do not pass
237	Preparation blank control limits do not pass
238	Blank correction was not performed
239	Winsorized mean plus standard deviation of the same not calculated or calculated wrong
240	Sample preparations for soil/sludge/sediment were not homog/aliq properly
241	No micro PPT or electroplating data available
242	Tracer requirements were not met
243	Standard values were not calculated correctly (LCS, tracer, standards)
244	Standard or tracer is not NIST traceable
245	Energy calibration criteria not met
246	Background calibration criteria were not met
247	Sample or control analysis not chemically separated from each other
248	Single combined TCLP result was not repeated for sample with both mis+nonm
249	Result qualified due to blank contamination
250	Incorrect analysis sequence
251	Misidentified target compounds
252	Result is suspect DU
701	Holding times were exceeded (not attributed to laboratory)
702	Holding times were grossly exceeded (not attributed to laboratory)
703	Samples were not preserved properly in the field (not attributed to laboratory)
801	Missing deliverables (required for data assessment)
802	Missing deliverables (not required for data assessment)
803	Omissions or errors on SDP deliverables (required for data assessment)
804	Omissions or errors on SDP deliverables (not required for data assessment
805	Information missing from case narrative
806	Site samples not used for sample matrix QC

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Table A2.2
V&V Reason Code Definitions

Validation Reason Code	Description
807	Original documentation not provided
808	Incorrect or incomplete DRC
809	Non-site samples reported with site samples
810	EDD does not match hard copy; EDD may be resubmitted

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Table A2.3
Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

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

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Table A2.3
Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
241	No micro pipette or electroplating data	Documentation issues	Other
26	No raw data submitted by the laboratory	Documentation issues	Representativeness
804	Omissions or errors in SDP (not required for	Documentation issues	Other
803	Omissions or errors in SDP (required for data	Documentation issues	Representativeness
807	Original documentation not provided	Documentation issues	Other
85	Record added by the validator	Documentation issues	Other
152	Reported data do not agree with raw data	Documentation issues	Other
89	Sample analysis was not requested	Documentation issues	Other
218	Sample COC was not verifiable (attributed to laboratory)	Documentation issues	Representativeness
704	Sample COC was not verifiable (not attributed to laboratory)	Documentation issues	Representativeness
83	Sample results were not included on Data Summary Table	Documentation issues	Other
52	Transcription error	Documentation issues	Other
205	Unobtainable omissions or errors on SDP (required for data assessment)	Documentation issues	Representativeness
1, 101, 701	Holding times were exceeded	Holding times	Representativeness
2, 102, 702	Holding times were grossly exceeded	Holding times	Representativeness
251	Misidentified target compounds	Identification errors	Representativeness
70	Resolution criteria not met	Identification errors	Representativeness
226	TIC misidentification	Identification errors	Representativeness
143, 43	Internal standards did not meet criteria	Internal standards	Accuracy
5	CRDL check sample recovery criteria were not met	LCS	Accuracy
33	LCS > ± 2 sigma and < ± 3 sigma	LCS	Accuracy
10, 110, 236	LCS recovery criteria were not met	LCS	Accuracy
132, 32	Laboratory control samples > ± 3 sigma	LCS	Accuracy
174, 74	LCS data not submitted	LCS	Representativeness
63	Expected LCS value not submitted/verifiable	LCS	Representativeness
62	LCS relative percent error criteria not met	LCS	Accuracy
105	Low-level check sample recovery criteria were not met	LCS	Accuracy
230	QC sample/analyte (e.g., spike, duplicate, LCS) not analyzed	LCS	Representativeness
28	Duplicate analysis was not performed	Matrices	Precision
11, 235	Duplicate sample precision criteria were not met	Matrices	Precision
111	LCS/LCSD precision criteria were not met	Matrices	Precision
128	Laboratory duplicate was not analyzed	Matrices	Precision
231	MS/MSD criteria not met	Matrices	Precision
116, 16	MSA calibration correlation coefficient <0.995	Matrices	Accuracy
115, 15	MSA was required but not performed	Matrices	Representativeness

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Table A2.3

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

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
58	Sample contained < 10 percent solid material	Matrices	Representativeness
57	Sample contained < 30 percent solid material	Matrices	Representativeness
217	Post-digestion spike recoveries were < 10%	Matrices	Accuracy
14, 114, 216	Post-digestion matrix spike criteria were not met	Matrices	Accuracy
113, 13	Predigestion matrix spike recovery is <30%	Matrices	Accuracy
112, 12	Predigestion matrix spike recovery criteria were not met	Matrices	Accuracy
27	Recovery criteria were not met	Matrices	Accuracy
31	Replicate analysis was not performed	Matrices	Precision
130, 30	Replicate precision criteria were not met	Matrices	Precision
61	Replicate recovery criteria were not met	Matrices	Accuracy
233	Sample matrix QC does not represent samples analyzed	Matrices	Representativeness
117, 17	Serial dilution criteria not met	Matrices	Accuracy
806	Site samples not used for sample matrix QC	Matrices	Representativeness
810	EDD does not match hard copy; EDD may be resubmitted	Other	Other
214	IDL is older than 3 months from date of	Other	Accuracy
250	Incorrect analysis sequence	Other	Representativeness
808	Incorrect or incomplete DRC	Other	Representativeness
212	Instrument detection limit was not provided	Other	Other
87	Laboratory did no analysis for this record	Other	Other
809	Nonsite samples reported with Site samples	Other	Other
64	Nontraceable/noncertified standard was used	Other	Accuracy
51	Nonverifiable laboratory results and/or unsubmitted data	Other	Representativeness
211	Poor cleanup recovery	Other	Accuracy
25	Primary standard had exceeded expiration date	Other	Accuracy
234	QC sample does not meet method requirement	Other	Representativeness
168, 68	QC sample frequency does not meet requirements	Other	Representativeness
252	Result is suspect due to dilution	Other	Other
79	Result obtained through dilution	Other	Other
37	Sample exceeded efficiency curve weight limit	Other	Accuracy
247	Sample or control analyses not chemically separated from each other	Other	Representativeness
90	Sample result was not validated due to re-analysis	Other	Other
67	Sample results not submitted/verifiable	Other	Representativeness

Table A2.3
Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
199, 99	See hard copy for further explanation	Other	Other
248	Single combined TCLP results was not reported for sample with both mis+nonm	Other	Accuracy
80	Spurious counts of unknown origin	Other	Representativeness
244	Standard or tracer is not NIST traceable	Other	Accuracy
164	Standard traceability or certification requirements not met	Other	Accuracy
219	Standards have expired or are not valid	Other	Accuracy
243	Standard values were not calculated correctly (LCS, tracer, standards)	Other	Other
22	Tracer contamination	Other	Accuracy
242	Tracer requirements were not met	Other	Accuracy
71	Unit conversion of results	Other	Other
239	Winsorized mean+standard deviation of the same not calculated or calculated wrong	Other	Other
38	Excessive solids on planchet	Sample preparation	Accuracy
123, 23	Improper aliquot size	Sample preparation	Accuracy
224	Incomplete TCLP extraction data	Sample preparation	Representativeness
225	Insufficient TCLP extraction time	Sample preparation	Representativeness
201	Preservation requirements not met by the laboratory	Sample preparation	Representativeness
24	Sample aliquot not taken quantitatively	Sample preparation	Accuracy
240	Sample preparation for soil/sludge/ sediment were not homog/aliq properly	Sample preparation	Representativeness
207	Sample pretreatment or preparation method is incorrect	Sample preparation	Representativeness
69	Samples not distilled	Sample preparation	Representativeness
703	Samples were not preserved properly in the	Sample preparation	Representativeness
222	TCLP particle size was not performed	Sample preparation	Representativeness
220	TCLP sample percent solids < 0.5 percent	Sample preparation	Representativeness
56	IDL changed due to significant figure discrepancy	Sensitivity	Representativeness
54	Incorrect reported activity or MDA	Sensitivity	Other
213	Instrument detection limit > the associated RDL	Sensitivity	Representativeness
136, 36	MDA exceeded the RDL	Sensitivity	Representativeness
78	MDA was calculated by reviewer	Sensitivity	Other
81	Repeat count outside of 3 sigma counting error	Sensitivity	Precision
86	Results considered qualitative not quantitative	Sensitivity	Accuracy
82	Sample results were not corrected for decay	Sensitivity	Other
91	Unit conversion, QC sample activity	Sensitivity	Representativeness
142, 42	Surrogates were outside criteria	Surrogate	Accuracy
20	AA duplicate injection precision criteria were not met	Instrument Set-up	Precision

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Table A2.3
Standardized V&V Reason Code Definitions, QC Categories, and Affected PARCC Parameters

Validation Reason Codes	Standardized Description	QC Category	Affected PARCC Parameter
73	Daily instrument performance assessment not performed	Instrument Set-up	Accuracy
177, 77	Detector efficiency criteria not met	Instrument Set-up	Accuracy
229	Element not analyzed in ICP interference check sample	Instrument Set-up	Representativeness
76	Instrument gain and/or efficiency not submitted	Instrument Set-up	Representativeness
109, 9	Interference indicated in the ICP interference check sample	Instrument Set-up	Accuracy
147, 47	Percent breakdown exceeded 20 percent	Instrument Set-up	Representativeness
170	Resolution criteria not met	Instrument Set-up	Representativeness
35	Transformed spectral index external site criteria were not met	Instrument Set-up	Representativeness
139, 39	Tune criteria not met	Instrument Set-up	Accuracy
206	Analysis was not requested according to SOW	Unknown	Other
166	Carrier aliquot nonverifiable	Unknown	Representativeness
150	Unknown carrier volume	Unknown	Representativeness

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Table A2.3.NNAEU.1
NN AEU - CRA Data V&V Summary

Analyte Group	Matrix	Total No. of V&V Records	Total No. of CRA Records	Percent V&V (%)
Dioxins and Furans	WATER	7	7	100.00
Herbicide	SOIL	16	16	100.00
Herbicide	WATER	58	81	71.60
Metal	SOIL	572	574	99.65
Metal	WATER	2,495	2,846	87.67
PCB	SOIL	42	42	100.00
PCB	WATER	35	49	71.43
Pesticide	SOIL	134	134	100.00
Pesticide	WATER	145	215	67.44
Radionuclide	SOIL	158	160	98.75
Radionuclide	WATER	490	588	83.33
SVOC	SOIL	937	937	100.00
SVOC	WATER	3,458	4,351	79.48
VOC	SOIL	857	857	100.00
VOC	WATER	5,729	7,343	78.02
Wet Chem	SOIL	19	20	95.00
Wet Chem	WATER	183	222	82.43
	Total	**15,335**	**18,442**	**83.15%**

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Table A2.3.NNAEU.2

NN AEU - Summary of Data Estimated or Undetected Due to V&V Determinations

Analyte Group	Matrix	No. of CRA Data Records Qualified	Total No. of V&V CRA Records	Detect?	Percent Qualified (%)
Dioxins and Furans	WATER	7	7	No	100.00
Herbicide	SOIL	1	16	No	6.25
Herbicide	WATER	10	58	No	17.24
Metal	SOIL	57	572	No	9.97
Metal	SOIL	118	572	Yes	20.63
Metal	WATER	300	2,495	No	12.75
Metal	WATER	318	2,495	Yes	12.02
PCB	SOIL	21	42	No	50.00
Pesticide	SOIL	61	134	No	45.52
Pesticide	WATER	14	145	No	9.66
Radionuclide	SOIL	1	158	No	1.27
Radionuclide	SOIL	2	158	Yes	0.63
Radionuclide	WATER	1	490	No	0.41
Radionuclide	WATER	2	490	Yes	0.20
SVOC	SOIL	75	937	No	0.32
SVOC	SOIL	3	937	Yes	8.00
SVOC	WATER	316	3,458	No	9.14
SVOC	WATER	81	3,458	Yes	2.34
VOC	SOIL	46	857	No	1.17
VOC	SOIL	10	857	Yes	5.37
VOC	WATER	510	5,729	No	8.90
VOC	WATER	137	5,729	Yes	2.39
Wet Chem	SOIL	1	19	Yes	5.26
Wet Chem	WATER	7	183	No	7.65
Wet Chem	WATER	14	183	Yes	3.83
	Total	**2,113**	**15,335**		**13.78%**

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Table A2.3.NNAEU.3
NN AEU - Summary of Data Qualified as Undetected Due to Blank Contamination

Analyte Group	Matrix	No. of CRA Records Qualified as Undetected	Total No. of CRA Records with Detected Results[a]	Percent Qualified as Undetected
Metal	SOIL	10	440	2.27
Metal	WATER	70	1,341	5.22
SVOC	WATER	2	308	0.65
VOC	WATER	3	792	0.38
	Total	**85**	**2,881**	**2.95%**

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

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Table A2.3.NNAEU.4
NN AEU - Summary of Data Rejected During V&V

Analyte Group	Matrix	Total No. of Rejected Records	Total No. of Records	Percent Rejected (%)
Dioxins and Furans	WATER	0	7	0.00
Herbicide	SOIL	0	34	0.00
Herbicide	WATER	4	76	5.26
Metal	SOIL	4	738	0.54
Metal	WATER	187	5,138	3.64
PCB	SOIL	0	77	0.00
PCB	WATER	14	84	16.67
Pesticide	SOIL	4	247	1.62
Pesticide	WATER	46	315	14.60
Radionuclide	SOIL	64	295	21.69
Radionuclide	WATER	248	1,116	22.22
SVOC	SOIL	19	1,554	1.22
SVOC	WATER	278	4,702	5.91
VOC	SOIL	11	1,207	0.91
VOC	WATER	181	7,913	2.29
Wet Chem	SOIL	0	28	0.00
Wet Chem	WATER	1	480	0.21
	Total	**1,061**	**24,011**	**4.42%**

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Table A2.3.NNAEU.5
NN AEU - Summary of RPDs/DERs of Field Duplicate Analyte Pairs

Analyte Group	Matrix	No. of Duplicates Failing RPD/DER Criteria	Total No. of Duplicate Pairs	Percent Failure (%)	Field Duplicate Frequency (%)
Herbicide	SOIL	0	2	0.00	12.50
Metal	SOIL	1	56	1.79	9.76
Metal	WATER	9	465	1.94	16.34
Pesticide	SOIL	0	22	0.00	16.42
Radionuclide	WATER	0	86	0.00	14.63
SVOC	SOIL	0	118	0.00	12.59
SVOC	WATER	0	243	0.00	5.58
VOC	SOIL	1	101	0.99	11.79
VOC	WATER	0	489	0.00	6.66
Wet Chem	SOIL	0	2	0.00	10.00
Wet Chem	WATER	1	56	1.79	25.23

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Table A2.3.NNAEU.6
NN AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Dioxins and Furans	WATER	Calibration	Continuing calibration verification criteria were not met	No	7	7	100.00
Dioxins and Furans	WATER	Documentation Issues	Transcription error	No	7	7	100.00
Herbicide	SOIL	Holding Times	Holding times were exceeded	No	1	16	6.25
Herbicide	SOIL	Matrices	MS/MSD precision criteria were not met	No	10	16	62.50
Herbicide	WATER	Calibration	Continuing calibration verification criteria were not met	No	3	58	5.17
Herbicide	WATER	Documentation Issues	Missing deliverables (not required for validation)	No	3	58	5.17
Herbicide	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	17	58	29.31
Herbicide	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	No	1	58	1.72
Herbicide	WATER	Documentation Issues	Original documentation not provided	No	7	58	12.07
Herbicide	WATER	Holding Times	Holding times were exceeded	No	4	58	6.90
Herbicide	WATER	LCS	LCS recovery criteria were not met	No	2	58	3.45
Herbicide	WATER	Matrices	MS/MSD precision criteria were not met	No	3	58	5.17
Herbicide	WATER	Other	See hard copy for further explanation	No	1	58	1.72
Herbicide	WATER	Sample Preparation	Samples were not properly preserved in the field	No	3	58	5.17
Herbicide	WATER	Surrogates	Surrogate recovery criteria were not met	No	4	58	6.90
Metal	SOIL	Blanks	Calibration verification blank contamination	No	10	572	1.75
Metal	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	6	572	1.05
Metal	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	7	572	1.22
Metal	SOIL	Blanks	Negative bias indicated in the blanks	No	4	572	0.70
Metal	SOIL	Documentation Issues	Transcription error	No	3	572	0.52
Metal	SOIL	Instrument Set-up	Interference was indicated in the interference check sample	No	2	572	0.35
Metal	SOIL	LCS	CRDL check sample recovery criteria were not met	No	6	572	1.05
Metal	SOIL	LCS	LCS recovery criteria were not met	No	12	572	2.10
Metal	SOIL	LCS	LCS recovery criteria were not met	Yes	26	572	4.55
Metal	SOIL	LCS	Low level check sample recovery criteria were not met	No	10	572	1.75
Metal	SOIL	LCS	Low level check sample recovery criteria were not met	Yes	17	572	2.97
Metal	SOIL	Matrices	Duplicate sample precision criteria were not met	No	1	572	0.17
Metal	SOIL	Matrices	Duplicate sample precision criteria were not met	Yes	15	572	2.62

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Table A2.3.NNAEU.6
NN AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Metal	SOIL	Matrices	Post-digestion MS did not meet control criteria	No	2	572	0.35
Metal	SOIL	Matrices	Post-digestion MS did not meet control criteria	Yes	3	572	0.52
Metal	SOIL	Matrices	Predigestion MS recovery criteria were not met	No	17	572	2.97
Metal	SOIL	Matrices	Predigestion MS recovery criteria were not met	Yes	53	572	9.27
Metal	SOIL	Matrices	Predigestion MS recovery was < 30 percent	Yes	1	572	0.17
Metal	SOIL	Matrices	Serial dilution criteria were not met	Yes	5	572	0.87
Metal	SOIL	Other	IDL is older than 3 months from date of analysis	No	61	572	10.66
Metal	SOIL	Other	IDL is older than 3 months from date of analysis	Yes	229	572	40.03
Metal	WATER	Blanks	Calibration verification blank contamination	No	121	2,495	4.85
Metal	WATER	Blanks	Calibration verification blank contamination	Yes	13	2,495	0.52
Metal	WATER	Blanks	Method, preparation, or reagent blank contamination	No	26	2,495	1.04
Metal	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	107	2,495	4.29
Metal	WATER	Blanks	Negative bias indicated in the blanks	No	48	2,495	1.92
Metal	WATER	Blanks	Negative bias indicated in the blanks	Yes	20	2,495	0.80
Metal	WATER	Calculation Errors	Control limits not assigned correctly	Yes	1	2,495	0.04
Metal	WATER	Calibration	Calibration correlation coefficient did not meet requirements	No	4	2,495	0.16
Metal	WATER	Documentation Issues	Key data fields incorrect	No	8	2,495	0.32
Metal	WATER	Documentation Issues	Key data fields incorrect	Yes	48	2,495	1.92
Metal	WATER	Documentation Issues	Missing deliverables (not required for validation)	No	8	2,495	0.32
Metal	WATER	Documentation Issues	Missing deliverables (not required for validation)	Yes	22	2,495	0.88
Metal	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	67	2,495	2.69
Metal	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	125	2,495	5.01
Metal	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	Yes	7	2,495	0.28
Metal	WATER	Documentation Issues	Transcription error	No	13	2,495	0.52
Metal	WATER	Documentation Issues	Transcription error	Yes	13	2,495	0.52
Metal	WATER	Holding Times	Holding times were exceeded	No	11	2,495	0.44
Metal	WATER	Holding Times	Holding times were exceeded	Yes	21	2,495	0.84

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Table A2.3.NNAEU.6
NN AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Metal	WATER	Holding Times	Holding times were grossly exceeded	Yes	1	2,495	0.04
Metal	WATER	Instrument Set-up	Interference was indicated in the interference check sample	No	15	2,495	0.60
Metal	WATER	Instrument Set-up	Interference was indicated in the interference check sample	Yes	44	2,495	1.76
Metal	WATER	LCS	CRDL check sample recovery criteria were not met	No	15	2,495	0.60
Metal	WATER	LCS	CRDL check sample recovery criteria were not met	Yes	4	2,495	0.16
Metal	WATER	LCS	LCS recovery criteria were not met	No	1	2,495	0.04
Metal	WATER	LCS	LCS recovery criteria were not met	Yes	7	2,495	0.28
Metal	WATER	LCS	Low level check sample recovery criteria were not met	No	37	2,495	1.48
Metal	WATER	LCS	Low level check sample recovery criteria were not met	Yes	30	2,495	1.20
Metal	WATER	LCS	QC sample/analyte (e.g. spike, duplicate, LCS) was not analyzed	No	11	2,495	0.44
Metal	WATER	LCS	QC sample/analyte (e.g. spike, duplicate, LCS) was not analyzed	Yes	10	2,495	0.40
Metal	WATER	Matrices	Duplicate sample precision criteria were not met	No	9	2,495	0.36
Metal	WATER	Matrices	Duplicate sample precision criteria were not met	Yes	11	2,495	0.44
Metal	WATER	Matrices	LCS/LCSD precision criteria were not met	No	2	2,495	0.08
Metal	WATER	Matrices	LCS/LCSD precision criteria were not met	Yes	7	2,495	0.28
Metal	WATER	Matrices	Post-digestion MS did not meet control criteria	No	28	2,495	1.12
Metal	WATER	Matrices	Post-digestion MS did not meet control criteria	Yes	3	2,495	0.12
Metal	WATER	Matrices	Predigestion MS recovery criteria were not met	No	36	2,495	1.44
Metal	WATER	Matrices	Predigestion MS recovery criteria were not met	Yes	32	2,495	1.28
Metal	WATER	Matrices	Predigestion MS recovery was < 30 percent	No	1	2,495	0.04
Metal	WATER	Matrices	Predigestion MS recovery was < 30 percent	Yes	1	2,495	0.04
Metal	WATER	Matrices	Serial dilution criteria were not met	No	6	2,495	0.24
Metal	WATER	Matrices	Serial dilution criteria were not met	Yes	50	2,495	2.00
Metal	WATER	Other	IDL is older than 3 months from date of analysis	No	70	2,495	2.81
Metal	WATER	Other	IDL is older than 3 months from date of analysis	Yes	97	2,495	3.89
Metal	WATER	Other	Incorrect analysis sequence	No	2	2,495	0.08
Metal	WATER	Other	Incorrect analysis sequence	Yes	2	2,495	0.08

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Table A2.3.NNAEU.6
NN AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Metal	WATER	Other	QC sample frequency does not meet method requirements	Yes	2	2,495	0.08
Metal	WATER	Sample Preparation	Samples were not properly preserved in the field	No	43	2,495	1.72
Metal	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	95	2,495	3.81
PCB	SOIL	Surrogates	Surrogate recovery criteria were not met	No	21	42	50.00
Pesticide	SOIL	Holding Times	Holding times were exceeded	No	1	134	0.75
Pesticide	SOIL	Matrices	MS/MSD precision criteria were not met	No	10	134	7.46
Pesticide	SOIL	Surrogates	Surrogate recovery criteria were not met	No	60	134	44.78
Pesticide	WATER	Calibration	Continuing calibration verification criteria were not met	No	10	145	6.90
Pesticide	WATER	Calibration	Independent calibration verification criteria not met	No	2	145	1.38
Pesticide	WATER	Documentation Issues	Missing deliverables (not required for validation)	No	3	145	2.07
Pesticide	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	17	145	11.72
Pesticide	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	No	1	145	0.69
Pesticide	WATER	Documentation Issues	Original documentation not provided	No	7	145	4.83
Pesticide	WATER	Holding Times	Holding times were exceeded	No	3	145	2.07
Pesticide	WATER	Matrices	MS/MSD precision criteria were not met	No	2	145	1.38
Pesticide	WATER	Other	See hard copy for further explanation	No	1	145	0.69
Pesticide	WATER	Sample Preparation	Samples were not properly preserved in the field	No	3	145	2.07
Radionuclide	SOIL	Blanks	Blank recovery criteria were not met	Yes	1	158	0.63
Radionuclide	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	1	158	0.63
Radionuclide	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	8	158	5.06
Radionuclide	SOIL	Calculation Errors	Calculation error	Yes	6	158	3.80
Radionuclide	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	1	158	0.63
Radionuclide	SOIL	Documentation Issues	Record added by the validator	Yes	2	158	1.27
Radionuclide	SOIL	Documentation Issues	Sufficient documentation not provided by the laboratory	No	1	158	0.63
Radionuclide	SOIL	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	24	158	15.19
Radionuclide	SOIL	Documentation Issues	Transcription error	Yes	22	158	13.92
Radionuclide	SOIL	Holding Times	Holding times were grossly exceeded	Yes	6	158	3.80
Radionuclide	SOIL	Instrument Set-up	Detector efficiency did not meet requirements	Yes	12	158	7.59
Radionuclide	SOIL	LCS	LCS recovery > +/- 3 sigma	Yes	2	158	1.27

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Table A2.3.NNAEU.6
NN AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Radionuclide	SOIL	LCS	LCS recovery criteria were not met	Yes	3	158	1.90
Radionuclide	SOIL	LCS	LCS relative percent error criteria not met	Yes	7	158	4.43
Radionuclide	SOIL	Matrices	Replicate precision criteria were not met	Yes	4	158	2.53
Radionuclide	SOIL	Other	Lab results not verified due to unsubmitted data	Yes	1	158	0.63
Radionuclide	SOIL	Other	Sample exceeded efficiency curve weight limit	Yes	1	158	0.63
Radionuclide	SOIL	Other	See hard copy for further explanation	Yes	10	158	6.33
Radionuclide	SOIL	Other	Tracer requirements were not met	No	1	158	0.63
Radionuclide	SOIL	Other	Tracer requirements were not met	Yes	2	158	1.27
Radionuclide	SOIL	Sensitivity	MDA was calculated by reviewer	Yes	31	158	19.62
Radionuclide	SOIL	Sensitivity	Results considered qualitative not quantitative	Yes	1	158	0.63
Radionuclide	WATER	Blanks	Blank recovery criteria were not met	No	2	490	0.41
Radionuclide	WATER	Blanks	Blank recovery criteria were not met	Yes	2	490	0.41
Radionuclide	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	27	490	5.51
Radionuclide	WATER	Calculation Errors	Calculation error	No	1	490	0.20
Radionuclide	WATER	Calculation Errors	Calculation error	Yes	1	490	0.20
Radionuclide	WATER	Calibration	Calibration counting statistics did not meet criteria	No	1	490	0.20
Radionuclide	WATER	Calibration	Continuing calibration verification criteria were not met	No	5	490	1.02
Radionuclide	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	20	490	4.08
Radionuclide	WATER	Documentation Issues	Information missing from case narrative	No	4	490	0.82
Radionuclide	WATER	Documentation Issues	Information missing from case narrative	Yes	2	490	0.41
Radionuclide	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	19	490	3.88
Radionuclide	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	18	490	3.67
Radionuclide	WATER	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	108	490	22.04
Radionuclide	WATER	Documentation Issues	Transcription error	No	15	490	3.06
Radionuclide	WATER	Documentation Issues	Transcription error	Yes	28	490	5.71
Radionuclide	WATER	Holding Times	Holding times were exceeded	No	12	490	2.45
Radionuclide	WATER	Holding Times	Holding times were exceeded	Yes	27	490	5.51
Radionuclide	WATER	Holding Times	Holding times were grossly exceeded	No	2	490	0.41
Radionuclide	WATER	Holding Times	Holding times were grossly exceeded	Yes	3	490	0.61

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Table A2.3.NNAEU.6
NN AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Radionuclide	WATER	LCS	Expected LCS value not submitted/verifiable	Yes	2	490	0.41
Radionuclide	WATER	LCS	LCS recovery > +/- 3 sigma	No	2	490	0.41
Radionuclide	WATER	LCS	LCS recovery > +/- 3 sigma	Yes	10	490	2.04
Radionuclide	WATER	LCS	LCS relative percent error criteria not met	Yes	13	490	2.65
Radionuclide	WATER	Matrices	Recovery criteria were not met	Yes	3	490	0.61
Radionuclide	WATER	Matrices	Replicate analysis was not performed	Yes	17	490	3.47
Radionuclide	WATER	Matrices	Replicate precision criteria were not met	No	8	490	1.63
Radionuclide	WATER	Matrices	Replicate precision criteria were not met	Yes	29	490	5.92
Radionuclide	WATER	Other	Lab results not verified due to unsubmitted data	Yes	1	490	0.20
Radionuclide	WATER	Other	QC sample does not meet method requirements	No	3	490	0.61
Radionuclide	WATER	Other	QC sample does not meet method requirements	Yes	2	490	0.41
Radionuclide	WATER	Other	See hard copy for further explanation	No	9	490	1.84
Radionuclide	WATER	Other	See hard copy for further explanation	Yes	32	490	6.53
Radionuclide	WATER	Other	Tracer requirements were not met	No	8	490	1.63
Radionuclide	WATER	Other	Tracer requirements were not met	Yes	11	490	2.24
Radionuclide	WATER	Sensitivity	Incorrect reported activity or MDA	No	1	490	0.20
Radionuclide	WATER	Sensitivity	MDA exceeded the RDL	No	6	490	1.22
Radionuclide	WATER	Sensitivity	MDA exceeded the RDL	Yes	11	490	2.24
Radionuclide	WATER	Sensitivity	MDA was calculated by reviewer	Yes	102	490	20.82
SVOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	7	937	0.75
SVOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	3	937	0.32
SVOC	SOIL	Calibration	Continuing calibration verification criteria were not met	No	10	937	1.07
SVOC	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	1	937	0.11
SVOC	SOIL	Holding Times	Holding times were exceeded	No	58	937	6.19
SVOC	SOIL	Holding Times	Holding times were exceeded	Yes	1	937	0.11
SVOC	SOIL	Matrices	MS/MSD precision criteria were not met	No	531	937	56.67
SVOC	SOIL	Matrices	MS/MSD precision criteria were not met	Yes	29	937	3.09
SVOC	WATER	Blanks	Method, preparation, or reagent blank contamination	No	2	3,458	0.06
SVOC	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	38	3,458	1.10
SVOC	WATER	Calibration	Continuing calibration verification criteria were not met	No	42	3,458	1.21
SVOC	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	4	3,458	0.12

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Table A2.3.NNAEU.6
NN AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
SVOC	WATER	Calibration	Independent calibration verification criteria not met	No	54	3,458	1.56
SVOC	WATER	Calibration	Independent calibration verification criteria not met	Yes	10	3,458	0.29
SVOC	WATER	Documentation Issues	Missing deliverables (not required for validation)	No	178	3,458	5.15
SVOC	WATER	Documentation Issues	Missing deliverables (not required for validation)	Yes	13	3,458	0.38
SVOC	WATER	Documentation Issues	Missing deliverables (required for validation)	No	10	3,458	0.29
SVOC	WATER	Documentation Issues	Missing deliverables (required for validation)	Yes	2	3,458	0.06
SVOC	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	913	3,458	26.40
SVOC	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	124	3,458	3.59
SVOC	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	No	55	3,458	1.59
SVOC	WATER	Documentation Issues	Original documentation not provided	No	389	3,458	11.25
SVOC	WATER	Documentation Issues	Original documentation not provided	Yes	17	3,458	0.49
SVOC	WATER	Holding Times	Holding times were exceeded	No	192	3,458	5.55
SVOC	WATER	Holding Times	Holding times were exceeded	Yes	27	3,458	0.78
SVOC	WATER	Instrument Set-up	Instrument tune criteria were not met	No	3	3,458	0.09
SVOC	WATER	LCS	LCS recovery criteria were not met	No	7	3,458	0.20
SVOC	WATER	Matrices	MS/MSD precision criteria were not met	No	114	3,458	3.30
SVOC	WATER	Matrices	MS/MSD precision criteria were not met	Yes	3	3,458	0.09
SVOC	WATER	Other	See hard copy for further explanation	No	58	3,458	1.68
SVOC	WATER	Other	See hard copy for further explanation	Yes	11	3,458	0.32
SVOC	WATER	Sample Preparation	Samples were not properly preserved in the field	No	163	3,458	4.71
SVOC	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	19	3,458	0.55
SVOC	WATER	Surrogates	Surrogate recovery criteria were not met	No	61	3,458	1.76
SVOC	WATER	Surrogates	Surrogate recovery criteria were not met	Yes	27	3,458	0.78
VOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	10	857	1.17
VOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	10	857	1.17
VOC	SOIL	Holding Times	Holding times were exceeded	No	4	857	0.47
VOC	SOIL	Internal Standards	Internal standards did not meet criteria	No	21	857	2.45
VOC	SOIL	Matrices	MS/MSD precision criteria were not met	No	20	857	2.33

Table A2.3.NNAEU.6
NN AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
VOC	SOIL	Surrogates	Surrogate recovery criteria were not met	No	34	857	3.97
VOC	WATER	Blanks	Method, preparation, or reagent blank contamination	No	26	5,729	0.45
VOC	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	35	5,729	0.61
VOC	WATER	Calculation Errors	Calculation error	Yes	1	5,729	0.02
VOC	WATER	Calibration	Continuing calibration verification criteria were not met	No	102	5,729	1.78
VOC	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	16	5,729	0.28
VOC	WATER	Calibration	Independent calibration verification criteria not met	No	81	5,729	1.41
VOC	WATER	Calibration	Independent calibration verification criteria not met	Yes	23	5,729	0.40
VOC	WATER	Documentation Issues	Missing deliverables (not required for validation)	No	260	5,729	4.54
VOC	WATER	Documentation Issues	Missing deliverables (not required for validation)	Yes	46	5,729	0.80
VOC	WATER	Documentation Issues	Missing deliverables (required for validation)	No	204	5,729	3.56
VOC	WATER	Documentation Issues	Missing deliverables (required for validation)	Yes	36	5,729	0.63
VOC	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	1,321	5,729	23.06
VOC	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	298	5,729	5.20
VOC	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	No	2	5,729	0.03
VOC	WATER	Documentation Issues	Original documentation not provided	No	410	5,729	7.16
VOC	WATER	Documentation Issues	Original documentation not provided	Yes	22	5,729	0.38
VOC	WATER	Documentation Issues	Record added by the validator	No	34	5,729	0.59
VOC	WATER	Holding Times	Holding times were exceeded	No	290	5,729	5.06
VOC	WATER	Holding Times	Holding times were exceeded	Yes	89	5,729	1.55
VOC	WATER	Instrument Set-up	Instrument tune criteria were not met	No	54	5,729	0.94
VOC	WATER	Internal Standards	Internal standards did not meet criteria	No	35	5,729	0.61
VOC	WATER	LCS	LCS recovery criteria were not met	No	36	5,729	0.63
VOC	WATER	Matrices	MS/MSD precision criteria were not met	No	61	5,729	1.06
VOC	WATER	Matrices	MS/MSD precision criteria were not met	Yes	2	5,729	0.03
VOC	WATER	Other	Sample results were not validated due to re-analysis	No	32	5,729	0.56
VOC	WATER	Other	Sample results were not validated due to re-analysis	Yes	1	5,729	0.02
VOC	WATER	Other	See hard copy for further explanation	No	209	5,729	3.65

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Table A2.3.NNAEU.6
NN AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
VOC	WATER	Other	See hard copy for further explanation	Yes	32	5,729	0.56
VOC	WATER	Sample Preparation	Samples were not properly preserved in the field	No	191	5,729	3.33
VOC	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	51	5,729	0.89
VOC	WATER	Surrogates	Surrogate recovery criteria were not met	No	102	5,729	1.78
VOC	WATER	Surrogates	Surrogate recovery criteria were not met	Yes	18	5,729	0.31
Wet Chem	SOIL	Holding Times	Holding times were exceeded	Yes	1	19	5.26
Wet Chem	SOIL	Other	IDL is older than 3 months from date of analysis	Yes	10	19	52.63
Wet Chem	WATER	Documentation Issues	Record added by the validator	No	1	183	0.55
Wet Chem	WATER	Documentation Issues	Transcription error	Yes	1	183	0.55
Wet Chem	WATER	Holding Times	Holding times were exceeded	No	4	183	2.19
Wet Chem	WATER	Holding Times	Holding times were exceeded	Yes	8	183	4.37
Wet Chem	WATER	Holding Times	Holding times were grossly exceeded	No	2	183	1.09
Wet Chem	WATER	Matrices	Predigestion MS recovery criteria were not met	No	1	183	0.55
Wet Chem	WATER	Matrices	Predigestion MS recovery criteria were not met	Yes	4	183	2.19
Wet Chem	WATER	Matrices	Predigestion MS recovery was < 30 percent	Yes	1	183	0.55
Wet Chem	WATER	Other	Lab results not verified due to unsubmitted data	Yes	1	183	0.55
Wet Chem	WATER	Other	Result obtained through dilution	Yes	4	183	2.19

Table A2.3.RCAEU.1
RC AEU - CRA Data V&V Summary

Analyte Group	Matrix	Total No. of V&V Records	Total No. of CRA Records	Percent V&V (%)
Herbicide	SOIL	17	17	100.00
Herbicide	WATER	3	3	100.00
Metal	SOIL	608	608	100.00
Metal	WATER	3,658	4,225	86.58
PCB	SOIL	84	91	92.31
PCB	WATER	21	21	100.00
Pesticide	SOIL	257	277	92.78
Pesticide	WATER	63	63	100.00
Radionuclide	SOIL	171	175	97.71
Radionuclide	WATER	301	307	98.05
SVOC	SOIL	1,094	1,099	99.55
SVOC	WATER	180	204	88.24
VOC	SOIL	450	450	100.00
VOC	WATER	1,056	1,655	63.81
Wet Chem	SOIL	22	22	100.00
Wet Chem	WATER	444	500	88.80
	Total	**8,429**	**9,717**	**86.74%**

Table A2.3.RCAEU.2

RC AEU - Summary of Data Estimated or Undetected Due to V&V Determinations

Analyte Group	Matrix	No. of CRA Data Records Qualified	Total No. of V&V CRA Records	Detect?	Percent Qualified (%)
Herbicide	SOIL	1	17	No	5.88
Metal	SOIL	89	608	No	14.64
Metal	SOIL	237	608	Yes	38.98
Metal	WATER	407	3,658	No	11.13
Metal	WATER	470	3,658	Yes	12.85
PCB	SOIL	14	84	No	16.67
Pesticide	SOIL	41	257	No	15.95
Radionuclide	SOIL	2	171	Yes	1.17
Radionuclide	WATER	2	301	Yes	0.66
SVOC	SOIL	92	1,094	No	8.41
SVOC	WATER	1	180	No	0.56
VOC	SOIL	100	450	No	22.22
VOC	SOIL	10	450	Yes	2.22
VOC	WATER	83	1,056	No	7.86
VOC	WATER	1	1,056	Yes	0.09
Wet Chem	SOIL	2	22	No	9.09
Wet Chem	SOIL	8	22	Yes	36.36
Wet Chem	WATER	13	444	No	2.93
Wet Chem	WATER	17	444	Yes	3.83
	Total	**1,590**	**8,429**		**18.86%**

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Table A2.3.RCAEU.3

RC AEU - Summary of Data Qualified as Undetected Due to Blank Contamination

Analyte Group	Matrix	No. of CRA Records Qualified as Undetected	Total No. of CRA Records with Detected Results[a]	Percent Qualified as Undetected
Metal	SOIL	9	453	1.99
Metal	WATER	94	1,956	4.81
Wet Chem	WATER	1	308	0.32
	Total	**104**	**2,717**	**3.83%**

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

Table A2.3.RCAEU.4
RC AEU - Summary of Data Rejected During V&V

Analyte Group	Matrix	Total No. of Rejected Records	Total No. of Records	Percent Rejected (%)
Herbicide	SOIL	6	30	20.00
Herbicide	WATER	0	4	0.00
Metal	SOIL	84	1,149	7.31
Metal	WATER	173	6,058	2.86
PCB	SOIL	42	196	21.43
PCB	WATER	0	42	0.00
Pesticide	SOIL	129	590	21.86
Pesticide	WATER	0	124	0.00
Radionuclide	SOIL	67	346	19.36
Radionuclide	WATER	370	1,055	35.07
SVOC	SOIL	258	1,773	14.55
SVOC	WATER	0	239	0.00
VOC	SOIL	250	1,034	24.18
VOC	WATER	29	1,638	1.77
Wet Chem	SOIL	2	31	6.45
Wet Chem	WATER	2	668	0.30
	Total	**1,412**	**14,977**	**9.43%**

Table A2.3.RCAEU.5
RC AEU - Summary of RPDs/DERs of Field Duplicate Analyte Pairs

Analyte Group	Matrix	No. of Duplicates Failing RPD/DER Criteria	Total No. of Duplicate Pairs	Percent Failure (%)	Field Duplicate Frequency (%)
Herbicide	SOIL	0	3	0.00	17.65
Metal	SOIL	0	89	0.00	14.64
Metal	WATER	2	312	0.64	7.38
Pesticide	SOIL	0	3	0.00	1.08
Radionuclide	SOIL	0	19	0.00	10.86
SVOC	SOIL	0	177	0.00	16.11
SVOC	WATER	0	3	0.00	1.47
VOC	SOIL	0	16	0.00	3.56
VOC	WATER	0	195	0.00	11.78
Wet Chem	SOIL	0	2	0.00	9.09
Wet Chem	WATER	1	47	2.13	9.40

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Table A2.3.RCAEU.6
RC AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Herbicide	SOIL	Surrogates	Surrogate recovery criteria were not met	No	1	17	5.88
Metal	SOIL	Blanks	Calibration verification blank contamination	No	9	608	1.48
Metal	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	11	608	1.81
Metal	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	23	608	3.78
Metal	SOIL	Blanks	Negative bias indicated in the blanks	No	3	608	0.49
Metal	SOIL	Blanks	Negative bias indicated in the blanks	Yes	8	608	1.32
Metal	SOIL	Calibration	Calibration correlation coefficient did not meet requirements	Yes	2	608	0.33
Metal	SOIL	Documentation Issues	Transcription error	Yes	3	608	0.49
Metal	SOIL	LCS	CRDL check sample recovery criteria were not met	No	2	608	0.33
Metal	SOIL	LCS	CRDL check sample recovery criteria were not met	Yes	3	608	0.49
Metal	SOIL	LCS	LCS recovery criteria were not met	No	38	608	6.25
Metal	SOIL	LCS	LCS recovery criteria were not met	Yes	131	608	21.55
Metal	SOIL	LCS	Low level check sample recovery criteria were not met	No	10	608	1.64
Metal	SOIL	LCS	Low level check sample recovery criteria were not met	Yes	9	608	1.48
Metal	SOIL	Matrices	Duplicate sample precision criteria were not met	Yes	16	608	2.63
Metal	SOIL	Matrices	LCS/LCSD precision criteria were not met	Yes	5	608	0.82
Metal	SOIL	Matrices	MSA calibration correlation coefficient < 0.995	Yes	1	608	0.16
Metal	SOIL	Matrices	Percent solids < 30 percent	Yes	48	608	7.89
Metal	SOIL	Matrices	Post-digestion MS did not meet control criteria	No	2	608	0.33
Metal	SOIL	Matrices	Post-digestion MS did not meet control criteria	Yes	4	608	0.66
Metal	SOIL	Matrices	Predigestion MS recovery criteria were not met	No	17	608	2.80
Metal	SOIL	Matrices	Predigestion MS recovery criteria were not met	Yes	30	608	4.93
Metal	SOIL	Matrices	Predigestion MS recovery was < 30 percent	Yes	2	608	0.33
Metal	SOIL	Matrices	Serial dilution criteria were not met	Yes	12	608	1.97
Metal	SOIL	Other	Result obtained through dilution	Yes	1	608	0.16
Metal	WATER	Blanks	Calibration verification blank contamination	No	153	3,658	4.18
Metal	WATER	Blanks	Calibration verification blank contamination	Yes	21	3,658	0.57
Metal	WATER	Blanks	Method, preparation, or reagent blank contamination	No	57	3,658	1.56
Metal	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	155	3,658	4.24
Metal	WATER	Blanks	Negative bias indicated in the blanks	No	66	3,658	1.80
Metal	WATER	Blanks	Negative bias indicated in the blanks	Yes	23	3,658	0.63

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Table A2.3.RCAEU.6
RC AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Metal	WATER	Calculation Errors	Control limits not assigned correctly	Yes	2	3,658	0.05
Metal	WATER	Calibration	Calibration correlation coefficient did not meet requirements	No	7	3,658	0.19
Metal	WATER	Calibration	Calibration correlation coefficient did not meet requirements	Yes	4	3,658	0.11
Metal	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	1	3,658	0.03
Metal	WATER	Calibration	Frequency or sequencing verification criteria not met	No	13	3,658	0.36
Metal	WATER	Calibration	Frequency or sequencing verification criteria not met	Yes	21	3,658	0.57
Metal	WATER	Documentation Issues	Key data fields incorrect	No	6	3,658	0.16
Metal	WATER	Documentation Issues	Key data fields incorrect	Yes	36	3,658	0.98
Metal	WATER	Documentation Issues	Missing deliverables (not required for validation)	No	41	3,658	1.12
Metal	WATER	Documentation Issues	Missing deliverables (not required for validation)	Yes	45	3,658	1.23
Metal	WATER	Documentation Issues	Missing deliverables (required for validation)	No	23	3,658	0.63
Metal	WATER	Documentation Issues	Missing deliverables (required for validation)	Yes	32	3,658	0.87
Metal	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	No	70	3,658	1.91
Metal	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	179	3,658	4.89
Metal	WATER	Documentation Issues	Omissions or errors in data package (required for validation)	No	1	3,658	0.03
Metal	WATER	Documentation Issues	Transcription error	No	65	3,658	1.78
Metal	WATER	Documentation Issues	Transcription error	Yes	46	3,658	1.26
Metal	WATER	Holding Times	Holding times were exceeded	No	6	3,658	0.16
Metal	WATER	Holding Times	Holding times were grossly exceeded	Yes	1	3,658	0.03
Metal	WATER	Instrument Set-up	Interference was indicated in the interference check sample	No	4	3,658	0.11
Metal	WATER	Instrument Set-up	Interference was indicated in the interference check sample	Yes	8	3,658	0.22
Metal	WATER	LCS	CRDL check sample recovery criteria were not met	No	30	3,658	0.82
Metal	WATER	LCS	CRDL check sample recovery criteria were not met	Yes	15	3,658	0.41
Metal	WATER	LCS	LCS recovery criteria were not met	No	28	3,658	0.77

Table A2.3.RCAEU.6
RC AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Metal	WATER	LCS	LCS recovery criteria were not met	Yes	66	3,658	1.80
Metal	WATER	LCS	Low level check sample recovery criteria were not met	No	40	3,658	1.09
Metal	WATER	LCS	Low level check sample recovery criteria were not met	Yes	27	3,658	0.74
Metal	WATER	LCS	QC sample/analyte (e.g. spike, duplicate, LCS) was not analyzed	No	11	3,658	0.30
Metal	WATER	LCS	QC sample/analyte (e.g. spike, duplicate, LCS) was not analyzed	Yes	15	3,658	0.41
Metal	WATER	Matrices	Duplicate sample precision criteria were not met	No	2	3,658	0.05
Metal	WATER	Matrices	Duplicate sample precision criteria were not met	Yes	11	3,658	0.30
Metal	WATER	Matrices	LCS/LCSD precision criteria were not met	No	6	3,658	0.16
Metal	WATER	Matrices	LCS/LCSD precision criteria were not met	Yes	15	3,658	0.41
Metal	WATER	Matrices	MSA calibration correlation coefficient < 0.995	No	1	3,658	0.03
Metal	WATER	Matrices	Post-digestion MS did not meet control criteria	No	21	3,658	0.57
Metal	WATER	Matrices	Post-digestion MS did not meet control criteria	Yes	6	3,658	0.16
Metal	WATER	Matrices	Predigestion MS recovery criteria were not met	No	35	3,658	0.96
Metal	WATER	Matrices	Predigestion MS recovery criteria were not met	Yes	62	3,658	1.69
Metal	WATER	Matrices	Serial dilution criteria were not met	No	4	3,658	0.11
Metal	WATER	Matrices	Serial dilution criteria were not met	Yes	83	3,658	2.27
Metal	WATER	Other	IDL is older than 3 months from date of analysis	No	80	3,658	2.19
Metal	WATER	Other	IDL is older than 3 months from date of analysis	Yes	59	3,658	1.61
Metal	WATER	Sample Preparation	Samples were not properly preserved in the field	No	37	3,658	1.01
Metal	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	72	3,658	1.97
PCB	SOIL	Documentation Issues	Transcription error	No	14	84	16.67
PCB	SOIL	Other	See hard copy for further explanation	No	7	84	8.33
PCB	SOIL	Surrogates	Surrogate recovery criteria were not met	No	14	84	16.67
Pesticide	SOIL	Other	See hard copy for further explanation	No	20	257	7.78
Pesticide	SOIL	Surrogates	Surrogate recovery criteria were not met	No	41	257	15.95
Radionuclide	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	1	171	0.58
Radionuclide	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	22	171	12.87
Radionuclide	SOIL	Calculation Errors	Calculation error	Yes	4	171	2.34
Radionuclide	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	4	171	2.34

Table A2.3.RCAEU.6
RC AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Radionuclide	SOIL	Documentation Issues	Results were not included on Data Summary Table	Yes	1	171	0.58
Radionuclide	SOIL	Documentation Issues	Sufficient documentation not provided by the laboratory	No	2	171	1.17
Radionuclide	SOIL	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	30	171	17.54
Radionuclide	SOIL	Documentation Issues	Transcription error	No	2	171	1.17
Radionuclide	SOIL	Documentation Issues	Transcription error	Yes	28	171	16.37
Radionuclide	SOIL	Holding Times	Holding times were grossly exceeded	Yes	6	171	3.51
Radionuclide	SOIL	Instrument Set-up	Detector efficiency did not meet requirements	Yes	8	171	4.68
Radionuclide	SOIL	Instrument Set-up	Resolution criteria were not met	Yes	1	171	0.58
Radionuclide	SOIL	LCS	LCS recovery > +/- 3 sigma	Yes	9	171	5.26
Radionuclide	SOIL	LCS	LCS recovery criteria were not met	No	1	171	0.58
Radionuclide	SOIL	LCS	LCS relative percent error criteria not met	No	1	171	0.58
Radionuclide	SOIL	LCS	LCS relative percent error criteria not met	Yes	6	171	3.51
Radionuclide	SOIL	Matrices	Recovery criteria were not met	Yes	2	171	1.17
Radionuclide	SOIL	Matrices	Replicate analysis was not performed	Yes	1	171	0.58
Radionuclide	SOIL	Matrices	Replicate precision criteria were not met	No	1	171	0.58
Radionuclide	SOIL	Matrices	Replicate precision criteria were not met	Yes	5	171	2.92
Radionuclide	SOIL	Other	Lab results not verified due to unsubmitted data	Yes	4	171	2.34
Radionuclide	SOIL	Other	Sample exceeded efficiency curve weight limit	Yes	4	171	2.34
Radionuclide	SOIL	Other	See hard copy for further explanation	No	1	171	0.58
Radionuclide	SOIL	Other	See hard copy for further explanation	Yes	19	171	11.11
Radionuclide	SOIL	Sensitivity	Incorrect reported activity or MDA	No	1	171	0.58
Radionuclide	SOIL	Sensitivity	MDA exceeded the RDL	No	3	171	1.75
Radionuclide	SOIL	Sensitivity	MDA exceeded the RDL	Yes	7	171	4.09
Radionuclide	SOIL	Sensitivity	MDA was calculated by reviewer	Yes	60	171	35.09
Radionuclide	SOIL	Sensitivity	Results considered qualitative not quantitative	Yes	4	171	2.34
Radionuclide	WATER	Blanks	Method, preparation, or reagent blank contamination	No	6	301	1.99
Radionuclide	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	19	301	6.31
Radionuclide	WATER	Calibration	Calibration counting statistics did not meet criteria	No	2	301	0.66
Radionuclide	WATER	Calibration	Continuing calibration verification criteria were not met	No	6	301	1.99
Radionuclide	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	26	301	8.64
Radionuclide	WATER	Documentation Issues	Missing deliverables (required for validation)	No	1	301	0.33

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Table A2.3.RCAEU.6
RC AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Radionuclide	WATER	Documentation Issues	Missing deliverables (required for validation)	Yes	1	301	0.33
Radionuclide	WATER	Documentation Issues	No raw data submitted by the laboratory	Yes	1	301	0.33
Radionuclide	WATER	Documentation Issues	Record added by the validator	Yes	4	301	1.33
Radionuclide	WATER	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	58	301	19.27
Radionuclide	WATER	Documentation Issues	Transcription error	No	16	301	5.32
Radionuclide	WATER	Documentation Issues	Transcription error	Yes	44	301	14.62
Radionuclide	WATER	Holding Times	Holding times were exceeded	No	10	301	3.32
Radionuclide	WATER	Holding Times	Holding times were exceeded	Yes	12	301	3.99
Radionuclide	WATER	Holding Times	Holding times were grossly exceeded	No	3	301	1.00
Radionuclide	WATER	LCS	Expected LCS value not submitted/verifiable	Yes	1	301	0.33
Radionuclide	WATER	LCS	LCS recovery > +/- 3 sigma	No	8	301	2.66
Radionuclide	WATER	LCS	LCS recovery > +/- 3 sigma	Yes	7	301	2.33
Radionuclide	WATER	LCS	LCS recovery criteria were not met	No	1	301	0.33
Radionuclide	WATER	LCS	LCS relative percent error criteria not met	No	3	301	1.00
Radionuclide	WATER	LCS	LCS relative percent error criteria not met	Yes	15	301	4.98
Radionuclide	WATER	Matrices	Recovery criteria were not met	No	1	301	0.33
Radionuclide	WATER	Matrices	Recovery criteria were not met	Yes	2	301	0.66
Radionuclide	WATER	Matrices	Replicate analysis was not performed	Yes	7	301	2.33
Radionuclide	WATER	Matrices	Replicate precision criteria were not met	No	14	301	4.65
Radionuclide	WATER	Matrices	Replicate precision criteria were not met	Yes	19	301	6.31
Radionuclide	WATER	Matrices	Replicate recovery criteria were not met	Yes	4	301	1.33
Radionuclide	WATER	Other	Lab results not verified due to unsubmitted data	Yes	6	301	1.99
Radionuclide	WATER	Other	Sample results were not validated due to re-analysis	No	1	301	0.33
Radionuclide	WATER	Other	Sample results were not validated due to re-analysis	Yes	2	301	0.66
Radionuclide	WATER	Other	See hard copy for further explanation	No	9	301	2.99
Radionuclide	WATER	Other	See hard copy for further explanation	Yes	23	301	7.64
Radionuclide	WATER	Sensitivity	MDA exceeded the RDL	No	3	301	1.00
Radionuclide	WATER	Sensitivity	MDA exceeded the RDL	Yes	4	301	1.33
Radionuclide	WATER	Sensitivity	MDA was calculated by reviewer	Yes	81	301	26.91
SVOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	4	1,094	0.37
SVOC	SOIL	Calibration	Continuing calibration verification criteria were not met	No	10	1,094	0.91

Table A2.3.RCAEU.6
RC AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
SVOC	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	3	1,094	0.27
SVOC	SOIL	Internal Standards	Internal standards did not meet criteria	No	22	1,094	2.01
SVOC	SOIL	Internal Standards	Internal standards did not meet criteria	Yes	5	1,094	0.46
SVOC	SOIL	Matrices	Percent solids < 30 percent	Yes	3	1,094	0.27
SVOC	SOIL	Surrogates	Surrogate recovery criteria were not met	No	56	1,094	5.12
SVOC	SOIL	Surrogates	Surrogate recovery criteria were not met	Yes	1	1,094	0.09
SVOC	WATER	Calibration	Continuing calibration verification criteria were not met	No	1	180	0.56
VOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	14	450	3.11
VOC	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	9	450	2.00
VOC	SOIL	Documentation Issues	Transcription error	No	12	450	2.67
VOC	SOIL	Internal Standards	Internal standards did not meet criteria	No	85	450	18.89
VOC	SOIL	Internal Standards	Internal standards did not meet criteria	Yes	7	450	1.56
VOC	SOIL	Matrices	Percent solids < 30 percent	No	1	450	0.22
VOC	SOIL	Matrices	Percent solids < 30 percent	Yes	4	450	0.89
VOC	SOIL	Surrogates	Surrogate recovery criteria were not met	No	5	450	1.11
VOC	SOIL	Surrogates	Surrogate recovery criteria were not met	Yes	2	450	0.44
VOC	WATER	Blanks	Method, preparation, or reagent blank contamination	No	22	1,056	2.08
VOC	WATER	Calibration	Continuing calibration verification criteria were not met	No	5	1,056	0.47
VOC	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	1	1,056	0.09
VOC	WATER	Documentation Issues	Transcription error	No	14	1,056	1.33
VOC	WATER	Holding Times	Holding times were exceeded	No	12	1,056	1.14
VOC	WATER	Internal Standards	Internal standards did not meet criteria	No	46	1,056	4.36
Wet Chem	SOIL	Documentation Issues	Transcription error	No	1	22	4.55
Wet Chem	SOIL	Holding Times	Holding times were exceeded	Yes	1	22	4.55
Wet Chem	SOIL	Holding Times	Holding times were grossly exceeded	No	2	22	9.09
Wet Chem	SOIL	Matrices	Duplicate sample precision criteria were not met	Yes	1	22	4.55
Wet Chem	SOIL	Matrices	Percent solids < 30 percent	Yes	2	22	9.09
Wet Chem	SOIL	Matrices	Predigestion MS recovery was < 30 percent	Yes	5	22	22.73
Wet Chem	WATER	Blanks	Calibration verification blank contamination	No	1	444	0.23
Wet Chem	WATER	Blanks	Negative bias indicated in the blanks	No	2	444	0.45

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Table A2.3.RCAEU.6
RC AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Wet Chem	WATER	Calibration	Calibration correlation coefficient did not meet requirements	Yes	5	444	1.13
Wet Chem	WATER	Documentation Issues	Omissions or errors in data package (not required for validation)	Yes	19	444	4.28
Wet Chem	WATER	Documentation Issues	Transcription error	No	5	444	1.13
Wet Chem	WATER	Documentation Issues	Transcription error	Yes	9	444	2.03
Wet Chem	WATER	Holding Times	Holding times were exceeded	No	5	444	1.13
Wet Chem	WATER	Holding Times	Holding times were exceeded	Yes	6	444	1.35
Wet Chem	WATER	Holding Times	Holding times were grossly exceeded	No	5	444	1.13
Wet Chem	WATER	Matrices	Predigestion MS recovery criteria were not met	Yes	6	444	1.35
Wet Chem	WATER	Matrices	Site samples were not used for sample matrix QC	Yes	1	444	0.23
Wet Chem	WATER	Other	IDL is older than 3 months from date of analysis	Yes	3	444	0.68
Wet Chem	WATER	Other	Lab results not verified due to unsubmitted data	Yes	1	444	0.23
Wet Chem	WATER	Sample Preparation	Samples were not properly preserved in the field	Yes	9	444	2.03

Table A2.3.MKAEU.1
MK AEU - CRA Data V&V Summary

Analyte Group	Matrix	Total No. of V&V Records	Total No. of CRA Records	Percent V&V (%)
Herbicide	SOIL	7	8	87.50
Herbicide	WATER	1	1	100.00
Metal	SOIL	348	348	100.00
Metal	WATER	1,286	1,827	70.39
PCB	SOIL	35	56	62.50
PCB	WATER	14	21	66.67
Pesticide	SOIL	106	169	62.72
Pesticide	WATER	43	64	67.19
Radionuclide	SOIL	91	103	88.35
Radionuclide	WATER	128	264	48.48
SVOC	SOIL	405	467	86.72
SVOC	WATER	102	102	100.00
VOC	SOIL	298	302	98.68
VOC	WATER	447	447	100.00
Wet Chem	SOIL	12	13	92.31
Wet Chem	WATER	131	164	79.88
	Total	**3,454**	**4,356**	**79.29%**

Table A2.3.MKAEU.2
MK AEU - Summary of Data Estimated or Undetected Due to V&V Determinations

Analyte Group	Matrix	No. of CRA Data Records Qualified	Total No. of V&V CRA Records	Detect?	Percent Qualified (%)
Metal	SOIL	50	348	No	14.37
Metal	SOIL	96	348	Yes	27.59
Metal	WATER	200	1,286	No	15.55
Metal	WATER	284	1,286	Yes	22.08
PCB	SOIL	7	35	No	20.00
PCB	WATER	7	14	No	50.00
Pesticide	SOIL	20	106	No	18.87
Pesticide	WATER	22	43	No	51.16
Radionuclide	WATER	2	128	No	1.56
Radionuclide	WATER	1	128	Yes	0.78
SVOC	SOIL	18	405	No	4.44
VOC	SOIL	41	298	No	13.76
VOC	SOIL	1	298	Yes	0.34
VOC	WATER	7	447	No	1.57
Wet Chem	SOIL	2	12	No	16.67
Wet Chem	SOIL	5	12	Yes	41.67
Wet Chem	WATER	6	131	No	4.58
Wet Chem	WATER	8	131	Yes	6.11
	Total	**777**	**3,454**		**22.50%**

Table A2.3.MKAEU.3

MK AEU - Summary of Data Qualified as Undetected Due to Blank Contamination

Analyte Group	Matrix	No. of CRA Records Qualified as Undetected	Total No. of CRA Records with Detected Results[a]	Percent Qualified as Undetected
Metal	SOIL	8	259	3.09
Metal	WATER	5	664	0.75
	Total	**13**	**923**	**1.41%**

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

Table A2.3.MKAEU.4
MK AEU - Summary of Data Rejected During V&V

Analyte Group	Matrix	Total No. of Rejected Records	Total No. of Records	Percent Rejected (%)
Herbicide	SOIL	0	10	0.00
Herbicide	WATER	1	4	25.00
Metal	SOIL	5	462	1.08
Metal	WATER	70	2,403	2.91
PCB	SOIL	0	63	0.00
PCB	WATER	0	35	0.00
Pesticide	SOIL	1	190	0.53
Pesticide	WATER	0	105	0.00
Radionuclide	SOIL	24	153	15.69
Radionuclide	WATER	222	512	43.36
SVOC	SOIL	6	589	1.02
SVOC	WATER	16	234	6.84
VOC	SOIL	7	515	1.36
VOC	WATER	37	763	4.85
Wet Chem	SOIL	4	20	20.00
Wet Chem	WATER	5	255	1.96
	Total	**398**	**6,313**	**6.30%**

Table A2.3.MKAEU.5
MK AEU - Summary of RPDs/DERs of Field Duplicate Analyte Pairs

Analyte Group	Matrix	No. of Duplicates Failing RPD/DER Criteria	Total No. of Duplicate Pairs	Percent Failure (%)	Field Duplicate Frequency (%)
Metal	WATER	0	56	0.00	3.07
Radionuclide	WATER	2	25	8.00	9.47
Wet Chem	WATER	0	8	0.00	4.88

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Table A2.3.MKAEU.6
MK AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Metal	SOIL	Blanks	Calibration verification blank contamination	No	8	348	2.30
Metal	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	7	348	2.01
Metal	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	2	348	0.57
Metal	SOIL	Blanks	Negative bias indicated in the blanks	No	2	348	0.57
Metal	SOIL	Blanks	Negative bias indicated in the blanks	Yes	4	348	1.15
Metal	SOIL	Calibration	Calibration correlation coefficient did not meet requirements	Yes	2	348	0.57
Metal	SOIL	Documentation Issues	Transcription error	Yes	3	348	0.86
Metal	SOIL	LCS	CRDL check sample recovery criteria were not met	No	1	348	0.29
Metal	SOIL	LCS	CRDL check sample recovery criteria were not met	Yes	3	348	0.86
Metal	SOIL	LCS	LCS recovery criteria were not met	No	12	348	3.45
Metal	SOIL	LCS	LCS recovery criteria were not met	Yes	33	348	9.48
Metal	SOIL	LCS	Low level check sample recovery criteria were not met	No	8	348	2.30
Metal	SOIL	LCS	Low level check sample recovery criteria were not met	Yes	6	348	1.72
Metal	SOIL	Matrices	Duplicate sample precision criteria were not met	Yes	4	348	1.15
Metal	SOIL	Matrices	LCS/LCSD precision criteria were not met	Yes	4	348	1.15
Metal	SOIL	Matrices	Post-digestion MS did not meet control criteria	Yes	1	348	0.29
Metal	SOIL	Matrices	Predigestion MS recovery criteria were not met	No	9	348	2.59
Metal	SOIL	Matrices	Predigestion MS recovery criteria were not met	Yes	18	348	5.17
Metal	SOIL	Matrices	Serial dilution criteria were not met	Yes	13	348	3.74
Metal	SOIL	Other	See hard copy for further explanation	No	5	348	1.44
Metal	SOIL	Other	See hard copy for further explanation	Yes	20	348	5.75
Metal	SOIL	Sensitivity	IDL changed due to a significant figure discrepancy	No	1	348	0.29
Metal	WATER	Blanks	Calibration verification blank contamination	No	8	1,286	0.62
Metal	WATER	Blanks	Method, preparation, or reagent blank contamination	No	55	1,286	4.28
Metal	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	64	1,286	4.98
Metal	WATER	Blanks	Negative bias indicated in the blanks	No	18	1,286	1.40
Metal	WATER	Blanks	Negative bias indicated in the blanks	Yes	19	1,286	1.48
Metal	WATER	Calibration	Calibration correlation coefficient did not meet requirements	No	2	1,286	0.16
Metal	WATER	Calibration	Calibration correlation coefficient did not meet requirements	Yes	1	1,286	0.08
Metal	WATER	Calibration	Continuing calibration verification criteria were not met	No	2	1,286	0.16
Metal	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	8	1,286	0.62
Metal	WATER	Documentation Issues	Key data fields incorrect	No	5	1,286	0.39
Metal	WATER	Documentation Issues	Key data fields incorrect	Yes	20	1,286	1.56
Metal	WATER	Documentation Issues	Transcription error	No	13	1,286	1.01

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Table A2.3.MKAEU.6
MK AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Metal	WATER	Documentation Issues	Transcription error	Yes	40	1,286	3.11
Metal	WATER	Holding Times	Holding times were exceeded	No	12	1,286	0.93
Metal	WATER	Holding Times	Holding times were exceeded	Yes	2	1,286	0.16
Metal	WATER	LCS	CRDL check sample recovery criteria were not met	No	9	1,286	0.70
Metal	WATER	LCS	CRDL check sample recovery criteria were not met	Yes	4	1,286	0.31
Metal	WATER	LCS	LCS recovery criteria were not met	No	55	1,286	4.28
Metal	WATER	LCS	LCS recovery criteria were not met	Yes	119	1,286	9.25
Metal	WATER	LCS	Low level check sample recovery criteria were not met	No	8	1,286	0.62
Metal	WATER	LCS	Low level check sample recovery criteria were not met	Yes	2	1,286	0.16
Metal	WATER	Matrices	Duplicate sample precision criteria were not met	No	1	1,286	0.08
Metal	WATER	Matrices	Duplicate sample precision criteria were not met	Yes	12	1,286	0.93
Metal	WATER	Matrices	Post-digestion MS did not meet control criteria	No	7	1,286	0.54
Metal	WATER	Matrices	Post-digestion MS did not meet control criteria	Yes	1	1,286	0.08
Metal	WATER	Matrices	Predigestion MS recovery criteria were not met	No	11	1,286	0.86
Metal	WATER	Matrices	Predigestion MS recovery criteria were not met	Yes	25	1,286	1.94
Metal	WATER	Matrices	Predigestion MS recovery was < 30 percent	Yes	2	1,286	0.16
Metal	WATER	Matrices	Serial dilution criteria were not met	Yes	22	1,286	1.71
Metal	WATER	Other	IDL is older than 3 months from date of analysis	No	27	1,286	2.10
Metal	WATER	Other	IDL is older than 3 months from date of analysis	Yes	31	1,286	2.41
Metal	WATER	Other	See hard copy for further explanation	No	17	1,286	1.32
Metal	WATER	Other	See hard copy for further explanation	Yes	30	1,286	2.33
Metal	WATER	Sensitivity	IDL changed due to a significant figure discrepancy	No	2	1,286	0.16
PCB	SOIL	Surrogates	Surrogate recovery criteria were not met	No	7	35	20.00
PCB	WATER	Surrogates	Surrogate recovery criteria were not met	No	7	14	50.00
Pesticide	SOIL	Surrogates	Surrogate recovery criteria were not met	No	20	106	18.87
Pesticide	WATER	Calibration	Continuing calibration verification criteria were not met	No	1	43	2.33
Pesticide	WATER	Surrogates	Surrogate recovery criteria were not met	No	21	43	48.84
Radionuclide	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	1	91	1.10
Radionuclide	SOIL	Blanks	Method, preparation, or reagent blank contamination	Yes	7	91	7.69
Radionuclide	SOIL	Calculation Errors	Calculation error	Yes	2	91	2.20
Radionuclide	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	4	91	4.40
Radionuclide	SOIL	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	12	91	13.19
Radionuclide	SOIL	Documentation Issues	Transcription error	No	1	91	1.10
Radionuclide	SOIL	Documentation Issues	Transcription error	Yes	16	91	17.58
Radionuclide	SOIL	Instrument Set-up	Detector efficiency did not meet requirements	Yes	4	91	4.40
Radionuclide	SOIL	LCS	LCS recovery > +/- 3 sigma	Yes	6	91	6.59

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Table A2.3.MKAEU.6
MK AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Radionuclide	SOIL	LCS	LCS relative percent error criteria not met	Yes	5	91	5.49
Radionuclide	SOIL	Matrices	Recovery criteria were not met	Yes	3	91	3.30
Radionuclide	SOIL	Matrices	Replicate analysis was not performed	No	1	91	1.10
Radionuclide	SOIL	Matrices	Replicate precision criteria were not met	Yes	9	91	9.89
Radionuclide	SOIL	Other	Lab results not verified due to unsubmitted data	Yes	1	91	1.10
Radionuclide	SOIL	Other	Sample exceeded efficiency curve weight limit	Yes	2	91	2.20
Radionuclide	SOIL	Other	See hard copy for further explanation	Yes	9	91	9.89
Radionuclide	SOIL	Sample Preparation	Improper aliquot size	Yes	1	91	1.10
Radionuclide	SOIL	Sensitivity	Incorrect reported activity or MDA	Yes	1	91	1.10
Radionuclide	SOIL	Sensitivity	MDA exceeded the RDL	Yes	2	91	2.20
Radionuclide	SOIL	Sensitivity	MDA was calculated by reviewer	Yes	29	91	31.87
Radionuclide	SOIL	Sensitivity	Results considered qualitative not quantitative	Yes	1	91	1.10
Radionuclide	WATER	Blanks	Method, preparation, or reagent blank contamination	No	1	128	0.78
Radionuclide	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	4	128	3.13
Radionuclide	WATER	Calibration	Calibration counting statistics did not meet criteria	No	1	128	0.78
Radionuclide	WATER	Calibration	Continuing calibration verification criteria were not met	No	3	128	2.34
Radionuclide	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	21	128	16.41
Radionuclide	WATER	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	9	128	7.03
Radionuclide	WATER	Documentation Issues	Transcription error	No	12	128	9.38
Radionuclide	WATER	Documentation Issues	Transcription error	Yes	9	128	7.03
Radionuclide	WATER	Holding Times	Holding times were exceeded	No	5	128	3.91
Radionuclide	WATER	Holding Times	Holding times were exceeded	Yes	4	128	3.13
Radionuclide	WATER	LCS	Expected LCS value not submitted/verifiable	Yes	1	128	0.78
Radionuclide	WATER	LCS	LCS recovery > +/- 3 sigma	No	1	128	0.78
Radionuclide	WATER	LCS	LCS recovery > +/- 3 sigma	Yes	1	128	0.78
Radionuclide	WATER	LCS	LCS relative percent error criteria not met	Yes	3	128	2.34
Radionuclide	WATER	Matrices	Replicate analysis was not performed	Yes	2	128	1.56
Radionuclide	WATER	Matrices	Replicate precision criteria were not met	No	4	128	3.13
Radionuclide	WATER	Matrices	Replicate precision criteria were not met	Yes	3	128	2.34
Radionuclide	WATER	Other	Lab results not verified due to unsubmitted data	Yes	3	128	2.34
Radionuclide	WATER	Other	See hard copy for further explanation	No	6	128	4.69
Radionuclide	WATER	Other	See hard copy for further explanation	Yes	7	128	5.47
Radionuclide	WATER	Sensitivity	MDA exceeded the RDL	No	2	128	1.56
Radionuclide	WATER	Sensitivity	MDA was calculated by reviewer	Yes	19	128	14.84
SVOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	1	405	0.25
SVOC	SOIL	Calibration	Continuing calibration verification criteria were not met	No	6	405	1.48

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Table A2.3.MKAEU.6
MK AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
SVOC	SOIL	Internal Standards	Internal standards did not meet criteria	No	12	405	2.96
SVOC	SOIL	Internal Standards	Internal standards did not meet criteria	Yes	1	405	0.25
SVOC	WATER	Blanks	Method, preparation, or reagent blank contamination	No	1	102	0.98
VOC	SOIL	Blanks	Method, preparation, or reagent blank contamination	No	10	298	3.36
VOC	SOIL	Calibration	Continuing calibration verification criteria were not met	Yes	1	298	0.34
VOC	SOIL	Internal Standards	Internal standards did not meet criteria	No	8	298	2.68
VOC	SOIL	Internal Standards	Internal standards did not meet criteria	Yes	1	298	0.34
VOC	SOIL	Surrogates	Surrogate recovery criteria were not met	No	33	298	11.07
VOC	SOIL	Surrogates	Surrogate recovery criteria were not met	Yes	1	298	0.34
VOC	WATER	Blanks	Method, preparation, or reagent blank contamination	No	5	447	1.12
VOC	WATER	Calibration	Continuing calibration verification criteria were not met	No	2	447	0.45
VOC	WATER	Documentation Issues	Record added by the validator	No	34	447	7.61
Wet Chem	SOIL	Holding Times	Holding times were exceeded	Yes	1	12	8.33
Wet Chem	SOIL	Holding Times	Holding times were grossly exceeded	No	1	12	8.33
Wet Chem	SOIL	Matrices	Predigestion MS recovery criteria were not met	No	1	12	8.33
Wet Chem	SOIL	Matrices	Predigestion MS recovery was < 30 percent	Yes	4	12	33.33
Wet Chem	WATER	Blanks	Method, preparation, or reagent blank contamination	No	1	131	0.76
Wet Chem	WATER	Calibration	Calibration correlation coefficient did not meet requirements	Yes	1	131	0.76
Wet Chem	WATER	Documentation Issues	Record added by the validator	No	4	131	3.05
Wet Chem	WATER	Documentation Issues	Record added by the validator	Yes	5	131	3.82
Wet Chem	WATER	Holding Times	Holding times were exceeded	No	2	131	1.53
Wet Chem	WATER	Holding Times	Holding times were exceeded	Yes	6	131	4.58
Wet Chem	WATER	LCS	LCS recovery criteria were not met	No	1	131	0.76
Wet Chem	WATER	Matrices	Duplicate sample precision criteria were not met	No	1	131	0.76
Wet Chem	WATER	Matrices	Duplicate sample precision criteria were not met	Yes	1	131	0.76
Wet Chem	WATER	Matrices	Predigestion MS recovery criteria were not met	No	1	131	0.76
Wet Chem	WATER	Other	IDL is older than 3 months from date of analysis	Yes	2	131	1.53

Table A2.3.SEAEU.1
SE AEU - CRA Data V&V Summary

Analyte Group	Matrix	Total No. of V&V Records	Total No. of CRA Records	Percent V&V (%)
Dioxins and Furans	WATER	1	1	100.00
Herbicide	WATER	4	4	100.00
Metal	SOIL	210	210	100.00
Metal	WATER	469	544	86.21
PCB	WATER	7	7	100.00
Pesticide	WATER	30	30	100.00
Radionuclide	SOIL	45	45	100.00
Radionuclide	WATER	83	83	100.00
SVOC	WATER	59	59	100.00
VOC	WATER	264	264	100.00
Wet Chem	SOIL	7	7	100.00
Wet Chem	WATER	63	73	86.30
	Total	**1,242**	**1,327**	**93.59%**

Table A2.3.SEAEU.2
SE AEU - Summary of Data Estimated or Undetected Due to V&V Determinations

Analyte Group	Matrix	No. of CRA Data Records Qualified	Total No. of V&V CRA Records	Detect?	Percent Qualified (%)
Herbicide	WATER	1	4	No	25.00
Metal	SOIL	25	210	No	11.90
Metal	SOIL	27	210	Yes	12.86
Metal	WATER	35	469	No	7.46
Metal	WATER	55	469	Yes	11.73
Pesticide	WATER	4	30	No	13.33
Radionuclide	WATER	4	83	No	4.82
Radionuclide	WATER	1	83	Yes	1.20
SVOC	WATER	9	59	No	15.25
VOC	WATER	40	264	No	15.15
Wet Chem	SOIL	4	7	Yes	57.14
Wet Chem	WATER	5	63	No	7.94
Wet Chem	WATER	4	63	Yes	6.35
	Total	**214**	**1,242**		**17.23%**

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Table A2.3.SEAEU.3
SE AEU - Summary of Data Qualified as Undetected Due to Blank Contamination

Analyte Group	Matrix	No. of CRA Records Qualified as Undetected	Total No. of CRA Records with Detected Results[a]	Percent Qualified as Undetected
Metal	SOIL	11	170	6.47
Metal	WATER	4	191	2.09
	Total	**15**	**361**	**4.16%**

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

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Table A2.3.SEAEU.4
SE AEU - Summary of Data Rejected During V&V

Analyte Group	Matrix	Total No. of Rejected Records	Total No. of Records	Percent Rejected (%)
Dioxins and Furans	WATER	0	1	0.00
Herbicide	WATER	0	4	0.00
Metal	SOIL	0	210	0.00
Metal	WATER	14	552	2.54
PCB	WATER	0	7	0.00
Pesticide	WATER	0	30	0.00
Radionuclide	SOIL	0	45	0.00
Radionuclide	WATER	25	117	21.37
SVOC	WATER	1	78	1.28
VOC	WATER	6	332	1.81
Wet Chem	SOIL	0	7	0.00
Wet Chem	WATER	0	72	0.00
	Total	**46**	**1455**	**3.16%**

Table A2.3.SEAEU.5
SE AEU - Summary of RPDs/DERs of Field Duplicate Analyte Pairs

Analyte Group	Matrix	No. of Duplicates Failing RPD/DER Criteria	Total No. of Duplicate Pairs	Percent Failure (%)	Field Duplicate Frequency (%)
Metal	SOIL	12	30	40.00	14.29
Metal	WATER	0	88	0.00	16.18
Radionuclide	WATER	0	15	0.00	18.07
Wet Chem	SOIL	0	1	0.00	14.29
Wet Chem	WATER	0	10	0.00	13.70

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Table A2.3.SEAEU.6
SE AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Dioxins and Furans	WATER	Documentation Issues	Record added by the validator	No	1	1	100.00
Herbicide	WATER	Calibration	Continuing calibration verification criteria were not met	No	1	4	25.00
Metal	SOIL	Blanks	Calibration verification blank contamination	No	11	210	5.24
Metal	SOIL	LCS	Low level check sample recovery criteria were not met	No	10	210	4.76
Metal	SOIL	LCS	Low level check sample recovery criteria were not met	Yes	6	210	2.86
Metal	SOIL	Matrices	LCS/LCSD precision criteria were not met	Yes	4	210	1.90
Metal	SOIL	Matrices	Predigestion MS recovery criteria were not met	No	7	210	3.33
Metal	SOIL	Matrices	Predigestion MS recovery criteria were not met	Yes	13	210	6.19
Metal	SOIL	Matrices	Serial dilution criteria were not met	Yes	4	210	1.90
Metal	SOIL	Other	IDL is older than 3 months from date of analysis	No	14	210	6.67
Metal	SOIL	Other	IDL is older than 3 months from date of analysis	Yes	73	210	34.76
Metal	WATER	Blanks	Calibration verification blank contamination	No	8	469	1.71
Metal	WATER	Blanks	Method, preparation, or reagent blank contamination	No	5	469	1.07
Metal	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	37	469	7.89
Metal	WATER	Blanks	Negative bias indicated in the blanks	No	7	469	1.49
Metal	WATER	Blanks	Negative bias indicated in the blanks	Yes	2	469	0.43
Metal	WATER	Calibration	Calibration correlation coefficient did not meet requirements	No	2	469	0.43
Metal	WATER	Documentation Issues	Key data fields incorrect	No	3	469	0.64
Metal	WATER	Documentation Issues	Key data fields incorrect	Yes	15	469	3.20
Metal	WATER	Documentation Issues	Transcription error	No	21	469	4.48
Metal	WATER	LCS	CRDL check sample recovery criteria were not met	Yes	1	469	0.21
Metal	WATER	LCS	LCS recovery criteria were not met	Yes	2	469	0.43
Metal	WATER	LCS	Low level check sample recovery criteria were not met	No	8	469	1.71
Metal	WATER	LCS	Low level check sample recovery criteria were not met	Yes	4	469	0.85
Metal	WATER	Matrices	Post-digestion MS did not meet control criteria	No	7	469	1.49
Metal	WATER	Matrices	Predigestion MS recovery criteria were not met	No	5	469	1.07
Metal	WATER	Matrices	Predigestion MS recovery criteria were not met	Yes	5	469	1.07
Metal	WATER	Matrices	Serial dilution criteria were not met	Yes	6	469	1.28
Metal	WATER	Other	IDL is older than 3 months from date of analysis	No	71	469	15.14
Metal	WATER	Other	IDL is older than 3 months from date of analysis	Yes	45	469	9.59
Pesticide	WATER	Calibration	Continuing calibration verification criteria were not met	No	4	30	13.33
Pesticide	WATER	Documentation Issues	Transcription error	No	1	30	3.33
Radionuclide	WATER	Blanks	Blank recovery criteria were not met	No	1	83	1.20
Radionuclide	WATER	Blanks	Blank recovery criteria were not met	Yes	1	83	1.20
Radionuclide	WATER	Blanks	Method, preparation, or reagent blank contamination	Yes	4	83	4.82
Radionuclide	WATER	Calibration	Calibration counting statistics did not meet criteria	No	1	83	1.20

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Table A2.3.SEAEU.6
SE AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Radionuclide	WATER	Calibration	Continuing calibration verification criteria were not met	No	7	83	8.43
Radionuclide	WATER	Calibration	Continuing calibration verification criteria were not met	Yes	6	83	7.23
Radionuclide	WATER	Documentation Issues	Sufficient documentation not provided by the laboratory	Yes	11	83	13.25
Radionuclide	WATER	Documentation Issues	Transcription error	No	14	83	16.87
Radionuclide	WATER	Documentation Issues	Transcription error	Yes	9	83	10.84
Radionuclide	WATER	Holding Times	Holding times were exceeded	No	1	83	1.20
Radionuclide	WATER	Holding Times	Holding times were exceeded	Yes	2	83	2.41
Radionuclide	WATER	Holding Times	Holding times were grossly exceeded	No	1	83	1.20
Radionuclide	WATER	Instrument Set-up	Resolution criteria were not met	No	1	83	1.20
Radionuclide	WATER	LCS	Expected LCS value not submitted/verifiable	No	1	83	1.20
Radionuclide	WATER	LCS	Expected LCS value not submitted/verifiable	Yes	1	83	1.20
Radionuclide	WATER	LCS	LCS recovery > +/- 3 sigma	No	4	83	4.82
Radionuclide	WATER	LCS	LCS recovery > +/- 3 sigma	Yes	3	83	3.61
Radionuclide	WATER	LCS	LCS recovery criteria were not met	No	1	83	1.20
Radionuclide	WATER	LCS	LCS recovery criteria were not met	Yes	2	83	2.41
Radionuclide	WATER	LCS	LCS relative percent error criteria not met	No	2	83	2.41
Radionuclide	WATER	LCS	LCS relative percent error criteria not met	Yes	6	83	7.23
Radionuclide	WATER	Matrices	Replicate analysis was not performed	Yes	4	83	4.82
Radionuclide	WATER	Matrices	Replicate precision criteria were not met	No	3	83	3.61
Radionuclide	WATER	Matrices	Replicate precision criteria were not met	Yes	1	83	1.20
Radionuclide	WATER	Other	See hard copy for further explanation	No	2	83	2.41
Radionuclide	WATER	Other	See hard copy for further explanation	Yes	6	83	7.23
Radionuclide	WATER	Sensitivity	Incorrect reported activity or MDA	No	1	83	1.20
Radionuclide	WATER	Sensitivity	MDA exceeded the RDL	No	3	83	3.61
Radionuclide	WATER	Sensitivity	MDA exceeded the RDL	Yes	1	83	1.20
Radionuclide	WATER	Sensitivity	MDA was calculated by reviewer	Yes	25	83	30.12
SVOC	WATER	Documentation Issues	Transcription error	No	2	59	3.39
SVOC	WATER	Holding Times	Holding times were exceeded	No	1	59	1.69
SVOC	WATER	Other	See hard copy for further explanation	No	8	59	13.56
VOC	WATER	Blanks	Method, preparation, or reagent blank contamination	No	5	264	1.89
VOC	WATER	Calibration	Continuing calibration verification criteria were not met	No	8	264	3.03
VOC	WATER	Documentation Issues	Record added by the validator	No	31	264	11.74
VOC	WATER	Documentation Issues	Transcription error	No	55	264	20.83
VOC	WATER	Holding Times	Holding times were exceeded	No	29	264	10.98
VOC	WATER	Other	See hard copy for further explanation	No	1	264	0.38
Wet Chem	SOIL	Matrices	Predigestion MS recovery was < 30 percent	Yes	4	7	57.14

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Table A2.3.SEAEU.6
SE AEU - Summary of V&V Observations

Analyte Group	Matrix	QC Category	V&V Observation	Detect ?	No. of Qualified Results	Total No. of V&V Records	Percent Qualified (%)
Wet Chem	SOIL	Other	IDL is older than 3 months from date of analysis	Yes	3	7	42.86
Wet Chem	WATER	Calibration	Calibration correlation coefficient did not meet requirements	Yes	1	63	1.59
Wet Chem	WATER	Documentation Issues	Record added by the validator	No	6	63	9.52
Wet Chem	WATER	Documentation Issues	Record added by the validator	Yes	3	63	4.76
Wet Chem	WATER	Documentation Issues	Transcription error	No	1	63	1.59
Wet Chem	WATER	Documentation Issues	Transcription error	Yes	4	63	6.35
Wet Chem	WATER	Holding Times	Holding times were exceeded	No	3	63	4.76
Wet Chem	WATER	Holding Times	Holding times were grossly exceeded	No	2	63	3.17
Wet Chem	WATER	Holding Times	Holding times were grossly exceeded	Yes	1	63	1.59
Wet Chem	WATER	Matrices	Predigestion MS recovery criteria were not met	Yes	1	63	1.59
Wet Chem	WATER	Matrices	Predigestion MS recovery was < 30 percent	Yes	1	63	1.59
Wet Chem	WATER	Other	IDL is older than 3 months from date of analysis	Yes	4	63	6.35
Wet Chem	WATER	Other	Result obtained through dilution	Yes	1	63	1.59

COMPREHENSIVE RISK ASSESSMENT

NO NAME GULCH AQUATIC EXPOSURE UNIT, ROCK CREEK AQUATIC EXPOSURE UNIT, MCKAY DITCH AQUATIC EXPOSURE UNIT, SOUTHEAST AQUATIC EXPOSURE UNIT

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ACRONYMS AND ABBREVIATIONS

µg/kg	micrograms per kilogram
AET	apparent effect threshold
AEU	Aquatic Exposure Unit
AL	action level
bgs	below ground surface
BZ	Buffer Zone
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
DQA	Data Quality Assessment
ECOI	ecological contaminant of interest
ECOPC	ecological contaminant of potential concern
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
EqP	equilibrium partitioning
ERA	Ecological Risk Assessment
ESL	ecological screening level
HEPA	high-efficiency particulate air
IA	Industrial Area
IHSS	Individual Hazardous Substance Site
LEL	lowest effect level
LOEC	lowest observed effect concentration
MDC	maximum detected concentration
mg/kg	milligrams per kilogram

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mg/L	milligrams per liter
MK AEU	McKay Ditch Aquatic Exposure Unit
NAWQC	National Ambient Water Quality Criteria
NFA	No Further Action
NN AEU	No Name Gulch Aquatic Exposure Unit
NOAEL	no observed adverse effect level
NPDES	National Pollutant Discharge Elimination System
OU	Operable Unit
PAC	Potential Area of Concern
PCOC	potential contaminant of concern
PDSR	Pre-Demolition Survey Report
PEC	probable effect concentration
PEL	probable effect level
RC AEU	Rock Creek Aquatic Exposure Unit
RFCA	Rocky Flats Cleanup Agreement
RFETS	Rocky Flats Environmental Technology Site
RLCR	Reconnaissance-Level Characterization Report
SE AEU	Southeast Aquatic Exposure Unit
SQG	sediment quality guideline
TNRCC	Texas Natural Resource Conservation Commission
UBC	under building contamination
UCL	upper confidence limit
UTL	upper tolerance limit
WRS	Wilcoxon Rank Sum

1.0 INTRODUCTION

This attachment presents the results for the statistical analyses and professional judgment evaluation used to select ecological contaminants of potential concern (ECOPCs) as part of the Ecological Risk Assessment (ERA) for four of the seven Aquatic Ecological Exposure Units (AEUs) at the Rocky Flats Environmental Technology Site (RFETS): No Name Gulch AEU (NN AEU), Rock Creek AEU (RC AEU), McKay Ditch AEU (MK AEU), and Southeast AEU (SE AEU). The remaining three AEUs are addressed in Appendix A, Volume 15B2 of the Resource Conservation and Recovery Act (RCRA) Facility Investigation-Remedial Investigation (RI)/Corrective Measures Study (CMS)-Feasibility Study (FS) Report (hereafter referred to as the RI/FS Report).

The methods used to perform the statistical analysis and to develop the professional judgment sections are described in Appendix A, Volume 2, Section 2.0 of the RI/FS Report and follow the Final Comprehensive Risk Assessment (CRA) Work Plan and Methodology, Revision 1 (DOE 2005).

2.0 RESULTS OF STATISTICAL COMPARISONS TO BACKGROUND FOR THE AQUATIC EXPOSURE UNITS

The results of the statistical background comparisons for inorganic and radionuclide and ecological contaminants of interest (ECOIs)in surface water (total and dissolved) and sediment samples collected from the AEUs are presented in this section. Surface water and sediment from NN AEU, RC AEU, MK AEU, and SE AEU included samples from locations considered part of the background data sets for RFETS. These background samples were included in the AEU data evaluated in the initial steps of the ECOPC identification as a conservative assessment measure. Background samples have been removed from the AEU data sets for the comparison of site sample concentrations to background concentrations that are presented in the following sections.

Box plots are provided for analytes that were carried forward into the statistical comparison step and are presented in Figures A3.2.NN AEU.1 to A3.2.SE AEU.6.[1] The box plots display several reference points: 1) the line inside the box is the median; 2) the lower edge of the box is the 25th percentile; 3) the upper edge of the box is the 75th percentile; 4) the upper lines (called whiskers) are drawn to the greatest value that is less than or equal to 1.5 times the inter-quartile range (the interquartile range is between the 75th and 25th percentiles); 5) the lower whiskers are drawn to the lowest value that is greater than or equal to 1.5 times the inter-quartile range; and 6) solid circles are data points greater or less than the whiskers.

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

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ECOIs (for non-PMJM receptors) with concentrations in the AEUs that are statistically greater than background (or those where background comparisons were not performed) are carried through to the upper-bound exposure point concentration (EPC) –ecological screening level (ESL) comparison step of the ECOPC selection processes. ECOIs with concentrations that are not statistically greater than background are not identified as ECOPCs and are not evaluated further.

2.1 No Name Gulch (NN AEU)

2.1.1 Surface Water Total Concentrations

In surface water, total concentrations of aluminum, barium, beryllium, lithium, selenium, and vanadium have MDCs that exceed their ESL and detection frequencies greater than 5 percent. These ECOIs were carried forward into the statistical background comparison. Bis(2-ethylhexyl)phthalate, di-n-butylphthalate, pentachlorophenol, phenanthrene, and phenol have MDCs that exceed their ESL and detection frequencies greater than 5 percent. The statistical comparison of the NN AEU surface water (total) data to background data is presented in Table A3.2.NN AEU.1, while summary statistics for background and NN AEU surface water (total) data are provided in Table A3.2.NN AEU.2.

The results of the statistical comparisons of the NN AEU surface water total concentrations data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Barium
- Lithium

Not Statistically Greater than Background at the 0.1 Significance Level

- Aluminum
- Vanadium

Background Comparison Not Performed[1]

- Beryllium
- Bis(2-ethylhexyl)phthalate
- Di-n-butylphthalate
- Pentachlorophenol
- Phenanthrene
- Phenol
- Selenium

2.1.2 Surface Water Dissolved Concentrations

In surface water, dissolved concentrations of copper, iron, lead, silver, and zinc have MDCs that exceed their ESL and detection frequencies greater than 5 percent. These

ECOIs were carried forward into the statistical background comparison. Samples were not collected for analysis of dissolved organics. The statistical comparison of the NN AEU surface water (dissolved) data to background data is presented in Table A3.2.NN AEU.3, while summary statistics for background and NN AEU surface water (dissolved) data are provided in Table A3.2.NN AEU.4.

The results of the statistical comparisons of the NN AEU surface water dissolved concentrations data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Zinc

Not Statistically Greater than Background at the 0.1 Significance Level

- Copper
- Iron

Background Comparison Not Performed[1]

- Lead
- Sliver

2.1.3 Sediment

In sediment, aluminum, barium, iron, lead, and manganese have MDCs that exceed their ESL and detection frequencies greater than 5 percent. These ECOIs were carried forward into the statistical background comparison. Benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene have MDCs that exceed their ESL and detection frequencies greater than 5 percent. The statistical comparison of the NN AEU sediment data to background data is presented in Table A3.2.NN AEU.5, while summary statistics for background and NN AEU sediment data are provided in Table A3.2.NN AEU.6.

The results of the statistical comparisons of the NN AEU sediment concentrations data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Aluminum
- Barium
- Iron
- Lead

Not Statistically Greater than Background at the 0.1 Significance Level

- Manganese

Background Comparison Not Performed[1]

- Benzo(a)anthracene

- Benzo(a)pyrene
- Benzo(g,h,i)perylene
- Chrysene
- Indeno(1,2,3-cd)pyrene
- Phenanthrene
- Pyrene

2.2 Rock Creek (RC AEU)

2.2.1 Surface Water Total Concentrations

In surface water, total concentrations of aluminum, barium, beryllium, cyanide, lithium, selenium, vanadium, and radium-226 have MDCs that exceeded their ESL and detection frequencies greater than 5 percent. These ECOIs were carried forward into the statistical background comparison. With respect to total organics in surface water, no analytes have MDCs greater than their ESLs and detection frequencies greater than 5 percent. The statistical comparison of the RC AEU surface water (total) data to background data is presented in Table A3.2.RC AEU.1, while summary statistics for background and RC AEU surface water (total) data are provided in Table A3.2.RC AEU.2. Radium-226 and cyanide were detected only in the background data set and are not considered further in the ECOPC screening process.

The results of the statistical comparisons of the RC AEU surface water total concentrations data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Barium
- Lithium
- Selenium

Not Statistically Greater than Background at the 0.1 Significance Level

- Aluminum
- Vanadium

Background Comparison Not Performed[1]

- Beryllium
- Selenium

2.2.2 Surface Water Dissolved Concentrations

In surface water, dissolved concentrations of cadmium, copper, iron, and lead had MDCs that exceeded their ESL and detection frequencies greater than 5 percent. These ECOIs were carried forward into the statistical background comparison. Samples were not collected for analysis of dissolved organics. The statistical comparison of the RC AEU surface water (dissolved) data to background data is presented in Table A3.2.RC AEU.3, while summary statistics for background and RC AEU surface water (dissolved) data are provided in Table A3.2.RC AEU.4.

The results of the statistical comparisons of the RC AEU surface water dissolved concentrations data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- None

Not Statistically Greater than Background at the 0.1 Significance Level

- Copper
- Iron

Background Comparison Not Performed[1]

- Cadmium
- Lead

2.2.3 Sediment

In sediment, 12 metals have MDCs that exceeded their ESL for the RC AEU and detection frequencies greater than 5 percent (aluminum, antimony, arsenic, barium, cadmium, iron, lead, manganese, nickel, selenium, silver, and zinc). These ECOIs were carried forward into the statistical background comparison. 2-butanone, 4-methylphenol, and pentachlorophenol have MDCs that exceed their ESL and detection frequencies greater than 5 percent. The statistical comparison of the RC AEU sediment data to background data is presented in Table A3.2.RC AEU.5, while summary statistics for background and RC AEU sediment data are provided in Table A3.2.RC AEU.6. Antimony, 2-butanone and 4-methylphenol were only detected within the background data sets, and are not considered further in the ECOPC screening process.

The results of the statistical comparisons of the RC AEU sediment concentrations data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Aluminum
- Arsenic
- Barium
- Iron
- Lead
- Nickel
- Selenium
- Zinc

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Not Statistically Greater than Background at the 0.1 Significance Level

- Manganese

Background Comparison Not Performed[1]

- Cadmium
- Silver
- Pentachlorophenol

2.3 McKay Ditch (MK AEU)

2.3.1 Surface Water Total Concentrations

In surface water, total concentrations of aluminum, selenium, and vanadium have MDCs that exceed the ESL and detection frequencies greater than 5 percent. These ECOIs were carried forward into the statistical background comparison. With respect to total organics in surface water, no analytes have MDCs greater than their ESLs and detection frequencies greater than 5 percent. The statistical comparison of the MK AEU surface water (total) data to background data is presented in Table A.3.3.MK AEU.1, while summary statistics for background and MK AEU surface water (total) data are provided in Table A.3.3.MK AEU.2.

The results of the statistical comparisons of the MK AEU surface water total concentrations data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Aluminum

Not Statistically Greater than Background at the 0.1 Significance Level

- Vanadium

Background Comparison Not Performed[1]

- Selenium

2.3.2 Surface Water Dissolved Concentrations

In surface water, dissolved concentrations of cadmium, copper, lead, and zinc have MDCs that exceed their ESL and detection frequencies greater than 5 percent. These ECOIs were carried forward into the statistical background comparison. Samples were not collected for analysis of dissolved organics. The statistical comparison of the MK AEU surface water (dissolved) data to background data is presented in Table A.3.3.MK AEU.3, while summary statistics for background and MK AEU surface water (dissolved) data are provided in Table A.3.3.MK AEU.4.

The results of the statistical comparisons of the MK AEU surface water dissolved concentrations data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Zinc

Not Statistically Greater than Background at the 0.1 Significance Level

- Copper
- Lead

***Background Comparison Not Performed*[1]**

- Cadmium

2.3.3 Sediment

In sediment, 10 inorganics had MDCs that exceeded their ESL and detection frequencies greater than 5 percent (aluminum, antimony, chromium, copper, fluoride, iron, lead, nickel, selenium, and zinc). These ECOIs were carried forward into the statistical background comparison. 4-methylphenol has an MDC that exceeds its ESL and a detection frequency greater than 5 percent. The statistical comparison of the MK AEU sediment data to background data is presented in Table A.3.3.MK AEU.5, while summary statistics for background and MK AEU sediment data are provided in Table A.3.3.MK AEU.6. Antimony and 4-methylphenol was only detected within the background data set, and are not considered further in the ECOPC screening process.

With respect to organics in sediment, 4-methylphenol has an MDC that exceeds its ESL and a detection frequency greater than 5 percent. However, 4-methylphenol was only detected within the background data set. Thus, it is not a valid ECOI for MK AEU sediment and was eliminated from further consideration as an ECOPC.

The results of the statistical comparisons of the MK AEU sediment concentrations data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Aluminum
- Chromium
- Nickel

Not Statistically Greater than Background at the 0.1 Significance Level

- Copper
- Iron
- Lead

***Background Comparison Not Performed*[1]**

- Fluoride
- Selenium

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2.4 Southeast (SE AEU)

2.4.1 Surface Water Total Concentrations

In surface water, total concentrations of aluminum have an MDC that exceeds the ESL and a detection frequency greater than 5 percent. Aluminum was carried forward into the statistical background comparison. With respect to total organics in surface water, no analytes have MDCs greater than their ESLs and detection frequencies greater than 5 percent. The statistical comparison of the SE AEU surface water (total) data to background data is presented in Table A.3.3.SE AEU.1, while summary statistics for background and SE AEU surface water (total) data are provided in Table A.3.3.SE AEU.2.

The results of the statistical comparisons of the SE AEU surface water total concentrations data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- None

Not Statistically Greater than Background at the 0.1 Significance Level

- Aluminum

Background Comparison Not Performed[1]

- None

2.4.2 Surface Water Dissolved Concentrations

For surface water, dissolved silver has an MDC that exceeds the ESL and a detection frequency greater than 5 percent. Silver carried forward into the statistical background comparison. Samples were not collected for analysis of dissolved organics. The statistical comparison of the SE AEU surface water (dissolved) data to background data is presented in Table A.3.3.SE AEU.3, while summary statistics for background and SE AEU surface water (dissolved) data are provided in Table A.3.3.SE AEU.4.

The results of the statistical comparisons of the SE AEU surface water dissolved concentrations data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- None

Not Statistically Greater than Background at the 0.1 Significance Level

- None

Background Comparison Not Performed[1]

- Silver

2.4.3 Sediment

In sediment, aluminum, barium, iron, and selenium have MDCs that exceed their ESL and detection frequencies greater than 5 percent. These ECOIs were carried forward into the statistical background comparison. The statistical comparison of the SE AEU sediment data to background data is presented in Table A.3.3.SE AEU.5, while summary statistics for background and SE AEU sediment data are provided in Table A.3.3.SE AEU.6.

The results of the statistical comparisons of the SE AEU sediment concentrations data to background data indicate the following:

Statistically Greater than Background at the 0.1 Significance Level

- Aluminum
- Barium
- Iron

Not Statistically Greater than Background at the 0.1 Significance Level

- None

Background Comparison Not Performed[1]

- Selenium

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

ECOIs in surface water (total and dissolved) and sediment with concentrations that are statistically greater than background, or background comparisons were not performed, are evaluated further by comparing the EPCs to the ESLs. The EPCs are the 95 percent UCLs of the 90th percentile [upper tolerance limit (UTL)], or the MDC in the event that the UTL is greater than the MDC.

3.1 No Name Gulch (NN AEU)

3.1.1 Surface Water Total Concentrations

The UTLs for beryllium, lithium, selenium, bis(2-ethylhexyl)phthalate, di-n-butylphthalate, and phenol are less than their ESLs. The UTLs for barium, pentachlorophenol, and phenanthrene are greater than its ESL, and are evaluated further using professional judgment, as presented in Section 4.0.

3.1.2 Surface Water Dissolved Concentrations

Lead, silver, and zinc have UTLs that exceed their ESLs, and are evaluated further using professional judgment, as presented in Section 4.0.

3.1.3 Sediment

The UTLs for aluminum, barium, iron, lead, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene are greater than their ESL, and are evaluated further using professional judgment, as presented in Section 4.0.

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3.2 Rock Creek (RC AEU)

3.2.1 Surface Water Total Concentrations

The UTLs for barium, beryllium, lithium, and selenium do not exceed their ESLs. Therefore, there are no ECOPCs in surface water (total) for the RC AEU.

3.2.2 Surface Water Dissolved Concentrations

The UTLs for cadmium and lead exceed their ESLs, and are evaluated further using professional judgment, as presented in Section 4.0.

3.2.3 Sediment

The UTLs for aluminum, arsenic, barium, cadmium, iron, lead, nickel, selenium, silver, zinc, and pentachlorophenol exceed their ESLs, and are evaluated further using professional judgment, as presented in Section 4.0. The UTL for nickel does not exceed the ESL, and is not considered further in the ECOPC screening process.

3.3 McKay Ditch (MK AEU)

3.3.1 Surface Water Total Concentrations

The UTLs for aluminum and selenium are greater than their ESLs, and are evaluated further using professional judgment, as presented in Section 4.0.

3.3.2 Surface Water Dissolved Concentrations

The UTLs for cadmium and zinc are greater than their ESLs, and are evaluated further using professional judgment, as presented in Section 4.0.

3.3.3 Sediment

The UTLs for aluminum, chromium, fluoride, nickel, and selenium are greater than their ESLs, and are evaluated further using professional judgment, as presented in Section 4.0.

3.4 Southeast (SE AEU)

3.4.1 Surface Water Total Concentrations

No analytes in SE AEU surface water (total) were statistically greater than background, therefore, the comparison of the UTL to the ESL was not performed. No ECOPCs were selected for SE AEU surface water (total concentrations).

3.4.2 Surface Water Dissolved Concentrations

Silver has a UTL that is greater than its ESL, and is evaluated further using professional judgment, as presented in Section 4.0.

3.4.3 Sediment

The UTLs for aluminum, barium, iron, and selenium are greater than their ESLs, and are evaluated further using professional judgment, as presented in Section 4.0.

4.0 PROFESSIONAL JUDGMENT

This section presents the results of the professional judgment step of the ECOPC selection processes for the ERA at the AEUs. The professional judgment evaluation takes into account the following lines of evidence: process knowledge, spatial trends, comparison to RFETS background and pattern recognition[2], and risk potential. Based on the weight of evidence evaluated in the professional judgment step, ECOIs are either included for further evaluation as ECOPCs in the risk characterization step, or excluded from further evaluation.

4.1 NN AEU

For the NNEU, the ECOPC selection process indicates many metals and organic analytes are ECOPCs in surface soil. Furthermore, the presence of organic analytes in environmental media is typically of anthropogenic origin. Therefore, considering runoff is a transport mechanism whereby surface water and sediment within the AEU may be impacted by ECOPCs or other ECOIs in EU surface soil, all ECOIs that pass through the EPC/ESL screen for surface water (total and dissolved concentrations) and sediment are considered ECOPCs, and are further evaluated in the risk characterizations for the NN AEU. The NN AEU ECOPCs are total barium, dissolved lead, dissolved silver, dissolved zinc, pentachlorophenol, and phenantherene in surface water, and aluminum, barium, iron, lead, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)pyrene, chrysene, indeno(1,2,-cd)pyrene, phenanthrene, and pyrene in sediment.

4.2 RC AEU

The RC AEU has unique physical characteristics applicable to professional judgment for all ECOIs in the environmental media considered herein. The RC AEU is located in the northwestern portion of RFETS, well outside areas that were used historically for site operations. One Potential Area of Concern (PAC) exists within the RC AEU: Roadway Spraying (PAC 000-501). Roadways throughout the Buffer Zone (BZ) Operable Unit (OU) were sprayed with waste oils for dust suppression. Reverse osmosis brine solutions and footing drain water were also applied. Based on the available evidence, PAC 000-501 was proposed for No Further Action (NFA) in 1991. The NFA was approved in 2002 (EPA 2002) as documented in the 2002 HRR Update (DOE 2002). The Nickel Carbonyl Disposal area (IHSS 195), which was a drywell used for the decomposition of approximately 185 pounds of nickel carbonyl gas between March and September 1972, is

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

also located in the area. This PAC and historical IHSS are not likely sources of contamination for the RC AEU.

The physical characteristics and principal surface features of the RC AEU are discussed in detail in Section 1.0 of this report.

The following sections outline the weight-of-evidence evaluation for the ECOIs exceeding background and ESLs in surface water and sediment and are being carried forward to the professional judgment step. These analytes are:

- Aluminum in sediment;
- Arsenic in sediment;
- Barium in sediment;
- Cadmium (dissolved) in surface water;
- Cadmium in sediment;
- Iron in sediment;
- Lead (dissolved) in surface water;
- Lead in sediment;
- Selenium in sediment;
- Silver in sediment;
- Zinc in sediment; and
- Pentachlorophenol in sediment.

4.2.1 Aluminum in Sediment

Summary of Process Knowledge

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

Evaluation of Spatial Trends

There are four exceedances of the sediment ESL (15,900 milligrams per kilogram [mg/kg]) at four separate locations in the Rock Creek AEU (see Figure A3.4.RC AEU.1). The ESL exceedances ranged from 17,000 to 19,500 mg/kg. The ESL was not exceeded in nine other sediment sample results at these four locations, showing that ESL exceedances are not consistent across the RC AEU. All sediment sample results for aluminum in the RC AEU are less than the maximum background concentration of 25,200 mg/kg. There are no historical source areas upgradient or downgradient of these locations that would contribute to an elevated aluminum concentration. Therefore, aluminum concentrations in sediment are indicative of variations in naturally occurring aluminum.

Pattern Recognition

Aluminum was detected in 12 of the 12 sediment samples collected in the RC AEU. Aluminum concentrations at the RC AEU range from 4,900 to 19,000 mg/kg, with a mean concentration of 12,092 mg/kg and a standard deviation of 3,754 mg/kg in the AEU-specific data set that excludes the background samples. Aluminum was detected in 55 of the 55 sediment samples collected in the background data set. Aluminum concentrations in background range from 811 to 25,200 mg/kg, with a mean concentration of 6,791 mg/kg and a standard deviation of 5,603 mg/kg (Table A3.2.RC AEU.6).

The probability plot for aluminum indicates a single background population approaching an asymptotic maximum upper background concentration of about 2 percent aluminum (Figure A3.4.RC AEU.21).

Risk Potential for Benthic Macroinvertebrates

The MDC for aluminum in RC AEU sediment (19,000 mg/kg) exceeded the sediment ESL (15,900 mg/kg) for the entire AEU data set including background samples. While an MDC less than the ESL indicates that adverse effects associated with exposure to a given analyte are unlikely (EPA 1997), an MDC greater than or equal to the ESL does not indicate that risks are actually present, only that data are insufficient to exclude the potential for risk. Only four of 22 samples (22 of 22 detected) from RC AEU sediments exceeded the ESL for aluminum. These samples were collected between December 1991 and December 2004, and the low frequency of exceedances (18 percent) suggests that potential adverse effects are low. This ESL was based on the 85th percentile concentration in streams (TNRCC 1996; cited in MacDonald et al. 1999), which defined the sediment quality guideline (SQG) by the Texas Natural Resource Conservation Commission (TNRCC). The potential for adverse effects associated with this ESL is uncertain; however, the four samples that exceed the aluminum ESL did not exceed that level by a high magnitude (HQs less than 2). Therefore, despite the MDC exceeding the screening level ESL, it is unlikely that the concentrations of aluminum in sediment pose a potential for adverse effects to benthic organisms in RC AEU.

Conclusion

The weight of evidence presented above shows that aluminum concentrations in sediment in the RC AEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the AEU that would impact aluminum concentrations in sediment. It is unlikely that the concentrations of aluminum in sediment pose a potential for adverse effects to benthic organisms in the RC AEU. Aluminum is not considered an ECOPC in sediment for the RC AEU and is not further evaluated quantitatively.

4.2.2 Arsenic in Sediment

Summary of Process Knowledge

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

Evaluation of Spatial Trends

There is one exceedance of the sediment ESL (9.79 mg/kg) at location BM69-000, which occurred on December 30, 2004 (see Figure A3.4.RC AEU.2). This ESL exceedance of 15.0 mg/kg was for a sample from 0 to 0.5 feet and is slightly above the arsenic background MDC in sediment of 8.7 mg/kg. At location BM69-000, there was another sediment sample taken from 0.5 to 1.25 feet, which had an arsenic concentration within the background range. Therefore, arsenic is not elevated at this location for all depths.

Pattern Recognition

Arsenic was detected in 12 of the 12 sediment samples collected in the RC AEU. Arsenic concentrations at the RC AEU range from 1.70 to 15.0 mg/kg, with a mean concentration of 4.85 mg/kg and a standard deviation of 3.82 mg/kg in the AEU-specific data set that excludes background samples. Arsenic was detected in 49 of the 55 sediment samples collected for the background data set. Arsenic concentrations in background range from 0.270 to 8.7 mg/kg, with a mean concentration of 2.43 mg/kg and a standard deviation of 1.92 mg/kg (Table A3.2.RC AEU.6).

The probability plot for arsenic indicates a background population extending from about 1.70 to 6.0 mg/kg with an anomalously low sample (SD00246WC, 0.50 mg/kg) and two to three anomalously higher samples. The higher samples appear to be forming a trend extending from the background line that includes samples: SD00003JE, 7.7 mg/kg; 05F0276-003, 9.4 mg/kg; and 05F0276-001, 15 mg/kg arsenic. There are too few samples to estimate a line or the nature of these samples. However, correlations coefficients indicate a strong association with iron (r=0.91) for the 22 samples strongly suggesting that the arsenic is adsorbed to iron oxyhydroxide in the sediments. Given this relationship, the arsenic concentrations in the sediment increases directly with the iron concentration (Figure A3.4.RC AEU.22).

Risk Potential for Benthic Macroinvertebrates

The MDC for arsenic in RC AEU sediment (15 mg/kg) exceeds the sediment ESL (9.79 mg/kg) for the entire AEU data set including background samples. While an MDC less than the ESL indicates that adverse effects associated with exposure to a given analyte are unlikely (EPA 1997), an MDC greater than or equal to the ESL does not indicate that risks are actually present, only that the potential for adverse effects cannot be excluded. Only one of 22 samples (21 of 22 detected) from RC AEU sediments exceeds the ESL (collected December 20, 2004). This low frequency of exceedances[3] (4.5 percent) suggests that potential adverse effects would not likely be widely distributed within the RC AEU. Further, the ESL was based on a consensus-based TEC (MacDonald et al. 2000a), at which the potential for adverse effects are first observed. Validation of this benchmark found that 74 percent of samples (n=150) below this concentration were accurately predicted to be non-toxic to benthic macroinvertebrates. The potential for adverse effects is uncertain at concentrations greater than this ESL, and below the consensus-based probable effects concentration (PEC) (33 mg/kg). It is, therefore, unlikely that arsenic, exceeding the screening level ESL in only one sample, poses an unacceptable risk to benthic populations that inhabit the RC AEU.

Conclusion

The weight of evidence presented above shows that arsenic concentrations in sediment in the RC AEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the AEU that would impact arsenic concentrations in sediment. It is unlikely that arsenic, exceeding the screening level ESL in only one sample, poses an unacceptable risk to benthic populations that inhabit the RC AEU. Arsenic is not considered an ECOPC in sediment for the RC AEU and is not further evaluated quantitatively.

[3] Greater than 20 percent ESL exceedances by detected concentrations of ECOPCs in media is not considered a low frequency for exceedances. The maximum acceptable adverse effect level generally selected for assessment endpoints is a 20 percent reduction in the measured attribute (Suter et al. 2000). This level is consistent with current EPA regulatory practices (e.g., development of the National Ambient Water Quality Criteria [NAWQC] and effluent discharges regulated by the National Pollutant Discharge Elimination System [NPDES]) and measurement limits for many field and laboratory tests. For example, aquatic subchronic toxicity tests are not reliable at detecting reductions at less than 20 percent adverse effect responses of the test organism; lowest observed effect concentrations (LOECs) for avian reproduction tests correspond to a 20 percent reduction; and 20 percent reduction in community is the limit of detection for assessing aquatic communities using EPA rapid bioassessment procedures (Suter et al. 2000). Using available methods, changes in natural populations of less than 20 percent cannot generally be differentiated from "noise" measurements.

4.2.3 Barium in Sediment

Summary of Process Knowledge

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

Evaluation of Spatial Trends

There are five exceedances of the sediment ESL (189 mg/kg) at five separate locations in the Rock Creek AEU (see Figure A3.4.RC AEU.3). The ESL exceedances ranged from 209 to 360 mg/kg. However, the ESL was not exceeded for 12 sediment sample results at these five locations, showing that ESL exceedances are not consistent across the RC AEU. Two of the sediment sample results for barium (290 and 360 mg/kg) in the RC AEU are only slightly greater than the maximum background concentration of 260 mg/kg. Therefore, barium concentrations in sediment are indicative of variations in naturally occurring barium.

Pattern Recognition

Barium was detected in 12 of the 12 sediment samples collected in the RC AEU. Barium concentrations at the RC AEU range from 52.0 to 360 mg/kg, with a mean concentration of 165 mg/kg and a standard deviation of 86.6 mg/kg in the AEU-specific data set that excludes background samples. Barium was detected in 54 of the 54 sediment samples collected in the background data set. Barium concentrations in background range from 10.6 to 260 mg/kg, with a mean concentration of 78.9 mg/kg and a standard deviation of 58.8 mg/kg (Table A3.2.RC AEU.6).

The probability plot for barium indicates a single background population (Figure A3.4.RC AEU.23).

Risk Potential for Benthic Macroinvertebrates

The MDC for barium in RC AEU sediment (360 mg/kg) exceeds the sediment ESL (189 mg/kg) for the entire AEU data set including background samples. While an MDC less than the ESL indicates that adverse effects associated with exposure to a given analyte are unlikely (EPA 1997), an MDC greater than or equal to the ESL does not indicate that risks are actually present, only that the potential for adverse effects cannot be excluded. Five of 22 samples (22 of 22 detected) from RC AEU sediments exceed the ESL for barium. These samples were collected between August 1991 and December 2004. This low frequency of exceedances (18 percent) suggests that potential adverse effects would not likely be widely distributed within the RC AEU. This ESL was based on the 85th percentile concentration in streams (TNRCC 1996; cited in MacDonald et al. 1999), which defined the SQG by TNRCC. The potential for adverse effects associated with this ESL is uncertain; however, the five samples that exceed the barium ESL did not exceed by a high magnitude (HQs less than 2). Therefore, it is unlikely that barium in sediment, exceeding the screening level ESL in relatively few samples, poses a potential for risk to benthic organisms in RC AEU.

Conclusion

The weight of evidence presented above shows that barium concentrations in sediment in the RC AEU are not a result of RFETS activities, but rather are representative of variations in naturally occurring barium concentrations. There is no evidence of a release from potential sources inside or outside the AEU that would impact barium concentrations in sediment. Barium is not considered an ECOPC in sediment for the RC AEU and is not further evaluated quantitatively.

4.2.4 Cadmium in Surface Water and Sediment

Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for cadmium to have been released into RFETS media because of the metal inventory and presence of cadmium in waste generated during former operations. Spills of cadmium-contaminated wastes have also occurred at RFETS. However, the localized documented source areas are remote from the RC AEU.

Evaluation of Spatial Trends

Surface Water

The surface water ESL for dissolved cadmium (0.00025 milligrams per liter [mg/L]) was consistently exceeded at SW005, SW006, SW108, SW135, and SW137. These surface water sampling locations are spread out across the RC AEU (see Figure A3.4.RC AEU.4). All ESL exceedances are below 0.004 mg/L (see Figures A3.4.RC AEU.5 through A3.4.RC AEU.9), which is less than the maximum background concentration of 0.017 mg/L. Therefore, cadmium concentrations in surface water are indicative of variations in naturally occurring cadmium.

Sediment

There are four exceedances of the sediment ESL (0.99 mg/kg) at two separate locations in the RC AEU (see Figure A3.4.RC AEU.10). The ESL exceedances range from 1.10 to 1.30 mg/kg. All sediment sample results for cadmium in the RC AEU are less than or equal to the maximum background concentration of 1.3 mg/kg. Therefore, cadmium concentrations in sediment are indicative of variations in naturally occurring cadmium.

Pattern Recognition

Surface Water

Dissolved cadmium was detected in one of the 13 surface water samples collected in the RC AEU. Cadmium concentrations at the RC AEU range from 0.003 to 0.003 mg/L, with a mean concentration of 0.002 mg/L and a standard deviation of 0.0005 mg/L in the AEU-specific data set that excludes background samples. Cadmium was detected in 10 of the 136 surface water samples collected in the background data set. Cadmium concentrations in background range from 0.001 to 0.017 mg/L, with a mean concentration of 0.002 mg/L and a standard deviation of 0.001 mg/L (Table A3.2.RC AEU.4). The concentrations of dissolved cadmium at SW005, SW006, SW108, SW135, and SW137 are extremely low relative to the MDC in background (Figures A3.4

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RC AEU.5 through A3.4 RC AEU 9. The probability plot for cadmium indicates a background population extending from non-detected concentrations to about 0.003 mg/l that may include the three samples with higher cadmium concentrations but all three are slightly above the background line. These three samples include: SW01288WC, 0.0030 mg/l; SW01855WC, 0.0032 mg/l; and SW01852WC with 0.0034 mg/l cadmium. The slightly higher concentrations of these three samples than the estimated 0.003 mg/l maximum background cadmium concentration suggest that these three apparently anomalously high samples may still be part of the background population but are poorly supported by higher cadmium concentrations in the database (Figure A3.4.RC AEU.24).

Sediment

Cadmium was detected in five of the 12 sediment samples collected in the RC AEU. Cadmium concentrations at the RC AEU range from 0.210 to 1.10 mg/kg, with a mean concentration of 0.580 mg/kg and a standard deviation of 0.231 mg/kg in the AEU-specific data set that excludes background samples. Cadmium was detected in five of the 48 sediment samples collected in the background data set. Cadmium concentrations in background range from 0.410 to 1.30 mg/kg, with a mean concentration of 0.525 mg/kg and a standard deviation of 0.345 mg/kg (Table A3.2.RC AEU.6).

The probability plot for cadmium indicates a single background population (Figure A3.4.RC AEU.26).

<u>Risk Potential for Benthic Macroinvertebrates</u>

Surface Water

The MDC for cadmium in RC AEU surface water (0.003 mg/L) exceeds the ESL (0.00025 mg/L) for the entire AEU data set including background samples. While an MDC less than the ESL indicates that adverse effects associated with exposure to a given analyte are unlikely (EPA 1997), an MDC greater than or equal to the ESL does not indicate that risks are actually present, only that the potential for adverse effects cannot be excluded. A total of six of 42 samples (six of 42 detected) from RC AEU surface waters exceed the ESL for cadmium. These samples were collected between July 1991 and March 1992. The low frequency of exceedance in detected concentrations (14 percent) suggests that potential adverse effects may not be widely distributed. The cadmium ESL is hardness-dependant and was calculated after CDPHE (2005) using an estimated hardness of 100. Site-specific hardness in RC AEU was determined to be 198 mg/L $CaCO_3$ (Attachment 5), and a refined ESL based on this site-specific hardness is 0.00371 mg/L. The MDC for cadmium (dissolved) does not exceed the site-specific ESL; therefore, there is no potential for risk from dissolved cadmium in surface water at the RC AEU.

Sediment

The MDC for cadmium in RC AEU sediment (1.1 mg/kg) exceeds the sediment ESL (0.99 mg/kg) for the entire AEU data set including background samples. While an MDC less than the ESL indicates that adverse effects associated with exposure to a given analyte are unlikely (EPA 1997), an MDC greater than or equal to the ESL does not indicate that risks are actually present, only that the potential for adverse effects cannot be excluded. Only two of 19 samples (seven of 19 detected) from RC AEU sediments exceed the ESL for cadmium. These samples were collected during August 1991 and December 2004. This low frequency of exceedances (11 percent) suggests that potential adverse effects would not likely be widely distributed within the RC AEU. Further, the ESL was based on a consensus-based TEC (MacDonald et al. 2000a), where the potential for adverse effects are first observed. Validation of this benchmark found that 80.4 percent of samples (n=347) below this concentration were accurately predicted to be non-toxic to benthic macroinvertebrates. The potential for adverse effects is uncertain at concentrations greater than this ESL, and below the consensus-based PEC (4.98 mg/kg). It is, therefore, unlikely that cadmium in sediment, exceeding the screening level ESL by a low magnitude (HQs<2) in relatively few samples, poses a potential for risk to benthic organisms in the RC AEU.

Conclusion

The weight of evidence presented above shows that cadmium concentrations in surface water and sediment in the RC AEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the AEU that would impact cadmium concentrations in surface water and sediment. The MDC for cadmium (dissolved) does not exceed the site-specific ESL; therefore, there is no potential for risk from dissolved cadmium in surface water at the RC AEU. It is unlikely that cadmium in sediment, exceeding the screening level ESL by a low magnitude in relatively few samples, poses a potential for risk to benthic organisms in RC AEU. Cadmium is not considered an ECOPC in surface water and sediment for the RC AEU and is not further evaluated quantitatively.

4.2.5 Iron in Sediment

Summary of Process Knowledge

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

Evaluation of Spatial Trends

There is one exceedance of the background MDC (31,400 mg/kg) at location BM69-000, which occurred on December 30, 2004 (see Figure A3.4.RC AEU.11). The background MDC is above the sediment ESL of 20,000 mg/kg. The one background MDC exceedance of 39,000 mg/kg was sampled from 0 to 0.5 feet and is slightly above the background MDC. At location BM69-000, there was another sediment sample taken from 0.5 to 1.25 feet that has an iron concentration within the background range. Therefore, iron is not elevated at this location for all depths.

Pattern Recognition

Iron was detected in 12 of the 12 sediment samples collected in the RC AEU. Iron concentrations at the RC AEU range from 7,800 to 39,000 mg/kg, with a mean concentration of 16,633 mg/kg and a standard deviation of 9,246 mg/kg in the AEU-

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specific data set that excludes background samples. Iron was detected in 55 of the 55 sediment samples collected in the background data set. Iron concentrations in background range from 1,040 to 31,400 mg/kg, with a mean concentration of 9,740 mg/kg and a standard deviation of 6,739 mg/kg (Table A3.2.RC AEU.6).

The probability plot for iron indicates a single background population extending from about 7,220 to 39,000 mg/kg with one anomalously low sample (SD00246WC, 2,520 mg/kg). The anomalously low sample is the same sample that was anomalously low for arsenic supporting the association between the arsenic and iron oxyhydroxide in the sediments (Figure A3.4.RC AEU.26).

Risk Potential for Benthic Macroinvertebrates

The MDC for iron in RC AEU sediment (39,000 mg/kg) exceeds the sediment ESL (20,000 mg/kg) for the entire AEU-specific data set including background samples. While an MDC less than the ESL indicates that adverse effects associated with exposure to a given analyte are unlikely (EPA 1997), an MDC greater than or equal to the ESL does not indicate that risks are actually present, only that the potential for adverse effects cannot be excluded. Three of 22 samples (22 of 22 detected) from RC AEU sediments exceed the ESL for iron. These samples were collected between March 1993 and December 2004. This low frequency of exceedances (14 percent) suggests that potential adverse effects would not likely be widely distributed within the RC AEU. The ESL was based on a lowest effect level (LEL) (NYSDEC 1994; cited in MacDonald et al. 1999). The potential for adverse effects associated with this ESL is low because the three samples greater than the iron ESL did not exceed that level by a high magnitude (HQs less than 2). Therefore, a low exceedance frequency and low magnitude of exceedance suggest the potential for adverse effects to benthic macroinvertebrate receptors from iron in sediments at the RC AEU is unlikely.

Conclusion

The weight of evidence presented above shows that iron concentrations in sediment in the RC AEU are not a result of RFETS activities, but rather are representative of variations of naturally occurring iron. There is no evidence of a release from potential sources inside or outside the AEU that would impact iron concentrations in sediment. A low exceedance frequency and low magnitude of exceedance suggest the potential for adverse effects to benthic macroinvertebrate receptors from iron in sediments at the RC AEU is unlikely. Iron is not considered an ECOPC in sediment for the RC AEU and is not further evaluated quantitatively.

4.2.6 Lead in Surface Water and Sediment

Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, process knowledge indicates a potential for lead to have been released into RFETS media because of the metal inventory and presence of lead in waste generated during former operations. Spills of lead contaminated wastes have also occurred at RFETS. However, the localized documented source areas are remote from the RC AEU.

Evaluation of Spatial Trends

Surface Water

The surface water ESL for dissolved lead (0.003 mg/L) was exceeded at sampling locations SW005, SW006 and SW134 (see Figure A3.4.RC AEU.13 through Figure A3.4.RC AEU.15) for the complete RC AEU data set (including background). The surface water ESL was exceeded only three times out of 23 samples. The infrequent number of ESL exceedances at a limited number of sampling locations shows that ESL exceedances are not consistent across the RC AEU. All ESL exceedances are less than the maximum background concentration of 0.002 mg/L. Therefore, dissolved lead concentrations in surface water are indicative of variations in naturally occurring lead.

Sediment

There are four exceedances of the sediment ESL (35.8 mg/kg) at three separate locations in the RC AEU (see Figure A3.4.RC AEU.16). The ESL exceedances range from 37.0 to 79.1 mg/kg. The ESL was not exceeded though for five sediment sample results at these three locations, showing that ESL exceedances are not consistent across the RC AEU. One of the sediment sample results for lead (79.1 mg/kg) in the RC AEU is slightly greater than the maximum background concentration of 68.8 mg/kg. Therefore, lead concentrations in sediment are indicative of variations in natural occurring lead.

Pattern Recognition

Surface Water

Dissolved lead was detected in one of the 13 surface water samples collected in the RC AEU. Lead concentrations at the RC AEU range from 0.002 to 0.002 mg/L, with a mean concentration of 0.0006 mg/L and a standard deviation of 0.0003 mg/L in the AEU-specific data set that excludes background samples. Lead was detected in 32 of the 133 surface water samples collected in the background data set. Lead concentrations in background range from 0.0001 to 0.013 mg/L, with a mean concentration of 0.002 mg/L and a standard deviation of 0.003 mg/L (Table A3.2.RC AEU.4).

The probability plot for lead indicates a background population extending from non-detected concentrations to about 0.0032 mg/l but with two anomalously high samples. The two anomalously high samples include: SW01932WC, 0.0088 mg/l; and SW02022WC with 0.0121 mg/l lead (Figure A3.4.RC AEU.27).

Sediment

Lead was detected in 12 of the 12 sediment samples collected in the RC AEU. Lead concentrations at the RC AEU range from 6.60 to 79.1 mg/kg, with a mean concentration of 25.7 mg/kg and a standard deviation of 19.6 mg/kg in the AEU-specific data set that excludes background samples. Lead was detected in 55 of the 55 sediment samples collected in the background data set. Lead concentrations in background range from 2.60 to 68.8 mg/kg, with a mean concentration of 13.3 mg/kg and a standard deviation of 12.4 mg/kg (Table A3.2.RC AEU.6).

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The probability plot for lead indicates a single background population (Figure A3.4.RC AEU.28).

Risk Potential for Benthic Macroinvertebrates

Surface Water

The MDC for dissolved lead in RC AEU surface water (0.002 mg/L) is less than the ESL (0.003 mg/L) for the entire AEU data set including background samples. While an MDC less than the ESL indicates that adverse effects associated with exposure to a given analyte are unlikely (EPA 1997), an MDC greater than or equal to the ESL does not indicate that risks are actually present, only that the potential for adverse effects cannot be excluded. A total of three detected concentrations from RC AEU surface waters exceeded the ESL for lead. These samples were collected between July 1991 and October 1994. This low frequency of exceedances (7 percent) suggests that potential adverse effects may not be widely distributed. The lead ESL is hardness-dependant and was calculated after CDPHE (2005) using an estimated hardness of 100. Site-specific hardness in RC AEU was determined to be 198 mg/L $CaCO_3$ (Attachment 5), and a refined ESL based on this site-specific hardness is 0.0053 mg/L. The MDC for lead (dissolved) continues to exceed this refined ESL by a low magnitude (an HQ of 2.3); however, the low exceedance frequency suggests the potential for adverse effects to aquatic organisms from lead in surface water at RC AEU is unlikely.

Sediment

The MDC for lead in RC AEU sediment (79.1 mg/kg) exceeds the sediment ESL (35.8 mg/kg) for the entire AEU data set including background samples. While an MDC less than the ESL indicates that adverse effects associated with exposure to a given analyte are unlikely (EPA 1997), an MDC greater than or equal to the ESL does not indicate that risks are actually present, only that the potential for adverse effects cannot be excluded. Only four of 22 samples (22 of 22 detected) from RC AEU sediments exceeded the ESL (collected June 1992 through January 1995). This low frequency of exceedances (18 percent) suggests that potential adverse effects would not likely be widely distributed within the RC AEU. Further, the ESL was based on a consensus-based TEC (MacDonald et al. 2000a), where the potential for adverse effects are first observed. Validation of this benchmark found that 81.6 percent of samples (n=347) below this concentration were accurately predicted to be non-toxic to benthic macroinvertebrates. The potential for adverse effects associated with this ESL is low because the four samples greater than the iron ESL did not exceed that level by a high magnitude (maximum HQ of 2.2). The potential for adverse effects is uncertain at concentrations greater than this ESL, and below the consensus-based PEC (128 mg/kg). Therefore, the potential for adverse effects to benthic macroinvertebrate receptors from lead in sediment at the RC AEU is unlikely.

Conclusion

The weight of evidence presented above shows that lead concentrations in sediment and surface water in the RC AEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the AEU that would impact lead concentrations in sediment and surface water. The low frequency of exceedances of the site-specific ESL (and low magnitude) suggests the potential for adverse effects to aquatic organisms from lead (dissolved) in surface water is unlikely. The potential for adverse effects to benthic macroinvertebrate receptors from lead in sediment at the RC AEU is also unlikely. Lead is not considered an ECOPC in sediment and surface water for the RC AEU and is not further evaluated quantitatively.

4.2.7 Selenium in Sediment

Summary of Process Knowledge

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

Evaluation of Spatial Trends

There are four exceedances of the sediment ESL (0.95 mg/kg) at one location in the RC AEU (see Figure A3.4.RC AEU.17) but these are located in background samples. The ESL exceedances ranged from 1.50 to 3.20 mg/kg. The ESL was not exceeded for two sediment sample results at this location, showing that ESL exceedances are not consistent at this location and ESL exceedances are not seen across the RC AEU. All sediment sample results for selenium in the RC AEU are less than or equal to the maximum background concentration of 3.2 mg/kg.

Pattern Recognition

Selenium was detected in three of the 12 sediment samples collected in the RC AEU. Selenium concentrations at the RC AEU range from 0.380 to 0.810 mg/kg, with a mean concentration of 0.534 mg/kg and a standard deviation of 0.361 mg/kg in the AEU-specific data set that excludes background samples. Selenium was detected in 15 of the 54 sediment samples collected in the background data set. Selenium concentrations in background range from 0.100 to 3.20 mg/kg, with a mean concentration of 0.458 mg/kg and a standard deviation of 0.634 mg/kg (Table A3.2.RC AEU.6).

The probability plot for selenium indicates a single background population (Figure A3.4.RC AEU.29).

Risk Potential for Benthic Macroinvertebrates

The MDC for selenium in RC AEU sediment (0.81 mg/kg) is less than the sediment ESL (0.95 mg/kg) when the background data is excluded from the EU-specific data set. While an MDC less than the ESL indicates that adverse effects associated with exposure to a given analyte are unlikely (EPA 1997), an MDC greater than or equal to the ESL does not indicate that risks are actually present, only that the potential for adverse effects cannot be excluded. Four samples from the complete RC AEU data set exceed the sediment ESL. These samples were collected between March 1992 and March 1993. This low frequency of exceedances (18 percent) suggests that potential adverse effects would not likely be widely distributed within the RC AEU. This ESL was based on the 85th

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percentile concentration in streams (TNRCC 1996; cited in MacDonald et al. 1999), which defined the SQG by TNRCC. The potential for adverse effects associated with this ESL is low, because the four samples that exceed the selenium ESL did not exceed by a high magnitude (HQs less than 3.5). Therefore, it is unlikely that the selenium in sediment poses a potential for unacceptable risk to benthic organisms in the RC AEU.

Conclusion

The weight of evidence presented above shows that selenium concentrations in sediment in the RC AEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the AEU that would impact selenium concentrations in sediment. It is unlikely that the selenium in sediment poses a potential for unacceptable risk to benthic organisms in the RC AEU. Selenium is not considered an ECOPC in sediment for the RC AEU and is not further evaluated quantitatively.

4.2.8 Silver in Sediment

Summary of Process Knowledge

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

Evaluation of Spatial Trends

There are four exceedances of the sediment ESL (1 mg/kg) at four separate locations in the RC AEU (see Figure A3.4.RC AEU.18). The ESL exceedances ranged from 1.20 to 3.40 mg/kg. The ESL was not exceeded for nine sediment sample results at these four locations, showing that ESL exceedances are not consistent across the RC AEU. All sediment sample results for silver in the RC AEU are less than or equal to the maximum background concentration of 3.4 mg/kg. Therefore, silver concentrations in sediment are indicative of variations in naturally occurring silver.

Pattern Recognition

Silver was detected in two of the 12 sediment samples collected in the RC AEU. Silver concentrations at the RC AEU range from 1.20 to 1.30 mg/kg, with a mean concentration of 0.628 mg/kg and a standard deviation of 0.483 mg/kg in the AEU-specific data set that excludes background samples. Silver was detected in three of the 48 sediment samples collected in the background data set. Silver concentrations in background range from 1.40 to 3.40 mg/kg, with a mean concentration of 0.737 mg/kg and a standard deviation of 0.654 mg/kg (Table A3.2.RC AEU.6).

The probability plot for silver indicates a single background population with the highest sample (SD0017WC) suggesting that this silver concentration (3.4 mg/kg) is approaching an asymptotic maximum background population concentration (Figure A3.4.RC AEU.30).

Risk Potential for Benthic Macroinvertebrates

The MDC for silver in RC AEU sediment (1.3 mg/kg) exceeds the sediment ESL (1 mg/kg) for the entire AEU data set including background samples. While an MDC less than the ESL indicates that adverse effects associated with exposure to a given analyte are unlikely (EPA 1997), an MDC greater than or equal to the ESL does not indicate that risks are actually present, only that the potential for adverse effects cannot be excluded. Four of 19 samples (four of 19 detected) from RC AEU sediments exceed the ESL for silver. These samples were collected between December 1991 and March 1992. This moderate frequency of exceedances (21 percent) suggests that potential adverse effects within the RC AEU cannot be excluded. The ESL was based on a LEL (NYSDEC 1994; cited in MacDonald et al. 1999). The potential for adverse effects associated with this ESL is low because the four detected samples that exceed the silver ESL did not exceed that level by a high magnitude (HQs less than 3.5). Despite the MDC exceeding the screening level ESL, exceedances did not exceed high screening benchmarks. It is, therefore, unlikely that the silver in sediment poses a potential for unacceptable risk to benthic organisms in the RC AEU.

Conclusion

The weight of evidence presented above shows that silver concentrations in sediment in the RC AEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the AEU that would impact silver concentrations in sediment. Despite the MDC exceeding the screening level ESL, exceedances did not exceed high screening benchmarks. It is, therefore, unlikely that the silver in sediment poses a potential for unacceptable risk to benthic organisms in the RC AEU. Silver is not considered an ECOPC in sediment for the RC AEU and is not further evaluated quantitatively.

4.2.9 Zinc in Sediment

Summary of Process Knowledge

As discussed in Appendix A, Volume 2, Attachment 8 of the RI/FS Report, zinc was used in moderate quantities at RFETS. However, zinc was not identified or discussed in building process information, and has not been found associated with UBL building processes.

Evaluation of Spatial Trends

There are three exceedances of the sediment ESL (121 mg/kg) at one location in the RC AEU (see Figure A3.4.RC AEU.19), but these are in background samples. The ESL exceedances ranged from 331 to 720 mg/kg for the complete data set. The ESL was not exceeded for one sediment sample result at this location, showing that ESL exceedances are not consistent at this location in the RC AEU. All sediment sample results for zinc in the RC AEU are less than or equal to the maximum background concentration of 720 mg/kg.

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Pattern Recognition

Zinc was detected in 12 of the 12 sediment samples collected in the RC AEU. Zinc concentrations at the RC AEU range from 29.0 to 95.0 mg/kg, with a mean concentration of 62.4 mg/kg and a standard deviation of 18.5 mg/kg in the AEU-specific data set that excludes background samples. Zinc was detected in 54 of the 55 sediment samples collected in the background data set. Zinc concentrations in background range from 6.50 to 720 mg/kg, with a mean concentration of 72.2 mg/kg and a standard deviation of 129 mg/kg (Table A3.2.RC AEU.6). The box plots in Figure A3.2.RC AEU.3 show the medians (midpoints) and distributions for background and RC AEU zinc are similar.

The probability plot for zinc indicates a background population extending from about 11.3 to 95 mg/kg but with three anomalously high samples. The three anomalously high samples include: SD00294WC, 331 mg/kg; SD00318WC, 639 mg/kg; and SD00007JE with 720 mg/kg zinc. This sample with the highest anomalous zinc concentration is one of the three anomalously high arsenic concentrations but the other two are apparently not related (Figure A3.4.RC AEU.31)

Risk Potential for Benthic Macroinvertebrates

The MDC for zinc in RC AEU sediment (95 mg/kg) is less than sediment ESL (121 mg/kg) excluding the background data set. While an MDC less than the ESL indicates that adverse effects associated with exposure to a given analyte are unlikely (EPA 1997), an MDC greater than or equal to the ESL does not indicate that risks are actually present, only that the potential for adverse effects cannot be excluded. Only three samples from RC AEU sediments exceed the ESL for zinc, and they are in the background data set. These samples were collected during August 1991 and March 1993. This low frequency of exceedances (14 percent) suggests that potential adverse effects would not likely be widely distributed within the RC AEU. Further, the ESL was based on a consensus-based TEC (MacDonald et al. 2000a), where the potential for adverse effects are first observed. Validation of this benchmark found that 81.6 percent of samples (n=347) below this concentration were accurately predicted to be non-toxic to benthic macroinvertebrates. The potential for adverse effects is uncertain at concentrations greater than this ESL, and below the consensus-based PEC (459 mg/kg). Only two samples (9 percent) exceed this PEC. It is, therefore, unlikely that zinc in sediment, exceeding the screening level ESL by a low magnitude (HQs<6) in relatively few samples collected over 10 years ago, poses an unacceptable level of risk to benthic organisms in the RC AEU.

Conclusion

The weight of evidence presented above shows that zinc concentrations in sediment in the RC AEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the EU that would impact zinc concentrations in sediment. Only two samples (10 percent) exceed this PEC. It is, therefore, unlikely that zinc in sediment, exceeding the screening level ESL by a low magnitude in relatively few samples collected over 10 years ago, poses an unacceptable level of risk to benthic organisms in the RC AEU. Zinc is not considered an ECOPC in sediment for the RC AEU and is not further evaluated quantitatively.

4.2.10 Pentachlorophenol in Sediment

Summary of Process Knowledge

There are no documented historical source areas present in the RC AEU and no documented operations or activities that occurred in RC AEU involving the use of pentachlorophenol (DOE 1992). Therefore, the potential for pentachlorophenol to be present in the RC AEU is low.

Evaluation of Spatial Trends

There is one detection of 1,500 mg/kg at location BM69-000, which occurred on December 30, 2004 (see Figure A3.4.RC AEU.20). The one detection is above the sediment ESL of 255 mg/kg. This single detection was sampled from 0 to 0.5 feet and is above the sediment ESL. At location BM69-000, there was another sediment sample taken from 0.5 to 1.25 feet that has a nondetected pentachlorophenol concentration. Therefore, pentachlorophenol is not detected at this location for all depths.

Pattern Recognition

Not applicable because background comparisons (and box plots) were not performed for organic compounds.

Risk Potential for Benthic Macroinvertebrates

The MDC for pentachlorophenol in RC AEU sediment (1,500 mg/kg) exceeds the sediment ESL (255 mg/kg). While an MDC less than the ESL indicates that adverse effects associated with exposure to a given analyte are unlikely (EPA 1997), an MDC greater than or equal to the ESL does not indicate that risks are actually present, only that the potential for adverse effects cannot be excluded. One detected concentration (one of 19 detected) of pentachlorophenol from RC AEU sediments exceeds the ESL. This sample was collected in December 2004. The low frequency of exceedances by detected concentrations (5 percent) suggests that the likelihood of potential adverse effects may not be widely distributed within the RC AEU. The pentachlorophenol ESL for sediment was based on an equilibrium partitioning (EqP)-based equation using the chronic ESL for surface water, and an estimate of 1 percent organic carbon (EPA 1997). There is uncertainty added to the potential for risk evaluation when extrapolating screening benchmarks using this method. However, it is the best option when alternative screening benchmarks are unavailable. Nevertheless, a low exceedance frequency and a low HQ (5.9) suggests the potential for adverse effects to benthic macroinvertebrate receptors from pentachlorophenol in sediments at the RC AEU is unlikely.

Conclusion

The weight of evidence presented above shows that pentachlorophenol concentrations in sediment in the RC AEU are not a result of RFETS activities. There is no evidence of a release from potential sources inside or outside the AEU that would impact pentachlorophenol concentrations in sediment. Therefore, a low exceedance frequency suggests the potential for adverse effects to benthic macroinvertebrate receptors from pentachlorophenol in sediments at the RC AEU is unlikely. Pentachlorophenol is not considered an ECOPC in sediment for the RC AEU and is not further evaluated quantitatively.

4.3 MK AEU

For the Inter-Drainage EU (IDEU), which comprises most of the MK AEU, the ECOPC selection process indicates some metals are ECOPCs in surface soil. Considering runoff is a transport mechanism whereby surface water and sediment within the AEU may be impacted by ECOPCs or other ECOIs in EU surface soil, all ECOIs that pass through the EPC/ESL screen for surface water (total and dissolved concentrations) and sediment are considered ECOPCs, and are further evaluated in the risk characterizations for the MK AEU. The MK AEU ECOPCs are total aluminum, dissolved cadmium, total selenium, and dissolved zinc in surface water, and aluminum, chromium, fluoride, nickel, and selenium in sediment.

4.4 SE AEU

The SE AEU has unique physical characteristics applicable to professional judgment for all ECOIs in the environmental media considered herein. The SE AEU is located in the southern portion of RFETS, well outside areas that were used historically for site operations. The SE AEU does not receive runoff from the IA. Only one PAC exists within the SE AEU: Roadway Spraying (PAC 000-501). Roadways throughout the BZ OU were sprayed with waste oils for dust suppression, and reverse osmosis brine solutions and footing drain water were also applied. Based on the available evidence, PAC 000-501 was proposed for NFA in 1991. The NFA was approved in 2002 (EPA 2002) as documented in the 2002 HRR Update (DOE 2002). Only a small segment of PAC 000-501 exists in the SE AEU and, based on the above findings, it is not a likely source of contamination for the SE AEU.

The physical characteristics and principal surface features of the SE AEU are discussed in detail in Section 1.0 of this report.

The following sections outline the weight-of-evidence evaluation for the ECOIs exceeding background and ESLs in sediment and are being carried forward to the professional judgment step. These analytes are:

- Aluminum in sediment
- Barium in sediment
- Iron in sediment
- Selenium in sediment
- Silver in surface water

4.4.1 Aluminum in Sediment

Summary of Process Knowledge

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

Evaluation of Spatial Trends

Three of five locations have sediment concentrations that exceed the ESL. These locations included CC16-000, D013-000, and DY05-000 (see Figure A3.4.SE AEU.1). However, only one location, DY05-000, exceeded the background MDC. Samples were collected at CC16-000 on December 29, 2004, while sample collection at D013-000 and DY05-000 occurred on January 10, 2005. Two samples were collected at CC16-000 at depths from 0 to 0.5 and 0.5 to 1.75 feet with respective concentrations of 16,000 and 20,000 mg/kg, both of which exceed the ESL. The sample from 0 to 0.5 feet was just above the ESL (15,900 mg/kg). Neither of these concentrations, however, exceeds the background MDC (25,200 mg/kg), suggesting that detected concentrations are within background levels. Two sediment samples were also collected at D013-000 from 0 to 0.4 and from 0.5 to1 foot below ground surface (bgs) with respective concentrations of 18,000 and 25,000 mg/kg. Both concentrations exceed the ESL, although neither exceeds the background MDC. Only one sample was collected at DY05-000. This sample was collected from 0 to 0.5 feet bgs and has a detected concentration of 26,000 mg/kg, which exceeds both the ESL and the background MDC, although this concentration was just above the background MDC (25,200 mg/kg). Based on this data, it is likely that aluminum concentrations are within background levels.

Pattern Recognition

Aluminum was detected in seven of the seven sediment samples collected in the SE AEU. Aluminum concentrations at the SE AEU range from 7,600 to 26,000 mg/kg, with a mean concentration of 18,229 mg/kg and a standard deviation of 6,295 mg/kg in the AEU-specific data set that excludes background samples. Aluminum was detected in 55 of the 55 sediment samples collected in the background data set. Aluminum concentrations in background range from 811 to 25,200 mg/kg, with a mean concentration of 6,791 mg/kg and a standard deviation of 5,603 mg/kg (Table A3.2.SE AEU.6).

The probability plot for aluminum indicates a background population (Figure A3.4.SE AEU.8)

Risk Potential for Benthic Macroinvertebrates

The MDC for aluminum in SE AEU sediment (26,000 mg/kg) exceeds the sediment ESL (15,900 mg/kg) for the entire AEU data set including background samples. While an MDC less than the ESL indicates that adverse effects associated with exposure to a given analyte are unlikely (EPA 1997), an MDC greater than or equal to the ESL does not indicate that risks are actually present, only that data are insufficient to exclude the potential for risk. Five of seven samples (seven of seven detected) from SE AEU sediments exceeded the ESL for aluminum. These samples were collected between December 2005 and January 2005, and the high frequency of exceedances (71 percent) suggests that potential adverse effects cannot be excluded for sediment in the SE AEU. This ESL was based on the 85th percentile concentration in streams (TNRCC 1996; cited in MacDonald et al. 1999), which defined the SQG by TNRCC. The potential for adverse effects associated with this ESL is uncertain; however, the five samples from three locations that exceed the aluminum ESL did not exceed by a high magnitude (HQs less than 2). Therefore, despite the MDC exceeding the screening level ESL, it is unlikely that the concentrations of aluminum in SE AEU sediment pose a potential for adverse effects to benthic organisms in the SE AEU.

Conclusion

The weight of evidence presented above shows that aluminum concentrations in sediment in the SE AEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the EU that would impact aluminum concentrations in sediment. Despite the MDC exceeding the screening level ESL, it is unlikely that the concentrations of aluminum in SE AEU sediment pose a potential for adverse effects to benthic organisms in the SE AEU. Aluminum is not considered an ECOPC in sediment for the SE AEU and is not further evaluated quantitatively.

4.4.2 Barium in Sediment

Summary of Process Knowledge

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

Evaluation of Spatial Trends

Two of five locations have sediment concentrations that exceed the ESL. These locations included D013-000 and DY05-000 (see Figure A3.4.SE AEU.2). However, none of the locations exceeded the background MDC. Samples were collected at D013-000 and DY05-000 on January 10, 2005. Two sediment samples were collected at D013-000 from 0 to 0.4 and from 0.5 to 1 foot bgs with respective concentrations of 130 mg/kg and 190 mg/kg. Only one sample just exceeds the ESL, while neither sample exceeds the background MDC. Only one sample was collected at DY05-000. This sample has a detected concentration of 240 mg/kg, which exceeds the ESL but not the background MDC. Based on these concentrations, it is likely that barium concentrations are within background levels.

Pattern Recognition

Barium was detected in seven of the seven sediment samples collected in the SE AEU. Barium concentrations at the SE AEU range from 77 to 240 mg/kg, with a mean concentration of 158 mg/kg and a standard deviation of 51.6 mg/kg in the AEU-specific data set that excludes background samples. Barium was detected in 54 of the 54 sediment samples collected in the background data set. Barium concentrations in background range from 10.6 to 260 mg/kg, with a mean concentration of 78.9 mg/kg and a standard deviation of 58.8 mg/kg (Table A3.2.SE AEU.6).

The probability plot for barium indicates a background population (Figure A3.4.SE AEU.9).

Risk Potential for Benthic Macroinvertebrates

The MDC for barium in SE AEU sediment (240 mg/kg) exceeds the ESL (189 mg/kg) for the entire AEU data set including background samples. While an MDC less than the ESL indicates that adverse effects associated with exposure to a given analyte are unlikely (EPA 1997), an MDC greater than or equal to the ESL does not indicate that risks are actually present, only that the potential for adverse effects cannot be excluded. Only two samples (seven of seven detected) from SE AEU sediments exceed the ESL for barium. These samples were collected in January 2005. This moderate frequency of exceedances (29 percent) suggests the potential for adverse effects cannot be excluded. The barium ESL was based on the 85th percentile concentration in streams (TNRCC 1996; cited in MacDonald et al. 1999), which defined the SQG for TNRCC. The potential for adverse effects associated with this ESL is uncertain; however, the samples greater than the barium ESL did not exceed by a high magnitude (HQs less than 2). Toxicity from barium in sediment is not well documented and there are no other applicable screening criteria available for this metal. It is, therefore, unlikely that barium in sediment, exceeding the screening level ESL by a low magnitude, poses a potential for risk to benthic organisms in the SE AEU.

Conclusion

The weight of evidence presented above shows that barium concentrations in sediment in the SE AEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the AEU that would impact barium concentrations in sediment. It is, therefore, unlikely that barium in sediment, exceeding the screening level ESL by a low magnitude, poses a potential for risk to benthic organisms in the SE AEU. Barium is not considered an ECOPC in sediment for the SE AEU and is not further evaluated quantitatively.

4.4.3 Iron in Sediment

Summary of Process Knowledge

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

Evaluation of Spatial Trends

Two of five locations had sediment concentrations that exceed the ESL. These locations included D013-000 and DY05-000 (see Figure A3.4.SE AEU.3). However, only one location, D013-000, exceeds the background MDC. Samples were collected at D013-000 and DY05-000 in January 2005. Two samples were collected at DO13-000 at depths from

0 to 0.4 feet and from 0.5 to 1 foot bgs with respective concentrations of 34,000 and 23,000 mg/kg, both of which exceeded the ESL. The 0.5-to-1-foot sample, however, was within the background MDC (31,400 mg/kg). Consequently, iron is not elevated at this location for all depths. The sample collected at DY05-000 was collected from 0.5 to 1 foot and has an iron concentration of 23,000 mg/kg, which exceeds the ESL but is below the background MDC. Based on these concentrations, it is likely that iron concentrations are within background.

Pattern Recognition

Iron was detected in seven of the seven sediment samples collected in the SE AEU. Iron concentrations at the SE AEU range from 11,000 to 34,000 mg/kg, with a mean concentration of 18,857 mg/kg and a standard deviation of 8,315 mg/kg in the AEU-specific data set that excludes background samples. Iron was detected in 55 of the 55 sediment samples collected in the background data set. Iron concentrations in background range from 1,040 to 31,400 mg/kg, with a mean concentration of 9,740 mg/kg and a standard deviation of 6,739 mg/kg (Table A3.2.SE AEU.6).

The probability plot for iron indicates a background population (Figure A3.4.SE AEU.10).

Risk Potential for Benthic Macroinvertebrates

The MDC for iron in SE AEU sediment (34,000 mg/kg) exceeds the sediment ESL (20,000 mg/kg) for the entire AEU data set including background samples. While an MDC less than the ESL indicates that adverse effects associated with exposure to a given analyte are unlikely (EPA 1997), an MDC greater than or equal to the ESL does not indicate that risks are actually present, only that the potential for adverse effects cannot be excluded. Three of seven samples (seven of seven detected) from SE AEU sediments exceeded the ESL for iron. These samples were all collected in January 2005. The frequency of exceedances (43 percent) suggests that the potential for adverse effects cannot be excluded. The ESL is based on a LEL (NYSDEC 1994; cited in MacDonald et al. 1999). The potential for adverse effects associated with this ESL is low because the three samples greater than the iron ESL did not exceed that level by a high magnitude (HQs less than 2). Therefore, it is unlikely that iron in sediment, exceeding the screening level ESL by a low magnitude, poses a potential for risk to benthic organisms in the SE AEU.

Conclusion

The weight of evidence presented above shows that iron concentrations in sediment in the SE AEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the EU that would impact iron concentrations in sediment. Therefore, it is unlikely that iron in sediment, exceeding the screening level ESL by a low magnitude, poses a potential for risk to benthic organisms in the SE AEU. Iron is not considered an ECOPC in sediment for the SE AEU and is not further evaluated quantitatively.

4.4.4 Selenium in Sediment

Summary of Process Knowledge

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

Evaluation of Spatial Trends

One of five locations, DY05-000, had a sediment concentration that exceeds the ESL (see Figure A3.4.SE AEU.4). This sample, however, did not exceed the background MDC. The sample was collected on January 10, 2005. All other locations were nondetect, although the detection limits for two sampling locations were greater than the ESL. They did not, however, exceed the background MDC. Consequently, it is likely that selenium concentrations are within background levels.

Pattern Recognition

Selenium was detected in one of the seven sediment samples collected in the SE AEU. The only detected sediment concentration is 1.70 mg/kg. This data set has a mean of 0.729 mg/kg and a standard deviation of 0.471 mg/kg in the AEU-specific data set that excludes background samples. Selenium was detected in 15 of the 54 sediment samples collected in the background data set. Selenium concentrations in background range from 0.100 to 3.20 mg/kg, with a mean concentration of 0.458 mg/kg and a standard deviation of 0.634 mg/kg (Table A3.2.SE AEU.6).

There are too few samples with detected selenium concentrations to estimate a background population for selenium.

Risk Potential for Benthic Macroinvertebrates

The MDC for selenium in SE AEU sediment (1.7 mg/kg) exceeded the sediment ESL (0.95 mg/kg) for the entire AEU data set including background samples. While an MDC less than the ESL indicates that adverse effects associated with exposure to a given analyte are unlikely (EPA 1997), an MDC greater than or equal to the ESL does not indicate that risks are actually present, only that the potential for adverse effects cannot be excluded. Only one detected sample (one of seven detected) from SE AEU sediments exceeds the ESL for selenium. This sample was collected in January 2005. This low frequency of exceedances (14 percent) suggests that potential adverse effects may not be widely distributed within the SE AEU. This ESL was based on the 85th percentile concentration in streams (TNRCC 1996; cited in MacDonald et al. 1999), which defined the SQG by TNRCC. The potential for adverse effects associated with this ESL is low, because the single sample that exceeds the selenium ESL did not exceed by a high magnitude (HQs less than 2). Therefore, despite the MDC exceeding the screening level ESL, the magnitude of this exceedance is low and it is, therefore, unlikely that the selenium in sediment poses a potential for unacceptable risk to benthic organisms in SE AEU.

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Conclusion

The weight of evidence presented above shows that selenium concentrations in sediment in the SE AEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the EU that would impact selenium concentrations in sediment. Despite the MDC exceeding the screening level ESL, the magnitude of this exceedance is low and it is, therefore, unlikely that the selenium in sediment poses a potential for unacceptable risk to benthic organisms in SE AEU. Selenium is not considered an ECOPC in sediment for the SE AEU and is not further evaluated quantitatively.

4.4.5 Dissolved Silver in Surface Water

Summary of Process Knowledge

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

Evaluation of Spatial Trends

The surface water ESL for dissolved silver (0.00032 mg/L) was consistently exceeded at SW130 and D1. These surface water sampling locations are located at the eastern and western ends of SE AEU, respectively (see Figure A3.4.SE AEU.5). All ESL exceedances are below 0.004 mg/L (see Figures A3.4.SE AEU.6 and A3.4.SE AEU.7), which is less than the maximum background concentration of 0.022 mg/L.

Pattern Recognition

Silver was detected in the only surface water sample collected in the SE AEU. The one detected silver concentration at the SE AEU is 0.003 mg/L in the AEU-specific data set that excludes background samples. Silver was detected in eight of the 141 surface water samples collected in the background data set. Silver concentrations in background range from 0.002 to 0.022 mg/L, with a mean concentration of 0.003 mg/L and a standard deviation of 0.003 mg/L (Table A3.2.SE AEU.6).

The probability plot for silver indicates a background population (Figure A3.4.SE AEU.11).

Risk Potential for Water Column Organisms

The MDC for dissolved silver in SE AEU surface water (0.003 mg/L) exceeds the ESL (0.00032 mg/L) for the entire AEU data set including background samples. While an MDC less than the ESL indicates that adverse effects associated with exposure to a given analyte are unlikely (EPA 1997), an MDC greater than or equal to the ESL does not indicate that risks are actually present, only that the potential for adverse effects cannot be excluded. A total of two detected samples (2 of 7 detected) from SE AEU surface waters exceeds the ESL for silver. This sample was collected in 1995. The sample that exceeds the silver ESL did not exceed by a high magnitude (HQs less than or equal to 10). The silver ESL is hardness-dependant and was calculated after CDPHE (2005) using an estimated hardness of 100. Site-specific hardness in SE AEU was determined to be 198 mg/L $CaCO_3$ (Attachment 5), and a refined ESL based on this site-specific hardness is 0.00104 mg/L. The MDC for silver (dissolved) still exceeds this refined ESL (HQ=3), but by a low magnitude; therefore, it is unlikely that an unacceptable potential risk from silver in surface water at SE AEU exists.

Conclusion

The weight of evidence presented above shows that silver concentrations in surface water in the SE AEU are not a result of RFETS activities, but rather are representative of naturally occurring concentrations. There is no evidence of a release from potential sources inside or outside the SE AEU that would impact silver concentrations in surface water. The MDC for silver (dissolved) still exceeds this refined ESL (HQ=2.9), but by a low magnitude; therefore, it is unlikely that an unacceptable potential risk from silver in surface water at SE AEU exists. Silver is not considered an ECOPC in surface water for the SE AEU and, therefore, is not further evaluated quantitatively.

5.0 REFERENCES

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TABLES

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Table A3.2.NN AEU.1
Statistical Distribution and Comparison to Background for Surface Water, Total Analyses (excluding background samples) NN AEU

Analyte	Statistical Distribution Testing Results				Background Comparison Test		
	Background		NN AEU (excluding background samples)				
	Total Samples	Detects (%)	Total Samples	Detects (%)	Test	1 - p	Statistically Greater than Background?
Aluminum	166	82	70	81	WRS	1.000	No
Barium	**172**	**78**	**72**	**100**	**WRS**	**0**	**Yes**
Beryllium	**167**	**13**	**71**	**28**	**N/A**	**N/A**	**N/A**
Lithium	**166**	**49**	**63**	**97**	**WRS**	**1.06E-10**	**Yes**
Selenium	**162**	**14**	**72**	**18**	**N/A**	**N/A**	**N/A**
Vanadium	171	34	72	54	WRS	0.992	No

WRS = Wilcoxon Rank Sum
N/A = Not applicable; site and/or background detection frequency less than 20%.
Bold = indicate ECOIs retained for further consideration in the upper-bound EPC comparison step.

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Table A3.2.NN AEU.2

Summary Statistics For Surface Water, Total Analyses (excluding background samples) NN AEU[a]

		Background					NN AEU (excluding background samples)				
Analyte	Units	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Benzo(a)pyrene	ug/L	18	N/A	N/A	5.17	0.420	71	1.00	1.00	7.08	19.0
bis(2-ethylhexyl)phthalate	ug/L	18	1.00	5.00	4.58	1.31	72	0.400	140	7.82	17.9
Di-n-butylphthalate	ug/L	18	1.00	1.00	4.94	1.07	72	0.400	48.0	4.83	5.40
Pentachlorophenol	ug/L	18	N/A	N/A	26.0	2.16	72	1.00	10.0	33.2	97.8
Phenanthrene	ug/L	18	N/A	N/A	5.17	0.420	73	2.80	6.00	6.59	18.8
Phenol	ug/L	18	N/A	N/A	5.17	0.420	76	0.500	5,000	138	694
Aluminum	mg/L	166	0.026	129	3.39	12.5	70	0.017	55.4	2.51	8.42
Barium	mg/L	172	0.009	0.630	0.079	0.079	72	0.003	0.820	0.332	0.241
Beryllium	mg/L	167	4.00E-05	0.004	8.01E-04	8.44E-04	71	3.00E-05	0.003	3.39E-04	4.13E-04
Lithium	mg/L	166	0.001	0.154	0.015	0.022	63	0.006	0.098	0.030	0.024
Selenium	mg/L	162	6.50E-04	0.019	0.002	0.003	72	0.001	0.038	0.002	0.005
Vanadium	mg/L	171	0.002	0.132	0.011	0.019	72	5.40E-04	0.095	0.007	0.014

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

N/A = Not applicable.

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Table A3.2.NN AEU.3
Statistical Distribution and Comparison to Background for Surface Water, Dissolved Analyses (excluding background samples) NN AEU

Analyte	Statistical Distribution Testing Results				Background Comparison Test		
	Background		NN AEU (excluding background samples)				
	Total Samples	Detects (%)	Total Samples	Detects (%)	Test	1 - p	Statistically Greater than Background?
Copper	138	33	31	42	WRS	0.988	No
Iron	137	80	30	90	WRS	0.404	No
Lead	**133**	**24**	**32**	**16**	**N/A**	**N/A**	**N/A**
Silver	**141**	**6**	**32**	**16**	**N/A**	**N/A**	**N/A**
Zinc	**138**	**57**	**31**	**74**	**WRS**	**0.068**	**Yes**

WRS = Wilcoxon Rank Sum

N/A = Not applicable; site and/or background detection frequency less than 20%.

Bold = indicate ECOIs retained for further consideration in the upper-bound EPC comparison step.

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Table A3.2.NN AEU.4
Summary Statistics For Surface Water, Dissolved Analyses (excluding background samples) NN AEU[a]

		Background					NN AEU (excluding background samples)				
Analyte	Units	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Copper	mg/L	138	0.001	0.026	0.006	0.005	31	0.002	0.012	0.004	0.003
Iron	mg/L	137	0.010	72.8	0.724	6.21	30	0.008	95.8	24.1	35.9
Lead	mg/L	133	1.20E-04	0.013	0.002	0.003	32	1.00E-03	0.005	8.69E-04	8.71E-04
Silver	mg/L	141	0.002	0.022	0.003	0.003	32	0.004	0.013	0.003	0.002
Zinc	mg/L	138	0.002	2.30	0.033	0.197	31	0.002	1.50	0.259	0.466

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

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Table A3.2.NN AEU.5
Statistical Distribution and Comparison to Background for Sediments (excluding background samples) NN AEU

Analyte	Statistical Distribution Testing Results						Background Comparison Test		
	Background			NN AEU (excluding background samples)					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Aluminum	**55**	**GAMMA**	**100**	**20**	**NORMAL**	**100**	**WRS**	**2.10E-06**	**Yes**
Barium	**54**	**GAMMA**	**100**	**20**	**GAMMA**	**100**	**WRS**	**6.57E-08**	**Yes**
Iron	**55**	**GAMMA**	**100**	**20**	**NORMAL**	**100**	**WRS**	**2.49E-05**	**Yes**
Lead	**55**	**LOGNORMAL**	**100**	**20**	**GAMMA**	**100**	**WRS**	**1.86E-04**	**Yes**
Manganese	55	GAMMA	100	20	GAMMA	100	WRS	0.305	No

WRS = Wilcoxon Rank Sum

N/A = Not applicable; site and/or background detection frequency less than 20%.

Bold = indicate ECOIs retained for further consideration in the upper-bound EPC comparison step.

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Table A3.2.NN AEU.6
Summary Statistics For Sediments (excluding background samples) NN AEU[a]

		Background					NN AEU (excluding background samples)				
Analyte	Units	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Aluminum	mg/kg	55	811	25,200	6,791	5,603	20	6,000	24,000	14,689	5,247
Barium	mg/kg	54	10.6	260	78.9	58.8	20	92.6	390	192	80.3
Iron	mg/kg	55	1,040	31,400	9,740	6,739	20	9,050	21,500	15,513	3,194
Lead	mg/kg	55	2.60	68.8	13.3	12.4	20	12.0	37.6	20.4	5.99
Manganese	mg/kg	55	9.00	1,280	238	216	20	78.0	1,100	254	226
Benzo(a)anthracene	ug/kg	43	37.0	1,700	434	335	16	42.0	150	220	146
Benzo(a)pyrene	ug/kg	43	120	900	407	260	16	98.0	160	316	131
Benzo(g,h,i)perylene	ug/kg	41	240	460	396	246	16	71.0	89.0	310	140
Chrysene	ug/kg	43	50.0	2,000	446	368	16	44.0	190	273	150
Indeno(1,2,3-cd)pyrene	ug/kg	42	220	470	388	243	16	57.0	86.0	309	142
Phenanthrene	ug/kg	43	260	3,200	527	614	16	57.0	280	237	138
Pyrene	ug/kg	43	61.0	4,700	536	742	16	210	320	333	113

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

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Table A3.2.RC AEU.1
Statistical Distribution and Comparison to Background for Surface Water, Total Analyses (excluding background samples) RC AEU

Analyte	Statistical Distribution Testing Results				Background Comparison Test		
	Background		RC AEU (excluding background samples)				
	Total Samples	Detects (%)	Total Samples	Detects (%)	Test	1 - p	Statistically Greater than Background?
Aluminum	166	82	49	84	WRS	0.801	No
Barium	**172**	**78**	**49**	**98**	**WRS**	**0.001**	**Yes**
Beryllium	**167**	**13**	**49**	**16**	**N/A**	**N/A**	**N/A**
Cyanide	**128**	**5**	**8**	**0**	**N/A**	**N/A**	**N/A**
Lithium	**166**	**49**	**45**	**91**	**WRS**	**1.26E-04**	**Yes**
Selenium	**162**	**14**	**48**	**25**	**N/A**	**N/A**	**N/A**
Vanadium	171	34	49	55	WRS	1.000	No
Radium-226	**5**	**100**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**

WRS = Wilcoxon Rank Sum
N/A = Not applicable; site and/or background detection frequency less than 20%.
Bold = indicate ECOIs retained for further consideration in the upper-bound EPC comparison step.

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Table A3.2.RC AEU.2

Summary Statistics For Surface Water, Total Analyses (excluding background samples) RC AEU[a]

Analyte	Units	Background					RC AEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Aluminum	mg/L	166	0.026	129	3.39	12.5	49	0.018	11.6	1.25	2.23
Barium	mg/L	172	0.009	0.630	0.079	0.079	49	0.003	0.132	0.080	0.025
Beryllium	mg/L	167	4.00E-05	0.004	8.01E-04	8.44E-04	49	3.00E-05	8.00E-04	2.54E-04	2.17E-04
Cyanide	mg/L	128	0.002	0.040	0.048	0.443	8	N/A	N/A	0.006	0.004
Lithium	mg/L	166	0.001	0.154	0.015	0.022	45	0.004	0.113	0.013	0.016
Selenium	mg/L	162	6.50E-04	0.019	0.002	0.003	48	4.10E-04	0.004	0.001	8.69E-04
Vanadium	mg/L	171	0.002	0.132	0.011	0.019	49	3.80E-04	0.024	0.004	0.004
Radium-226	pCi/L	5	-0.100	4.90	1.76	2.06	N/A	N/A	N/A	N/A	N/A

N/A = Not applicable.

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

302

Table A3.2.RC AEU.3

Statistical Distribution and Comparison to Background for Surface Water, Dissolved Analyses (excluding background samples) RC AEU

Analyte	Statistical Distribution Testing Results				Background Comparison Test		
	Background		RC AEU (excluding background samples)				
	Total Samples	Detects (%)	Total Samples	Detects (%)	Test	1 - p	Statistically Greater than Background?
Cadmium	**136**	**7**	**13**	**8**	**N/A**	**N/A**	**N/A**
Copper	138	33	13	77	WRS	0.336	No
Iron	137	80	12	83	WRS	0.926	No
Lead	**133**	**24**	**13**	**8**	**N/A**	**N/A**	**N/A**

WRS = Wilcoxon Rank Sum

N/A = Not applicable; site and/or background detection frequency less than 20%.

Bold = indicate ECOIs retained for further consideration in the upper-bound EPC comparison step.

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Table A3.2.RC AEU.4
Summary Statistics For Surface Water, Dissolved Analyses (excluding background samples) RC AEU[a]

		Background					RC AEU (excluding background samples)				
Analyte	Units	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Cadmium	mg/L	136	1.00E-03	0.017	0.002	0.001	13	0.003	0.003	0.002	5.27E-04
Copper	mg/L	138	0.001	0.026	0.006	0.005	13	0.003	0.022	0.008	0.007
Iron	mg/L	137	0.010	72.8	0.724	6.21	12	0.009	0.319	0.096	0.104
Lead	mg/L	133	1.20E-04	0.013	0.002	0.003	13	0.002	0.002	6.42E-04	3.16E-04

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

304

Table A3.2.RC AEU.5
Statistical Distribution and Comparison to Background for Sediments (excluding background samples) RC AEU

Analyte	Statistical Distribution Testing Results						Background Comparison Test		
	Background			RC AEU (excluding background samples)					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Aluminum	**55**	**GAMMA**	**100**	**12**	**NORMAL**	**100**	**WRS**	**3.46E-04**	**Yes**
Antimony	**47**	**LOGNORMAL**	**11**	**12**	**NORMAL**	**0**	**N/A**	**N/A**	**N/A**
Arsenic	**55**	**GAMMA**	**89**	**12**	**GAMMA**	**100**	**WRS**	**0.002**	**Yes**
Barium	**54**	**GAMMA**	**100**	**12**	**NORMAL**	**100**	**WRS**	**2.26E-04**	**Yes**
Cadmium	**48**	**LOGNORMAL**	**10**	**12**	**NORMAL**	**42**	**N/A**	**N/A**	**N/A**
Iron	**55**	**GAMMA**	**100**	**12**	**LOGNORMAL**	**100**	**WRS**	**0.002**	**Yes**
Lead	**55**	**LOGNORMAL**	**100**	**12**	**GAMMA**	**100**	**WRS**	**0.002**	**Yes**
Manganese	55	GAMMA	100	12	NON-PARAMETRIC	100	WRS	0.454	No
Nickel	**53**	**GAMMA**	**72**	**12**	**NORMAL**	**100**	**WRS**	**5.03E-04**	**Yes**
Selenium	**54**	**NON-PARAMETRIC**	**28**	**12**	**NORMAL**	**25**	**WRS**	**0.044**	**Yes**
Silver	**48**	**NON-PARAMETRIC**	**6**	**12**	**NORMAL**	**17**	**N/A**	**N/A**	**N/A**
Zinc	**55**	**NON-PARAMETRIC**	**98**	**12**	**NORMAL**	**100**	**WRS**	**0.009**	**Yes**

WRS = Wilcoxon Rank Sum

N/A = Not applicable; site and/or background detection frequency less than 20%.

Bold = indicate ECOIs retained for further consideration in the upper-bound EPC comparison step.

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Table A3.2.RC AEU.6

Summary Statistics For Sediments (excluding background samples) RC AEU[a]

Analyte	Units	Background					RC AEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Aluminum	mg/kg	55	811	25,200	6,791	5,603	12	4,900	19,000	12,092	3,754
Antimony	mg/kg	47	1.00	12.4	3.64	3.21	12	N/A	N/A	2.60	2.20
Arsenic	mg/kg	55	0.270	8.70	2.43	1.92	12	1.70	15.0	4.85	3.82
Barium	mg/kg	54	10.6	260	78.9	58.8	12	52.0	360	165	86.6
Cadmium	mg/kg	48	0.410	1.30	0.525	0.345	12	0.210	1.10	0.580	0.231
Iron	mg/kg	55	1,040	31,400	9,740	6,739	12	7,800	39,000	16,633	9,246
Lead	mg/kg	55	2.60	68.8	13.3	12.4	12	6.60	79.1	25.7	19.6
Manganese	mg/kg	55	9.00	1,280	238	216	12	80.2	2,500	415	685
Nickel	mg/kg	53	1.20	25.6	6.93	5.32	12	6.30	23.0	12.2	4.42
Selenium	mg/kg	54	0.100	3.20	0.458	0.634	12	0.380	0.810	0.534	0.361
Silver	mg/kg	48	1.40	3.40	0.737	0.654	12	1.20	1.30	0.628	0.483
Zinc	mg/kg	55	6.50	720	72.2	129	12	29.0	95.0	62.4	18.5
2-Butanone	ug/kg	41	2.00	190	17.2	38.7	6	N/A	N/A	8.83	2.75
4-Methylphenol	ug/kg	44	68.0	1,500	432	314	12	N/A	N/A	510	363
Pentachlorophenol	ug/kg	43	N/A	N/A	1,980	1,221	12	1,500	1,500	2,213	1,593

N/A = Not applicable.

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Table A3.2.MK AEU.1

Statistical Distribution and Comparison to Background for Surface Water, Total Analyses (excluding background samples) MK AEU

Analyte	Statistical Distribution Testing Results				Background Comparison Test		
	Background		MK AEU (excluding background samples)				
	Total Samples	Detects (%)	Total Samples	Detects (%)	Test	1 - p	Statistically Greater than Background?
Aluminum	**166**	**82**	**33**	**100**	**WRS**	**3.15E-06**	**Yes**
Selenium	**162**	**14**	**33**	**6**	**N/A**	**N/A**	**N/A**
Vanadium	171	34	33	55	WRS	0.683	No

WRS = Wilcoxon Rank Sum

N/A = Not applicable; site and/or background detection frequency less than 20%.

Bold = indicate ECOIs retained for further consideration in the upper-bound EPC comparison step.

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Table A3.2.MK AEU.2
Summary Statistics For Surface Water, Total Analyses (excluding background samples) MK AEU[a]

Analyte	Units	Background					MK AEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Aluminum	mg/L	166	0.026	129	3.39	12.5	33	0.088	46.0	4.54	8.27
Selenium	mg/L	162	6.50E-04	0.019	0.002	0.003	33	0.002	0.005	0.005	0.007
Vanadium	mg/L	171	0.002	0.132	0.011	0.019	33	6.80E-04	0.082	0.009	0.015

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

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Table A3.2.MK AEU.3
Statistical Distribution and Comparison to Background for Surface Water, Dissolved Analyses (excluding background samples) MK AEU

Analyte	Statistical Distribution Testing Results				Background Comparison Test		
	Background		MK AEU (excluding background samples)				
	Total Samples	Detects (%)	Total Samples	Detects (%)	Test	1 - p	Statistically Greater than Background?
Cadmium	**136**	**7**	**20**	**25**	**N/A**	**N/A**	**N/A**
Copper	138	33	19	74	WRS	0.373	No
Lead	133	24	19	63	WRS	0.430	No
Zinc	**138**	**57**	**20**	**85**	**WRS**	**7.69E-04**	**Yes**

WRS = Wilcoxon Rank Sum

N/A = Not applicable; site and/or background detection frequency less than 20%.

Bold = indicate ECOIs retained for further consideration in the upper-bound EPC comparison step.

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Table A3.2.MK AEU.4
Summary Statistics For Surface Water, Dissolved Analyses (excluding background samples) MK AEU[a]

Analyte	Units	Background					MK AEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Cadmium	mg/L	136	1.00E-03	0.017	0.002	0.001	20	2.10E-04	0.003	8.42E-04	8.82E-04
Copper	mg/L	138	0.001	0.026	0.006	0.005	19	0.003	0.025	0.006	0.005
Lead	mg/L	133	1.20E-04	0.013	0.002	0.003	19	3.90E-04	0.071	0.008	0.017
Zinc	mg/L	138	0.002	2.30	0.033	0.197	20	0.006	0.245	0.046	0.058

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

310

Table A3.2.MK AEU.5

Statistical Distribution and Comparison to Background for Sediments (excluding background samples) MK AEU

Analyte	Statistical Distribution Testing Results						Background Comparison Test		
	Background			MK AEU (excluding background samples)					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Aluminum	**55**	**GAMMA**	**100**	**6**	**NORMAL**	**100**	**WRS**	**0.022**	**Yes**
Antimony	**47**	**LOGNORMAL**	**11**	**6**	**NON-PARAMETRIC**	**0**	**N/A**	**N/A**	**N/A**
Chromium	**55**	**GAMMA**	**85**	**6**	**GAMMA**	**100**	**WRS**	**0.100**	**Yes**
Copper	55	GAMMA	80	6	GAMMA	100	WRS	0.624	No
Fluoride	**N/A**	**N/A**	**N/A**	**1**	**0**	**100**	**N/A**	**N/A**	**N/A**
Iron	55	GAMMA	100	6	NORMAL	100	WRS	0.195	No
Lead	55	LOGNORMAL	100	6	GAMMA	100	WRS	0.719	No
Nickel	**53**	**GAMMA**	**72**	**6**	**NORMAL**	**100**	**WRS**	**0.036**	**Yes**
Selenium	**54**	**NON-PARAMETRIC**	**28**	**6**	**LOGNORMAL**	**17**	**N/A**	**N/A**	**N/A**
Zinc	55	NON-PARAMETRIC	98	6	NON-PARAMETRIC	100	WRS	0.834	No

WRS = Wilcoxon Rank Sum

N/A = Not applicable; site and/or background detection frequency less than 20%.

Bold = indicate ECOIs retained for further consideration in the upper-bound EPC comparison step.

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Table A3.2.MK AEU.6

Summary Statistics For Sediments (excluding background samples) MK AEU[a]

Analyte	Units	Background					MK AEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Aluminum	mg/kg	55	811	25,200	6,791	5,603	6	3,700	30,300	13,832	10,138
Antimony	mg/kg	47	1.00	12.4	3.64	3.21	6	N/A	N/A	0.928	1.46
Chromium	mg/kg	55	1.50	30.4	8.78	7.87	6	4.00	44.3	14.7	15.2
Copper	mg/kg	55	2.20	36.7	10.8	8.43	6	3.10	33.2	10.7	11.4
Fluoride	mg/kg	N/A	N/A	N/A	N/A	N/A	1	8.47	8.47	8.47	N/A
Iron	mg/kg	55	1,040	31,400	9,740	6,739	6	4,200	27,500	12,017	8,347
Lead	mg/kg	55	2.60	68.8	13.3	12.4	6	2.00	73.6	17.9	27.7
Nickel	mg/kg	53	1.20	25.6	6.93	5.32	6	3.50	28.3	13.4	9.45
Selenium	mg/kg	54	0.100	3.20	0.458	0.634	6	2.70	2.70	0.710	0.980
Zinc	mg/kg	55	6.50	720	72.2	129	6	19.0	347	79.1	131
4-Methylphenol	ug/kg	44	68.0	1,500	432	314	2	N/A	N/A	308	194

N/A = Not applicable.

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

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Table A3.2.SE AEU.1
Statistical Distribution and Comparison to Background for Surface Water, Total Analyses (excluding background samples) SE AEU

Analyte	Statistical Distribution Testing Results				Background Comparison Test		
	Background		SE AEU (excluding background samples)				
	Total Samples	Detects (%)	Total Samples	Detects (%)	Test	1 - p	Statistically Greater than Background?
Aluminum	166	82	6	50	WRS	0.998	No

WRS = Wilcoxon Rank Sum
N/A = Not applicable; site and/or background detection frequency less than 20%.
Bold = indicate ECOIs retained for further consideration in the upper-bound EPC comparison step.

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Table A3.2.SE AEU.2

Summary Statistics For Surface Water, Total Analyses (excluding background samples) SE AEU[a]

Analyte	Units	Background					SE AEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Aluminum	mg/L	166	0.026	129	3.39	12.5	6	0.061	0.160	0.065	0.051

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

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Table A3.2.SE AEU.3

Statistical Distribution and Comparison to Background for Surface Water, Dissolved Analyses (excluding background samples) SE AEU

Analyte	Statistical Distribution Testing Results				Background Comparison Test		
	Background		SE AEU (excluding background samples)		Test	1 - p	Statistically Greater than Background?
	Total Samples	Detects (%)	Total Samples	Detects (%)			
Silver	141	6	1	100	N/A	N/A	N/A

N/A = Not applicable; site and/or background detection frequency less than 20%.

315

Table A3.2.SE AEU.4

Summary Statistics For Surface Water, Dissolved Analyses (excluding background samples) SE AEU[a]

Analyte	Units	Background					SE AEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Silver	mg/L	141	0.002	0.022	0.003	0.003	1	0.003	0.003	0.003	N/A

N/A = Not applicable.

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

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Table A3.2.SE AEU.5
Statistical Distribution and Comparison to Background for Sediments (excluding background samples) SE AEU

Analyte	Statistical Distribution Testing Results						Background Comparison Test		
	Background			SE AEU (excluding background samples)					
	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	Statistically Greater than Background?
Aluminum	55	GAMMA	100	7	NORMAL	100	WRS	2.50E-04	Yes
Barium	54	GAMMA	100	7	NORMAL	100	WRS	0.001	Yes
Iron	55	GAMMA	100	7	NORMAL	100	WRS	0.001	Yes
Selenium	54	NON-PARAMETRIC	28	7	NON-PARAMETRIC	14	N/A	N/A	N/A

WRS = Wilcoxon Rank Sum
N/A = Not applicable; site and/or background detection frequency less than 20%.
Bold = indicate ECOIs retained for further consideration in the upper-bound EPC comparison step.

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Table A3.2.SE AEU.6
Summary Statistics For Sediments (excluding background samples) SE AEU[a]

Analyte	Units	Background					SE AEU (excluding background samples)				
		Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation	Total Samples	Minimum Detected Concentration	Maximum Detected Concentration	Mean Concentration	Standard Deviation
Aluminum	mg/kg	55	811	25,200	6,791	5,603	7	7,600	26,000	18,229	6,295
Barium	mg/kg	54	10.6	260	78.9	58.8	7	77.0	240	158	51.6
Iron	mg/kg	55	1,040	31,400	9,740	6,739	7	11,000	34,000	18,857	8,315
Selenium	mg/kg	54	0.100	3.20	0.458	0.634	7	1.70	1.70	0.729	0.471

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

FIGURES

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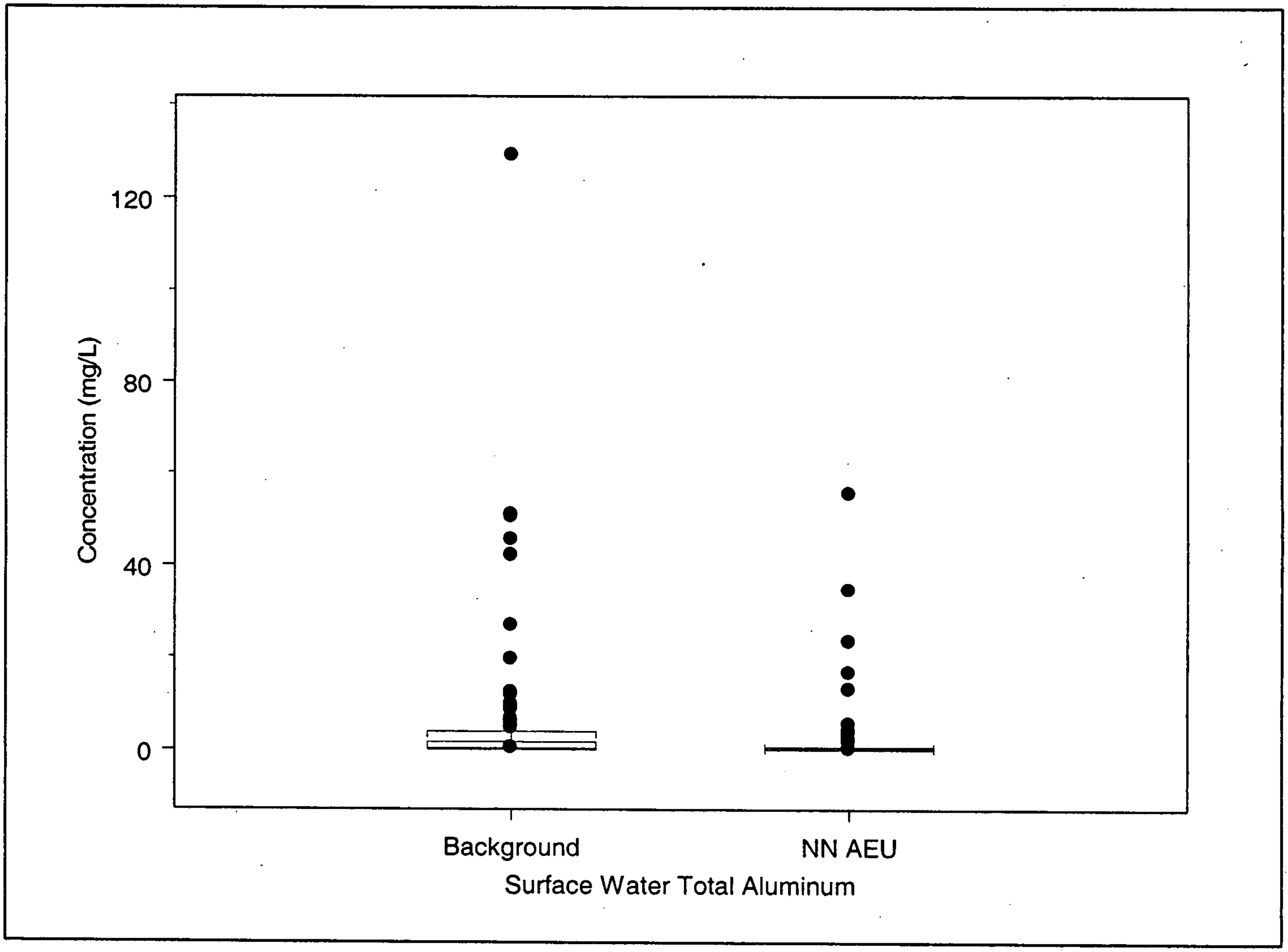
Figure A3[illegible]NN AEU.1
NN AEU Surface Water Total Box Plots for Aluminum



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

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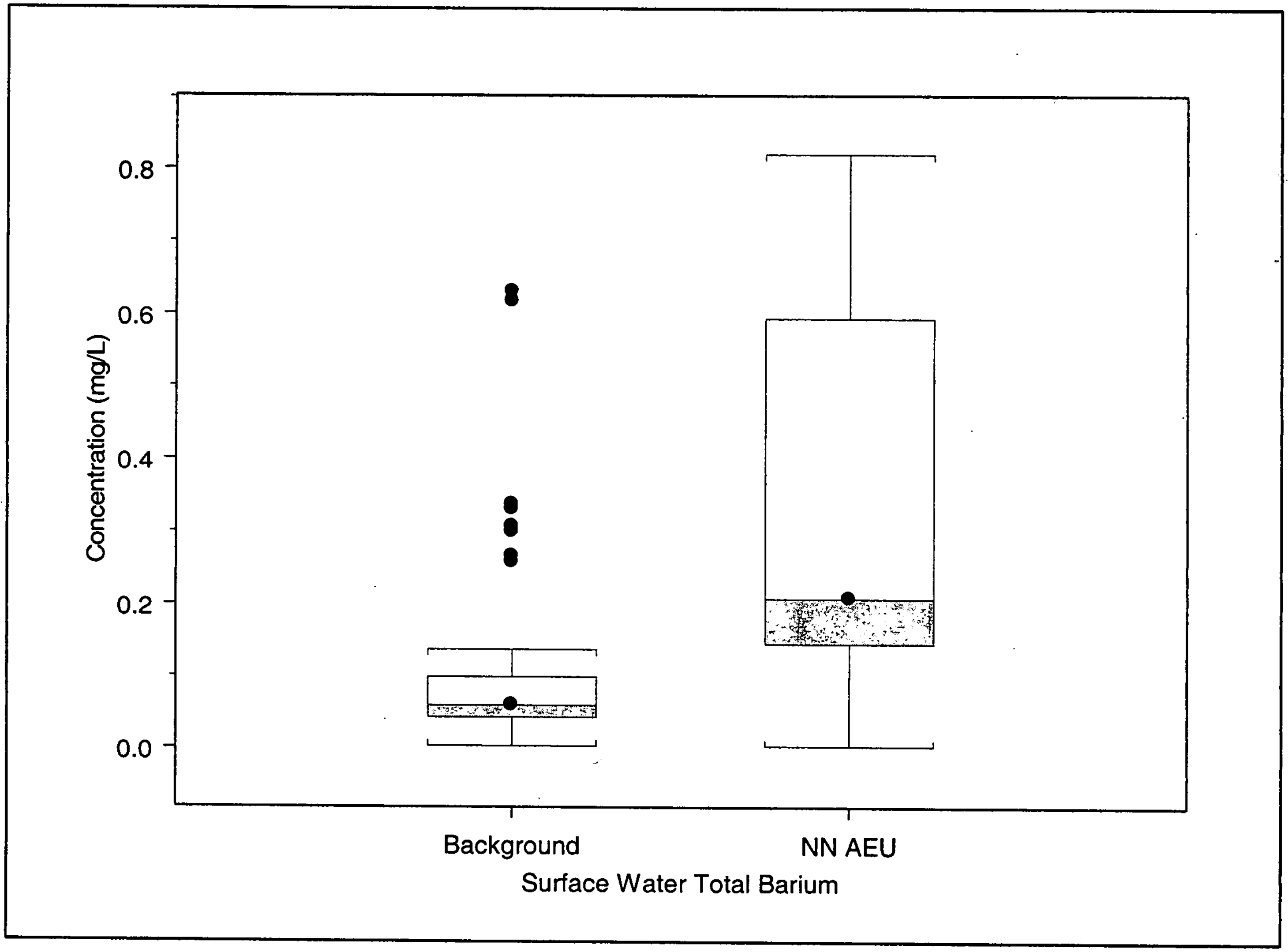
Figure A[illegible]N AEU.2
NN AEU Surface Water Total Box Plots for Barium



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

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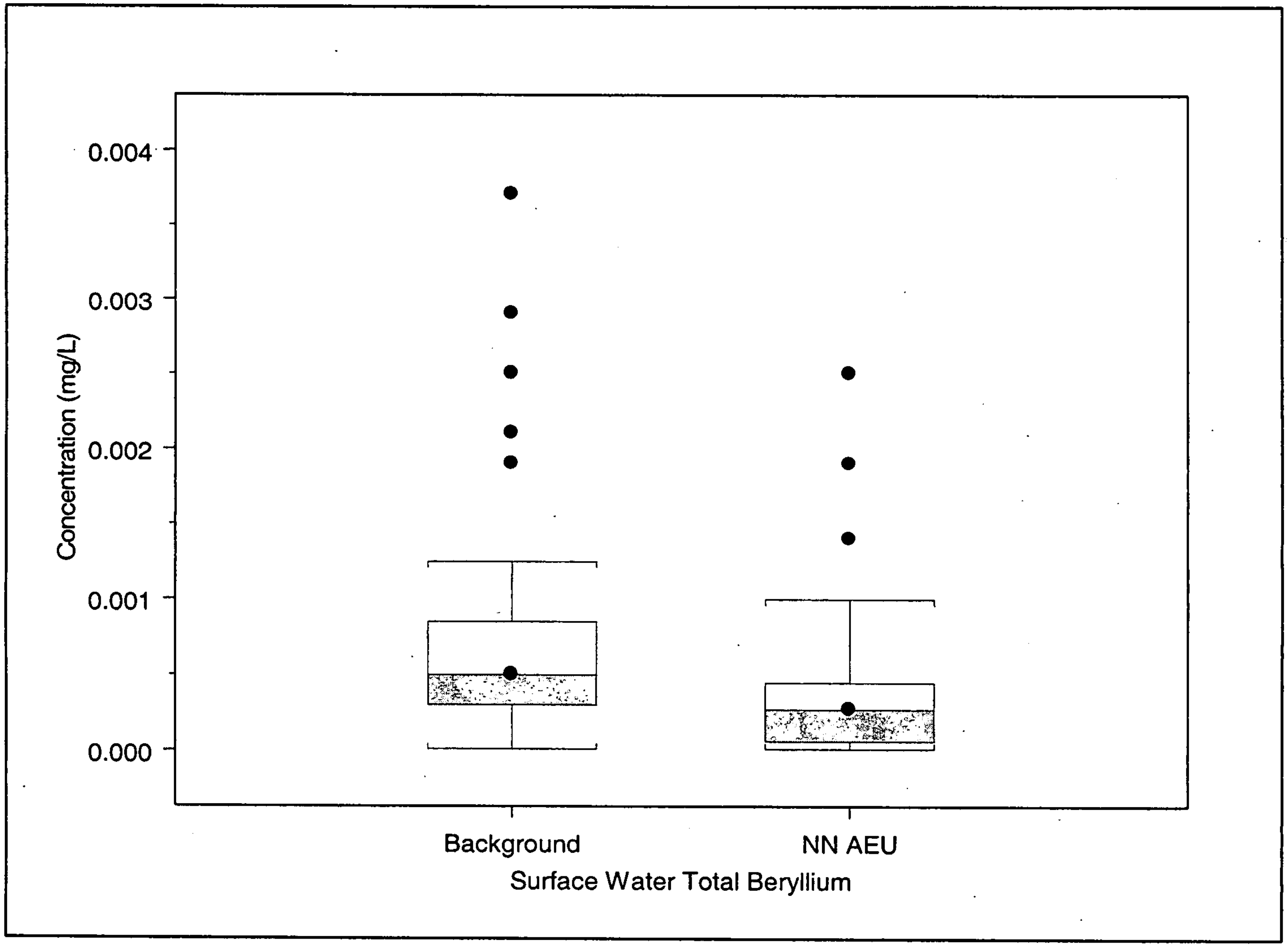
Figure A3[illegible]N AEU.3
NN AEU Surface Water Total Box Plots for Beryllium



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

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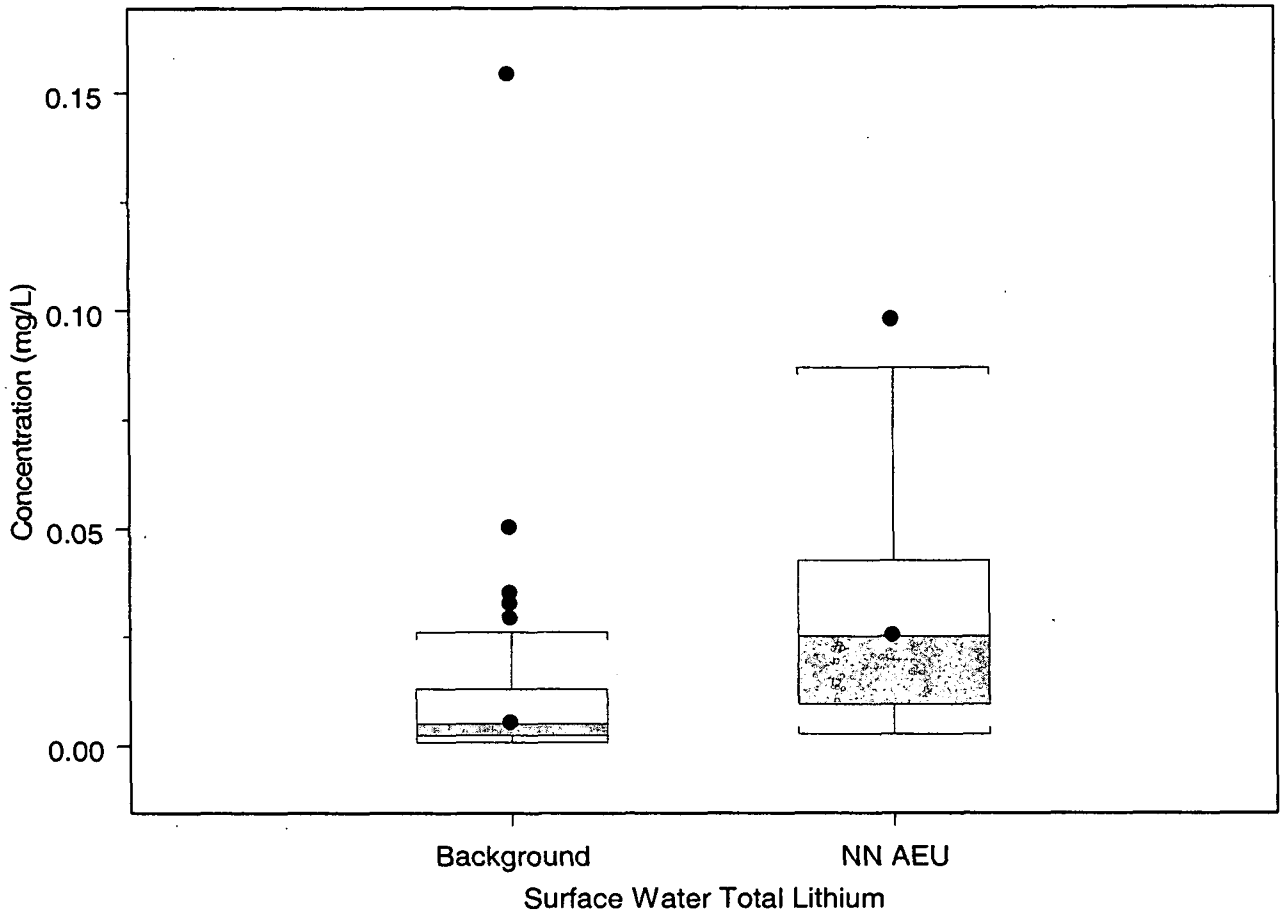
Figure A3.2.NN AEU.4
NN AEU Surface Water Total Box Plots for Lithium



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

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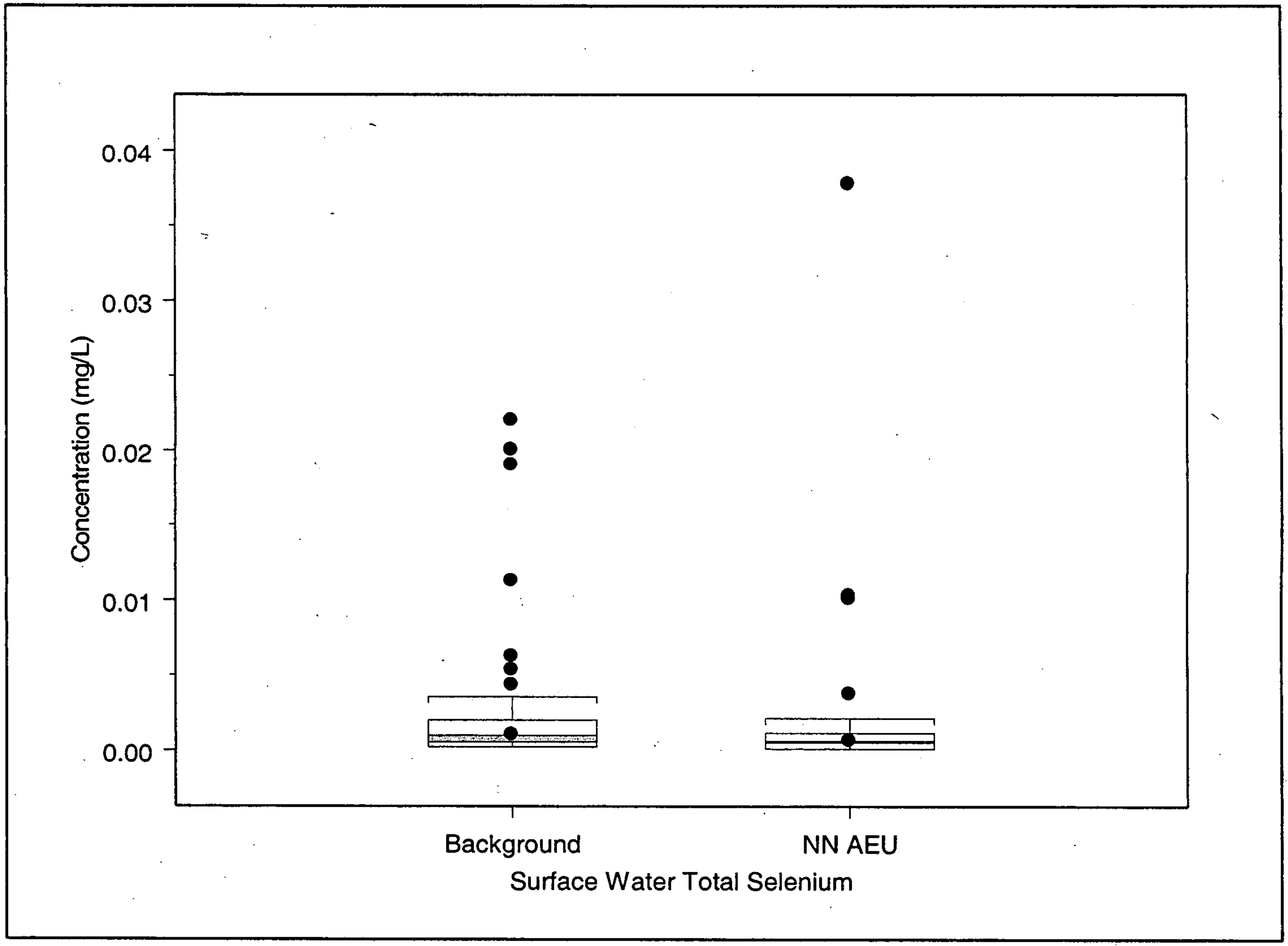
Figure A3.2.NN AEU.5
NN AEU Surface Water Total Box Plots for Selenium



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

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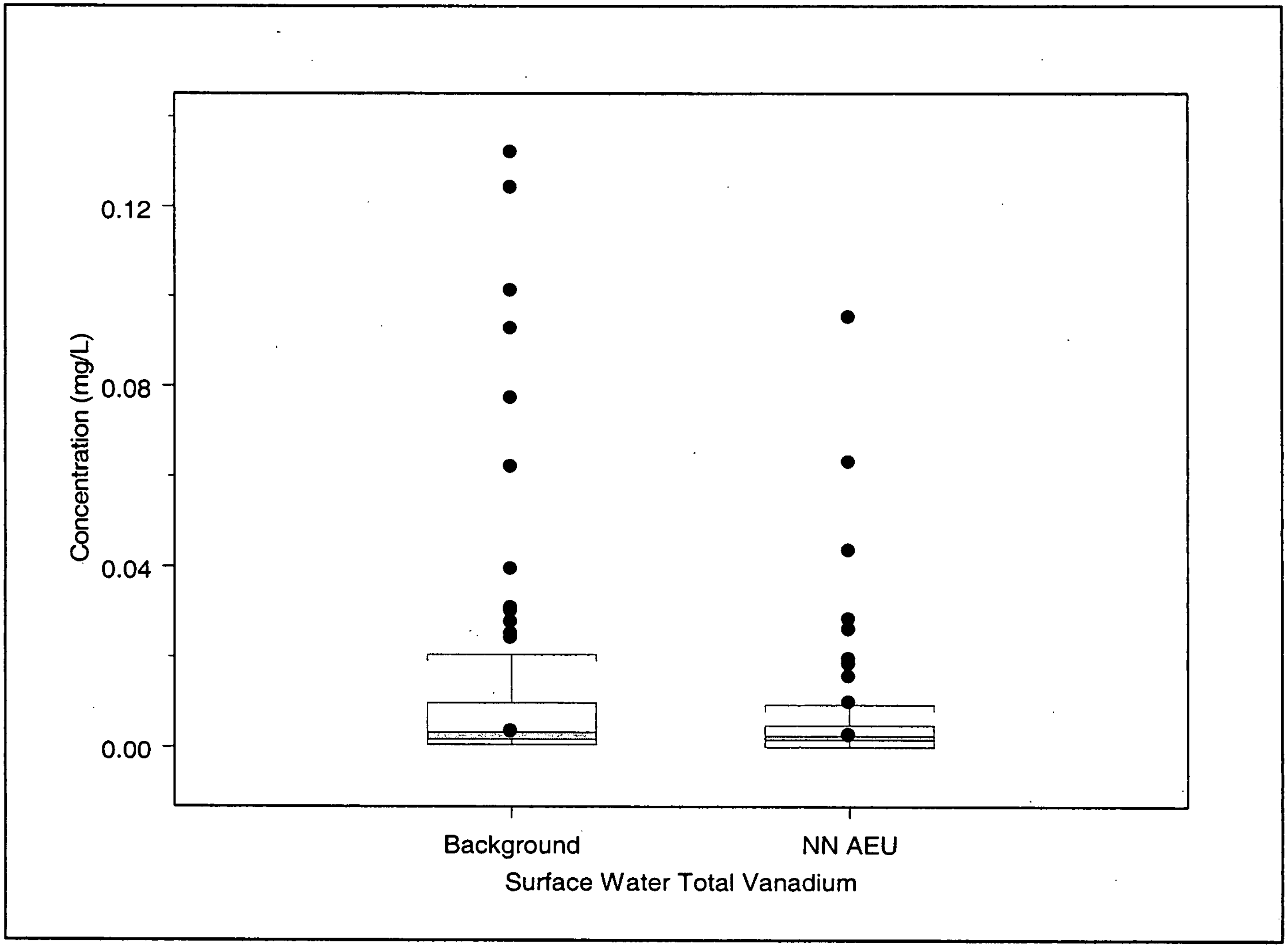
Figure A3.2.NN AEU.6
NN AEU Surface Water Total Box Plots for Vanadium



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

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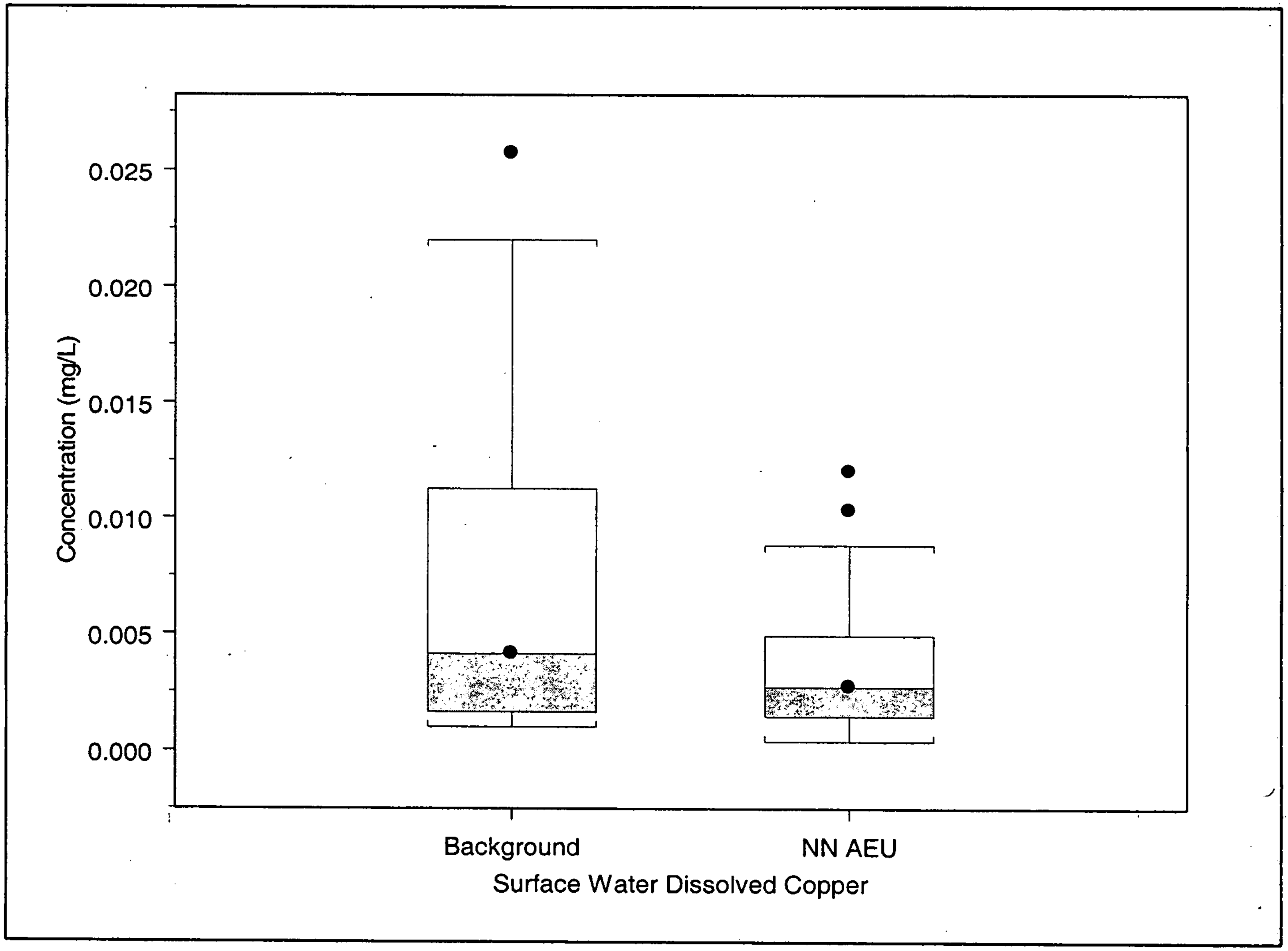
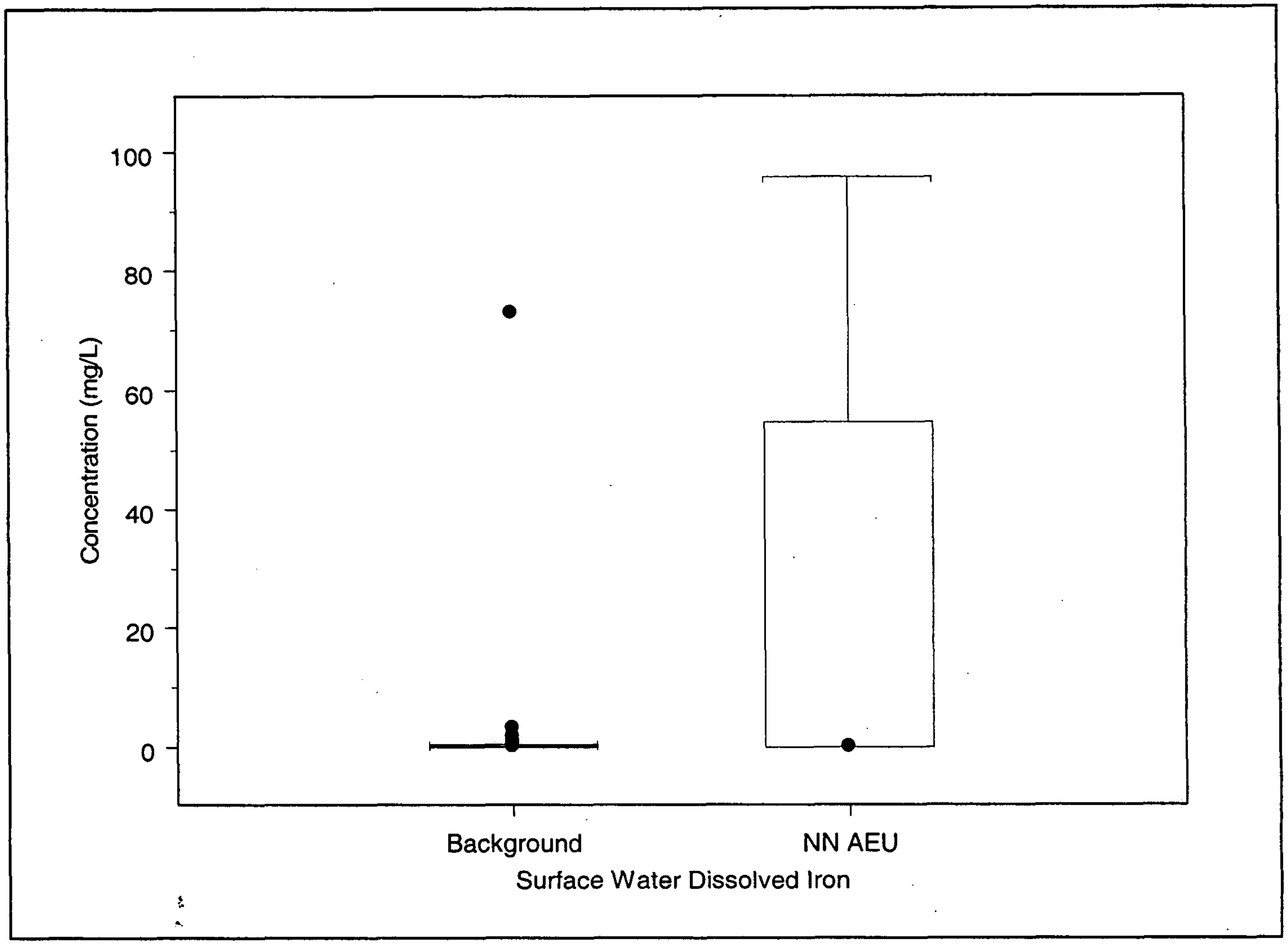
Figure A3.[illegible]N AEU.7
NN AEU Surface Water Dissolved Box Plots for Copper



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

327

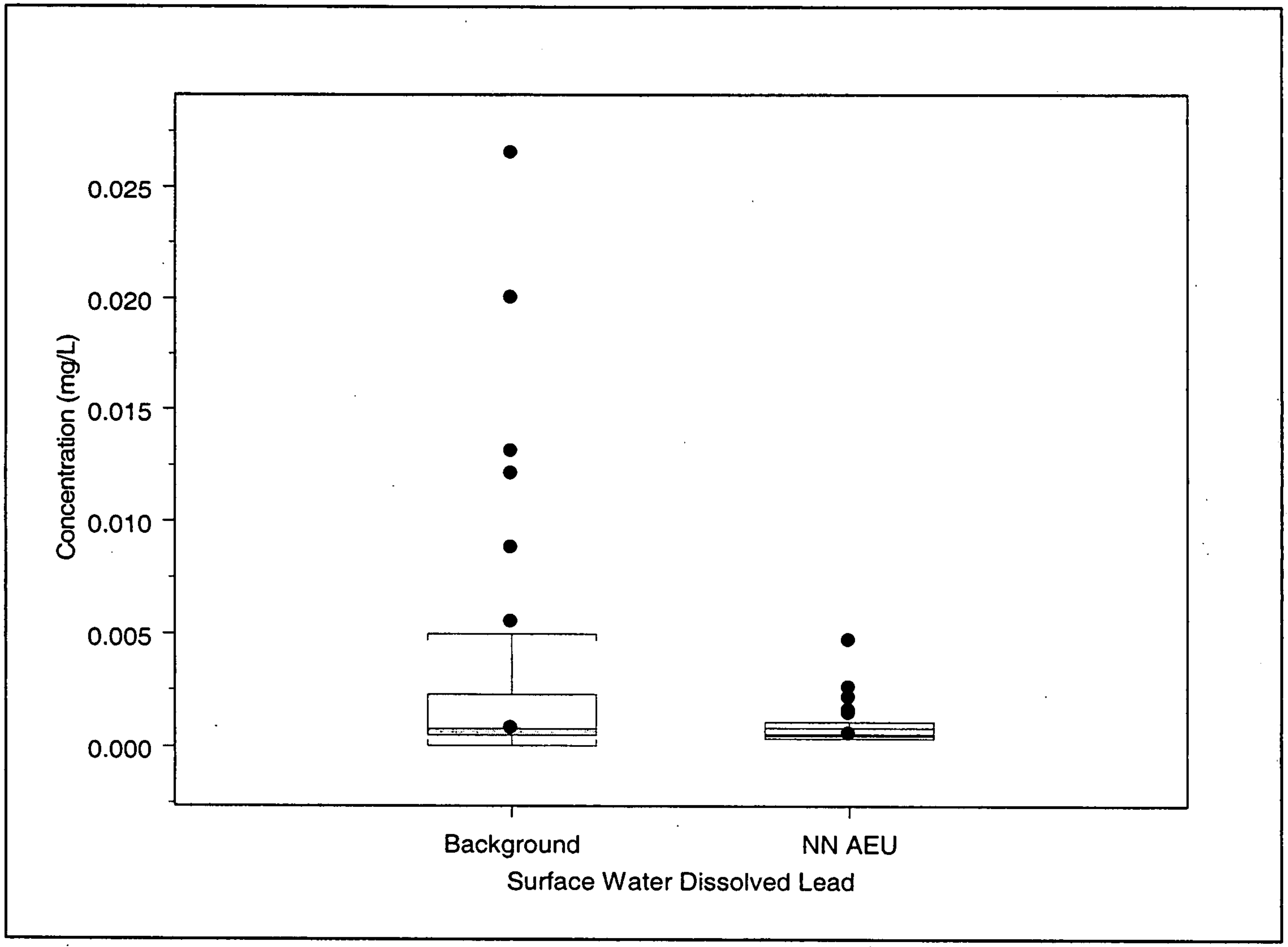
Figure A3.[illegible]N AEU.8
NN AEU Surface Water Dissolved Box Plots for Iron



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

328

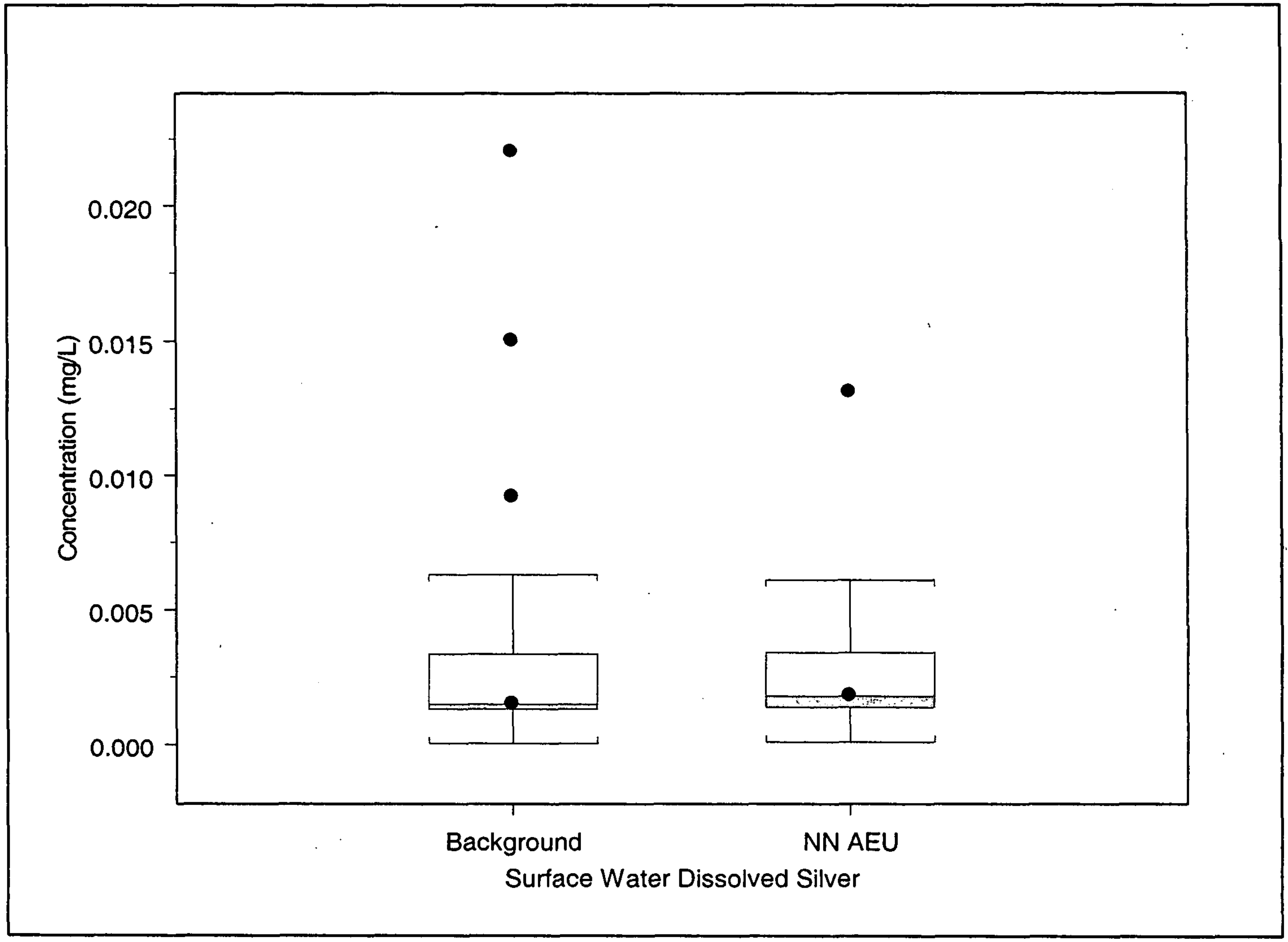
Figure A3.2.NN AEU.9
NN AEU Surface Water Dissolved Box Plots for Lead



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

329

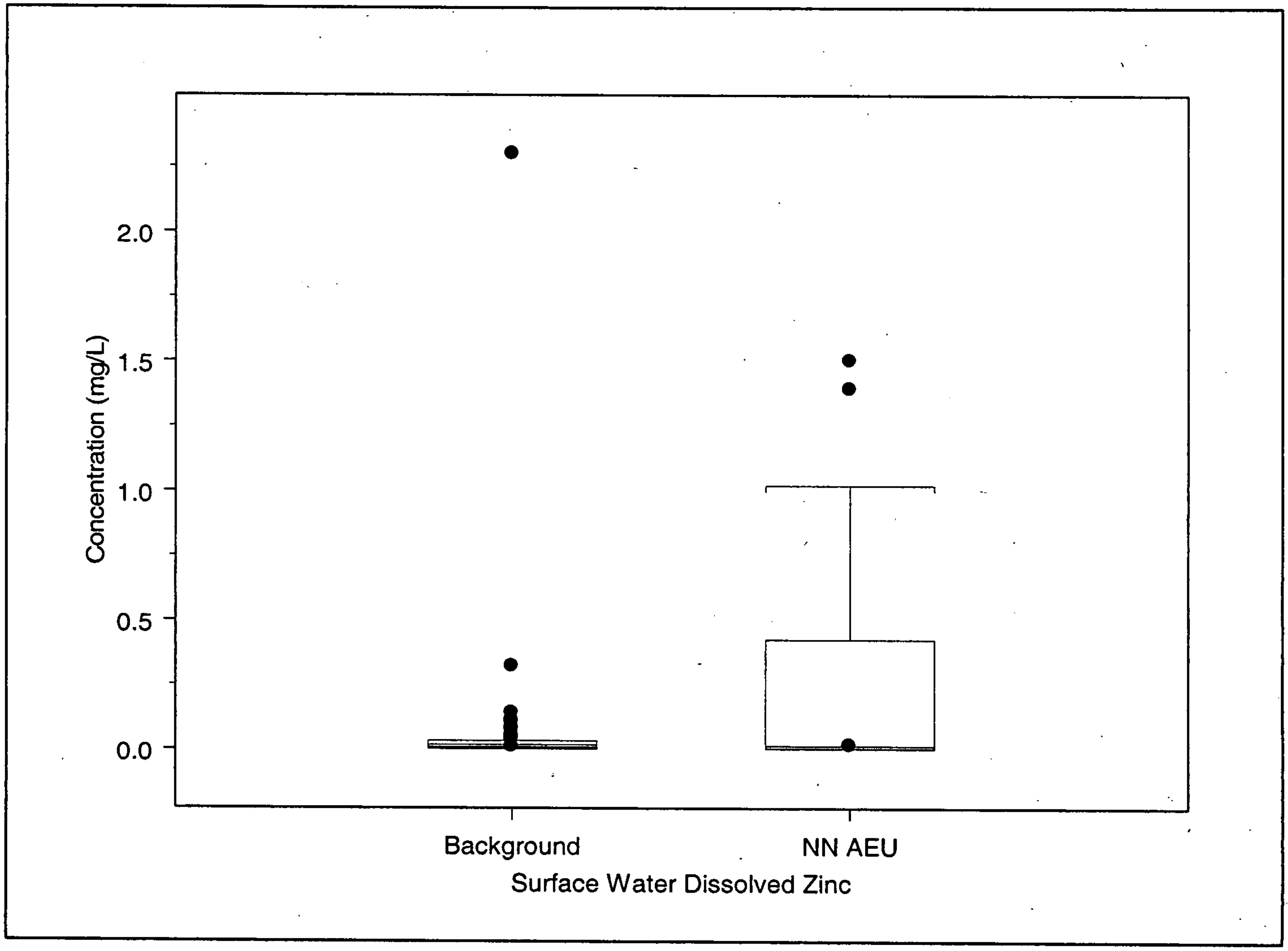
Figure A3.2.NN AEU.10
NN AEU Surface Water Dissolved Box Plots for Silver



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

330

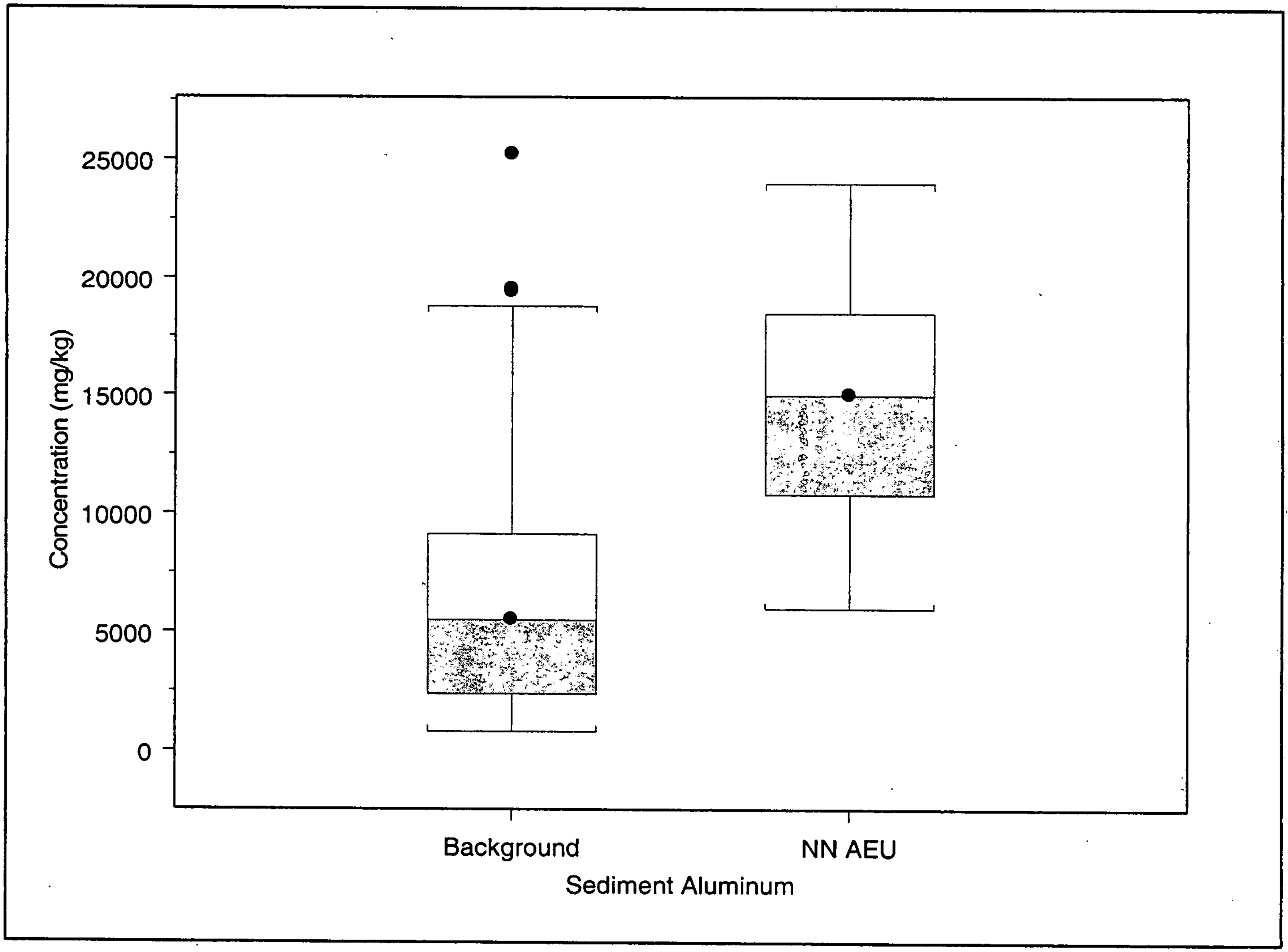
Figure A3.[illegible]N AEU.11
NN AEU Surface Water Dissolved Box Plots for Zinc



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

331

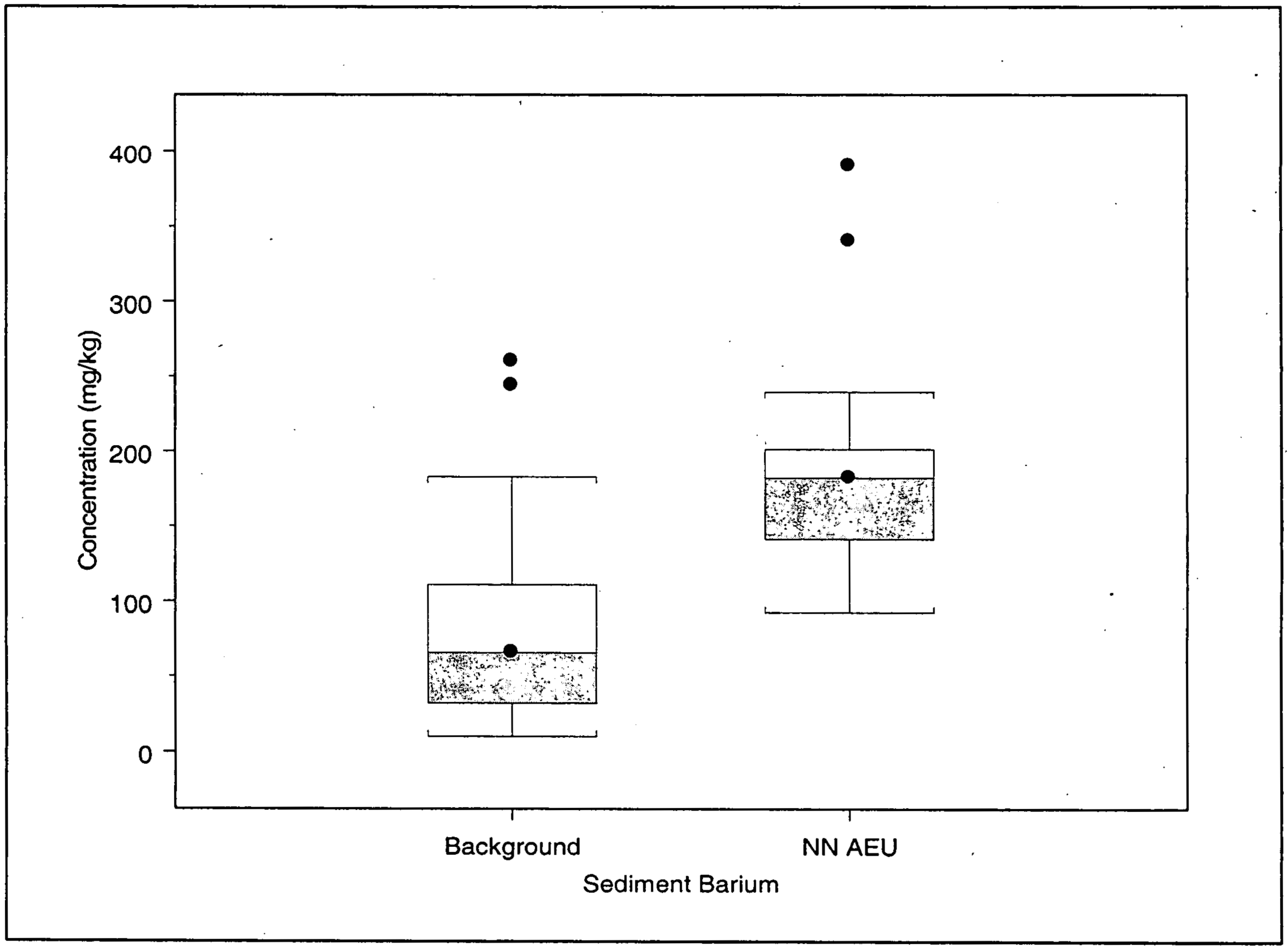
Figure A3.[illegible]N AEU.12
NN AEU Sediment Box Plots for Aluminum



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

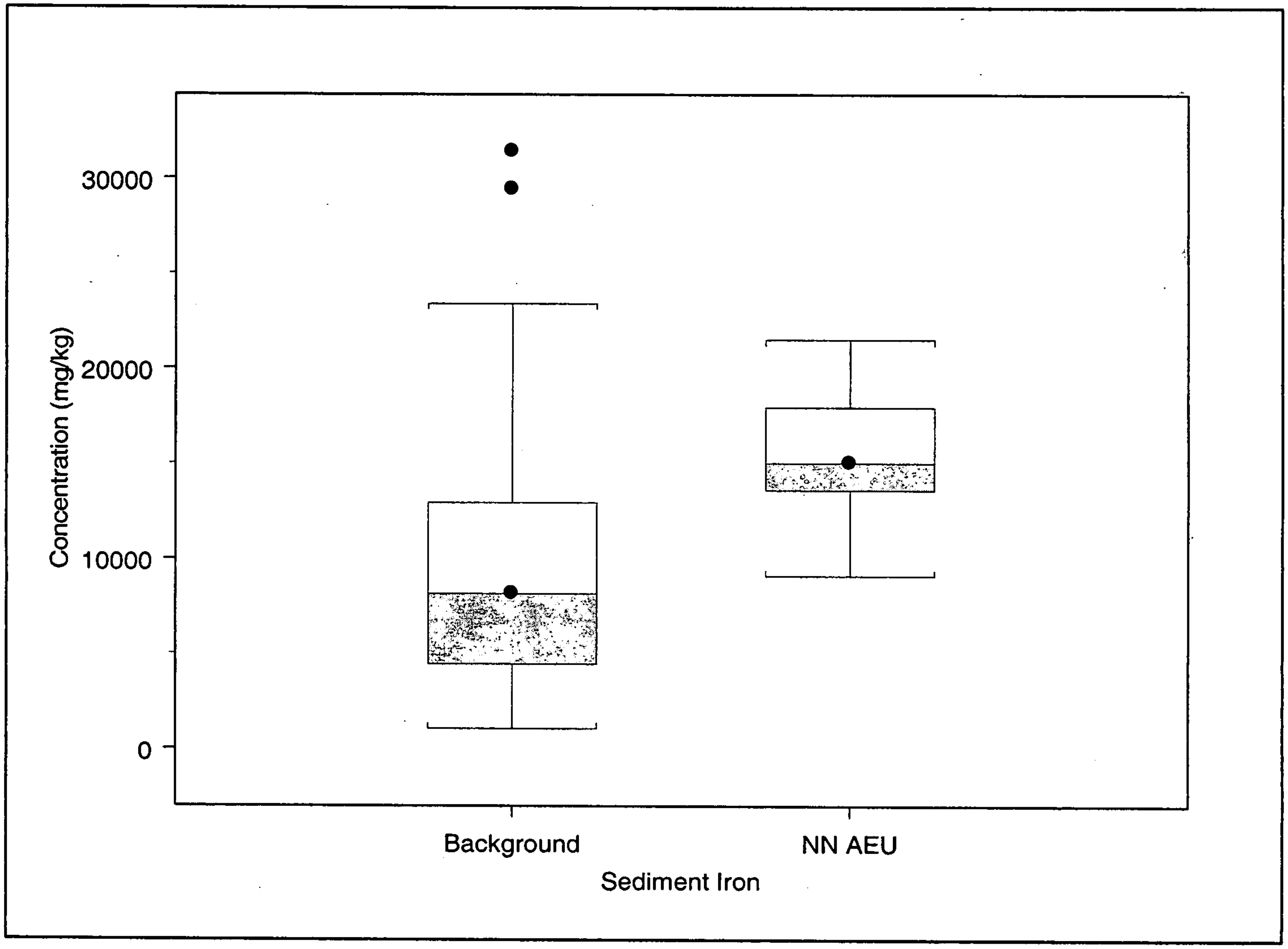
332

Figure A3[illegible]N AEU.13
NN AEU Sediment Box Plots for Barium



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

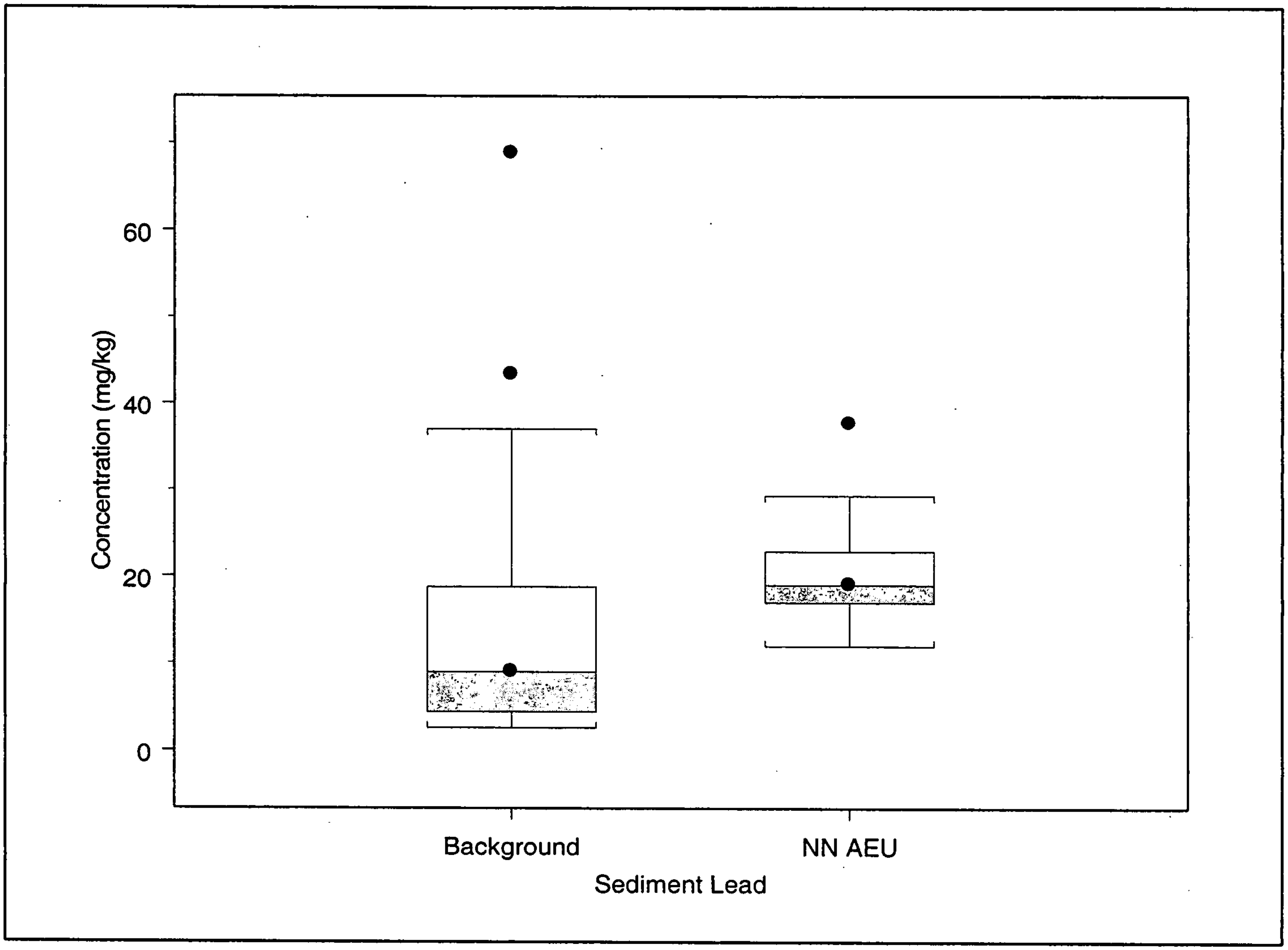
Figure A3.2.NN AEU.14
NN AEU Sediment Box Plots for Iron



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

334

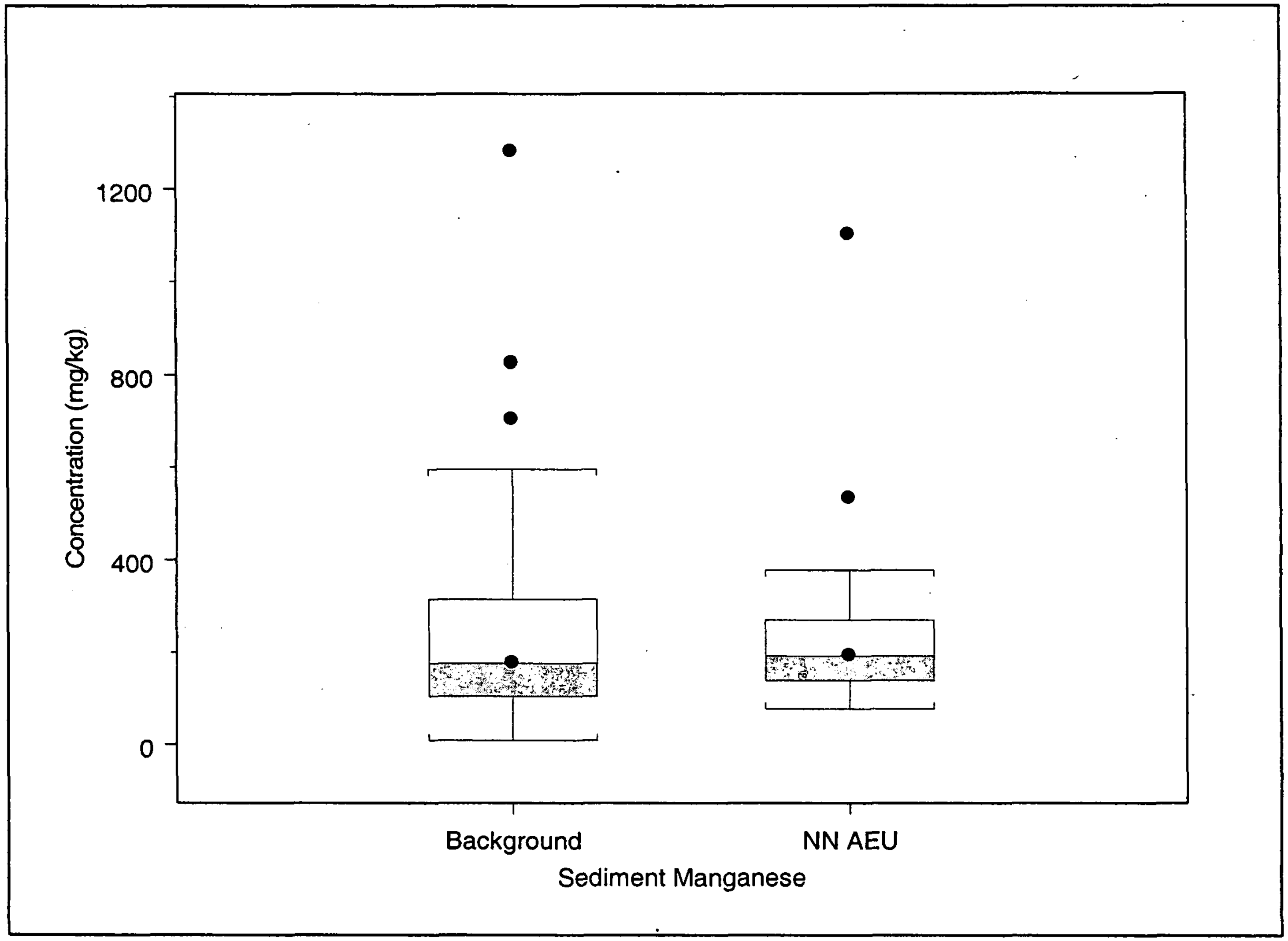
Figure A3.2.NN AEU.15
NN AEU Sediment Box Plots for Lead



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

335

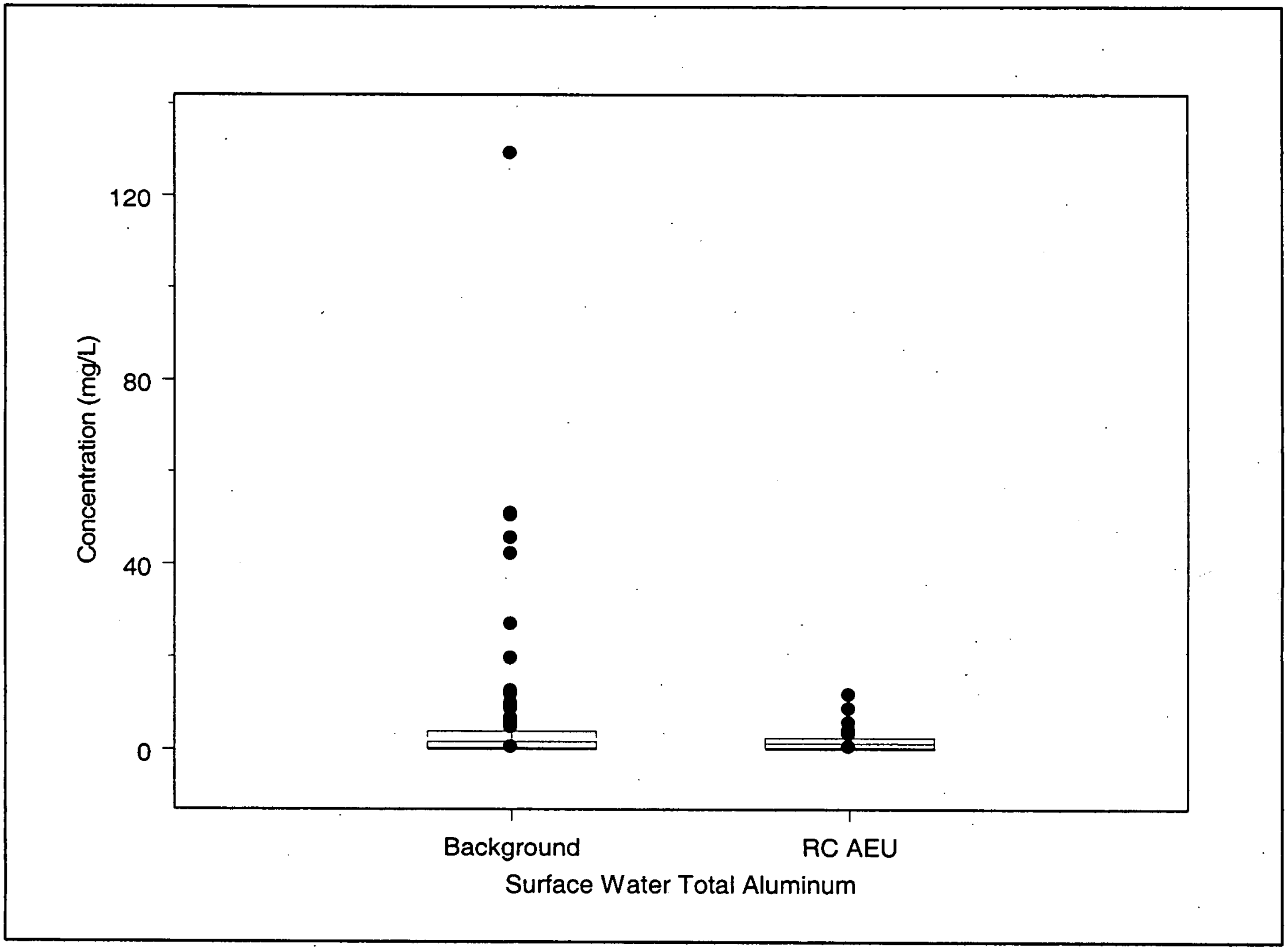
Figure A3.[illegible]N AEU.16
NN AEU Sediment Box Plots for Manganese



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

336

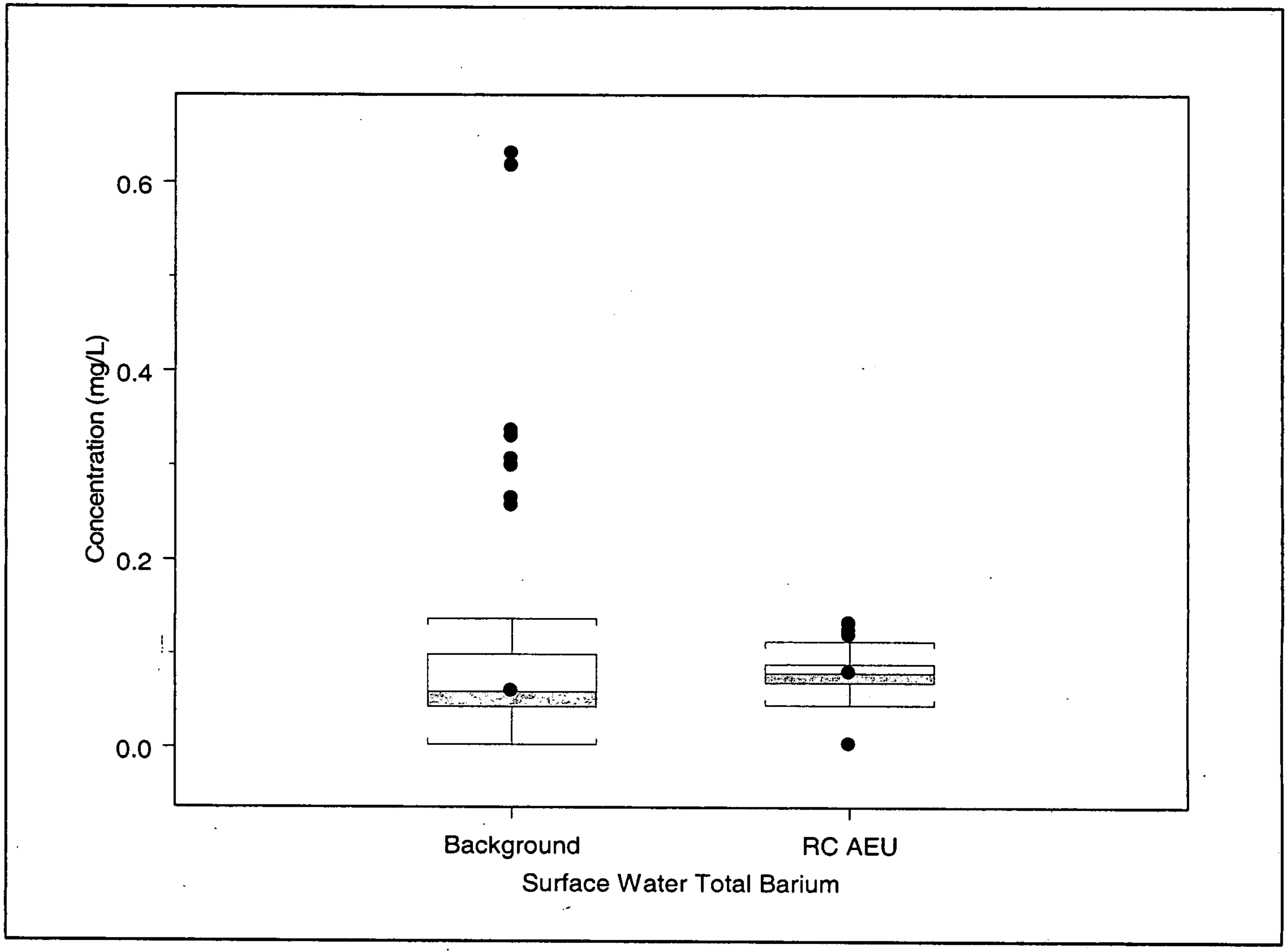
Figure A3.[illegible]C AEU.1
RC AEU Surface Water Total Box Plots for Aluminum



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

337

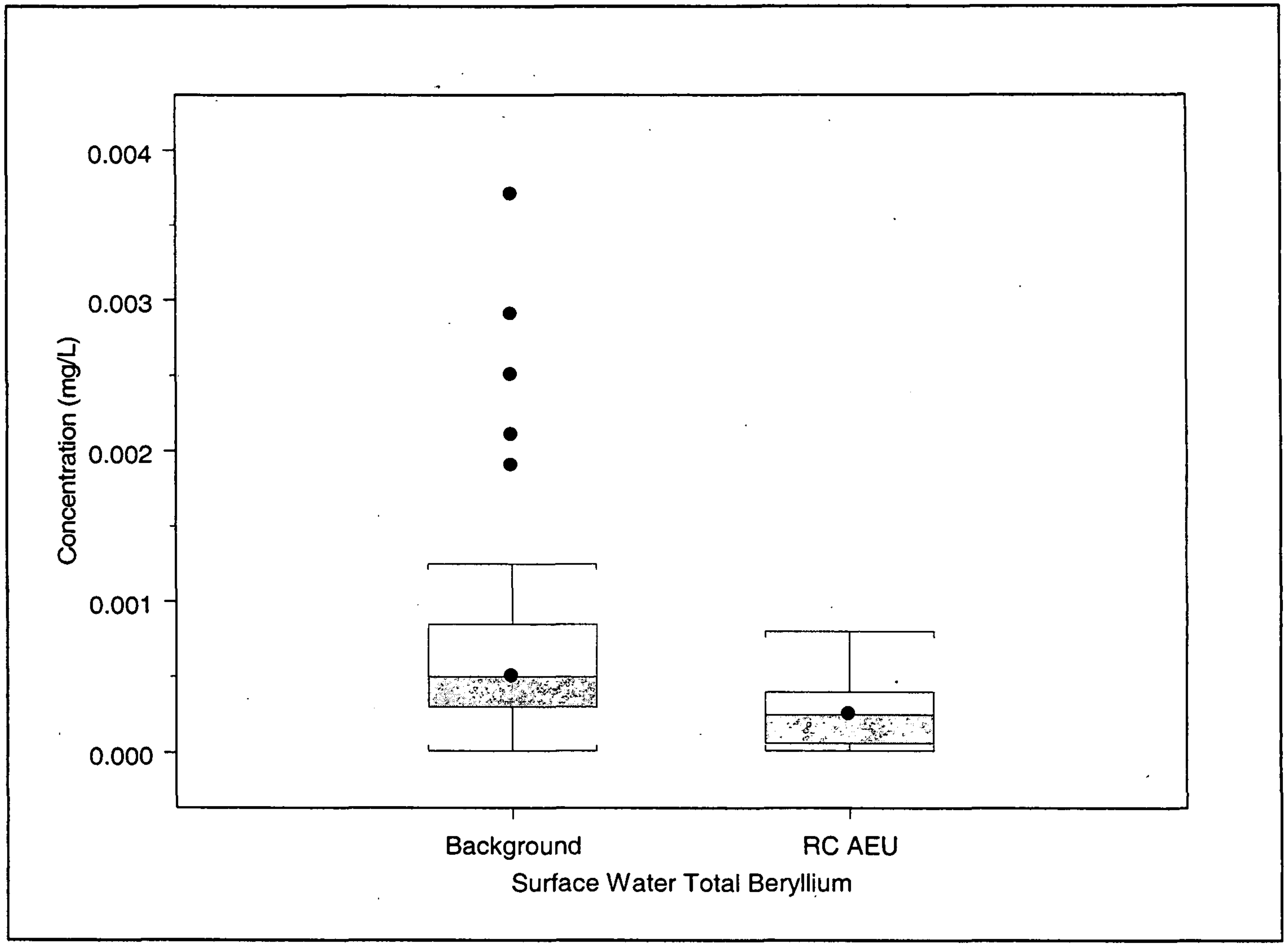
Figure A[illegible]RC AEU.2
RC AEU Surface Water Total Box Plots for Barium



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

338

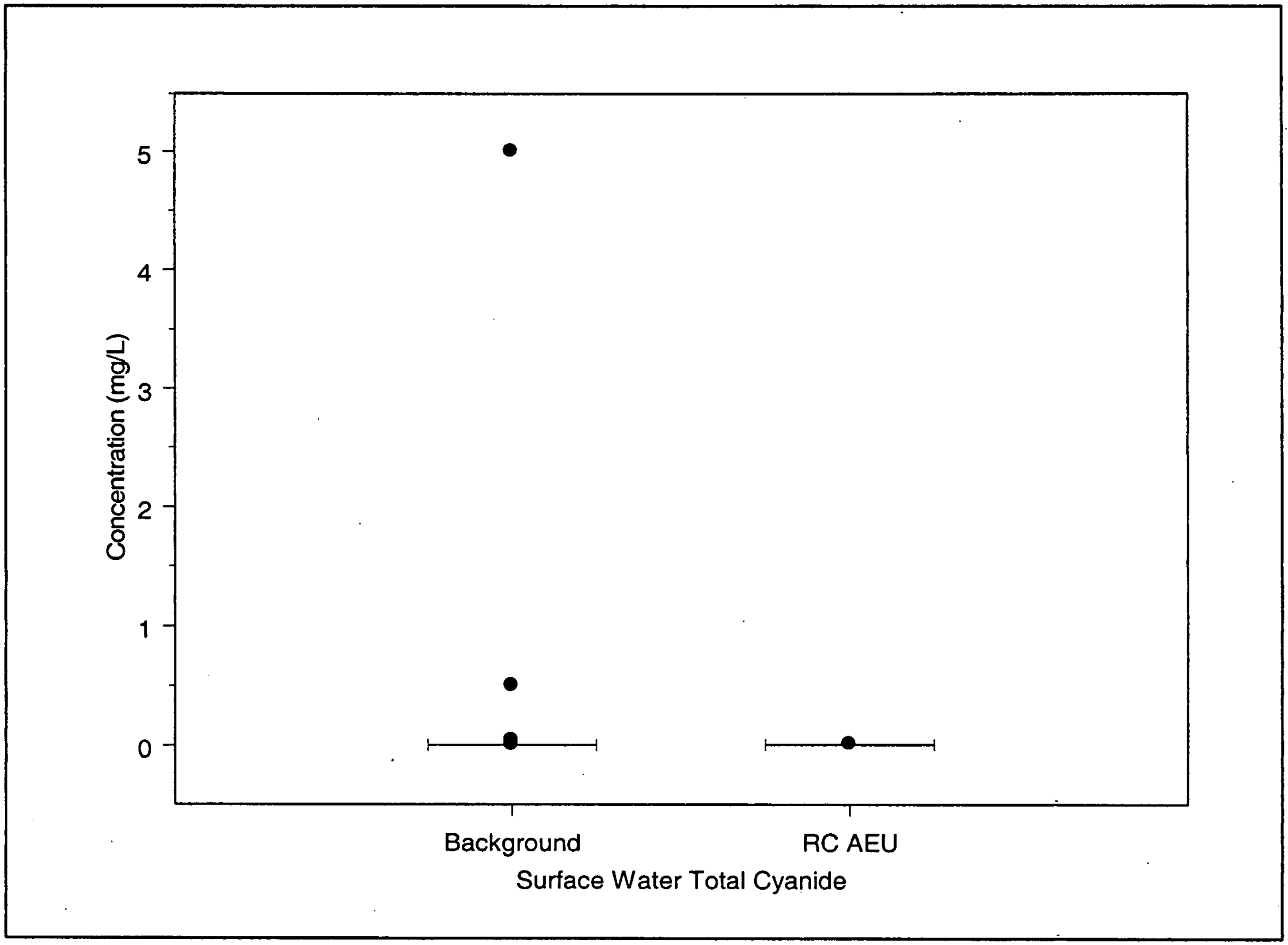
Figure A3.2.RC AEU.3
RC AEU Surface Water Total Box Plots for Beryllium



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

339

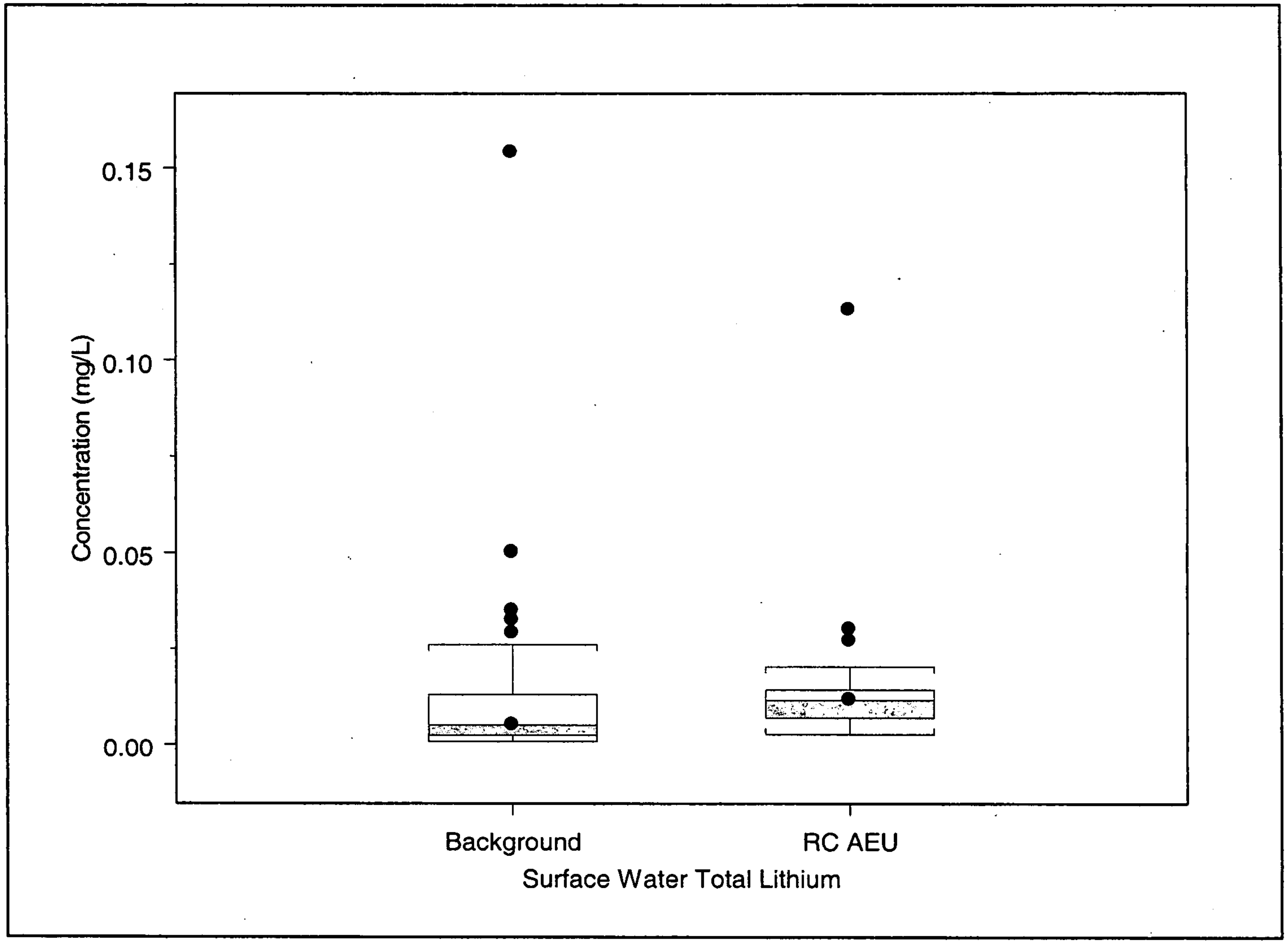
Figure A3.2.RC AEU.4
RC AEU Surface Water Total Box Plots for Cyanide



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

340

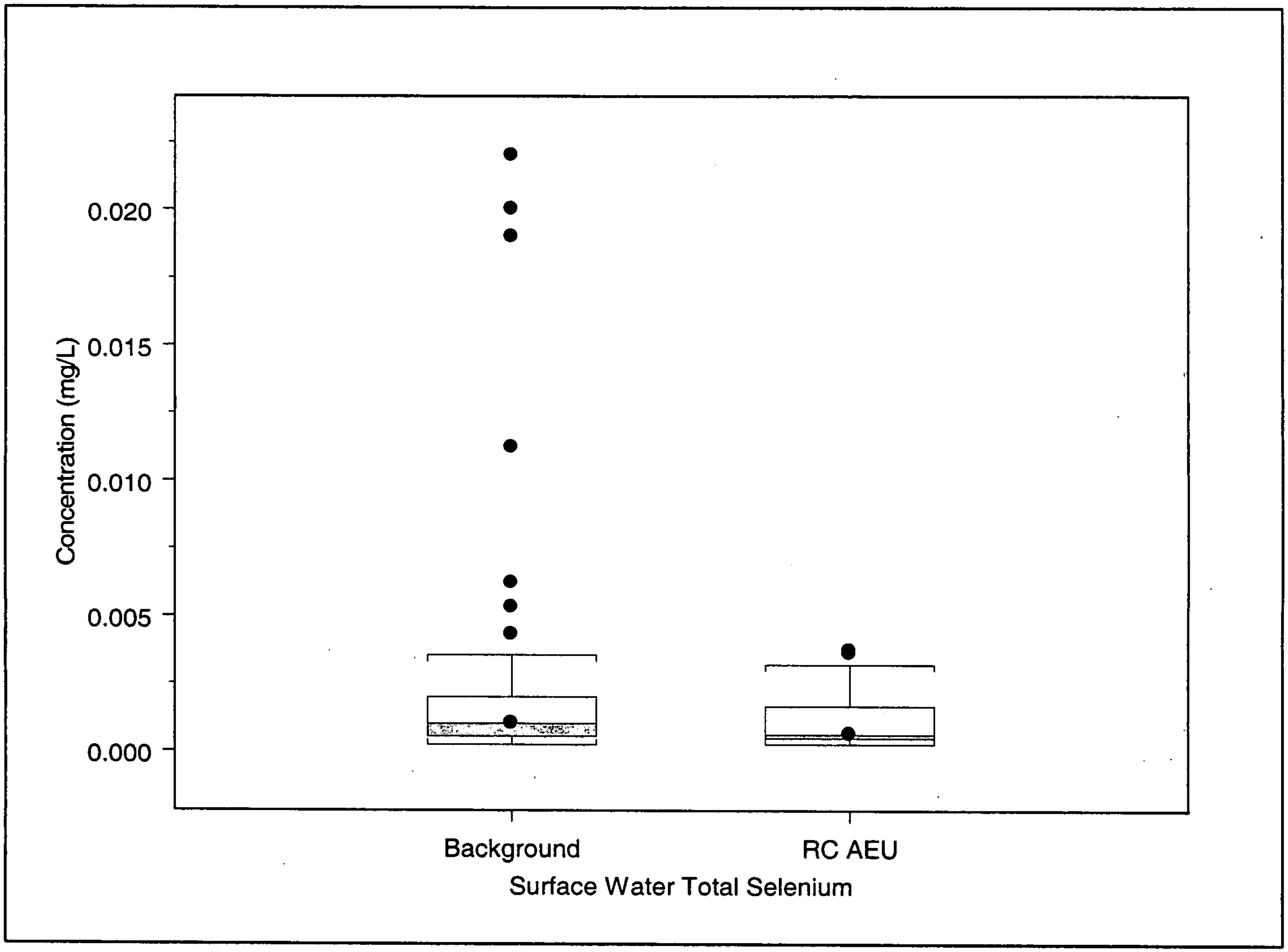
Figure A3.2.RC AEU.5
RC AEU Surface Water Total Box Plots for Lithium



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

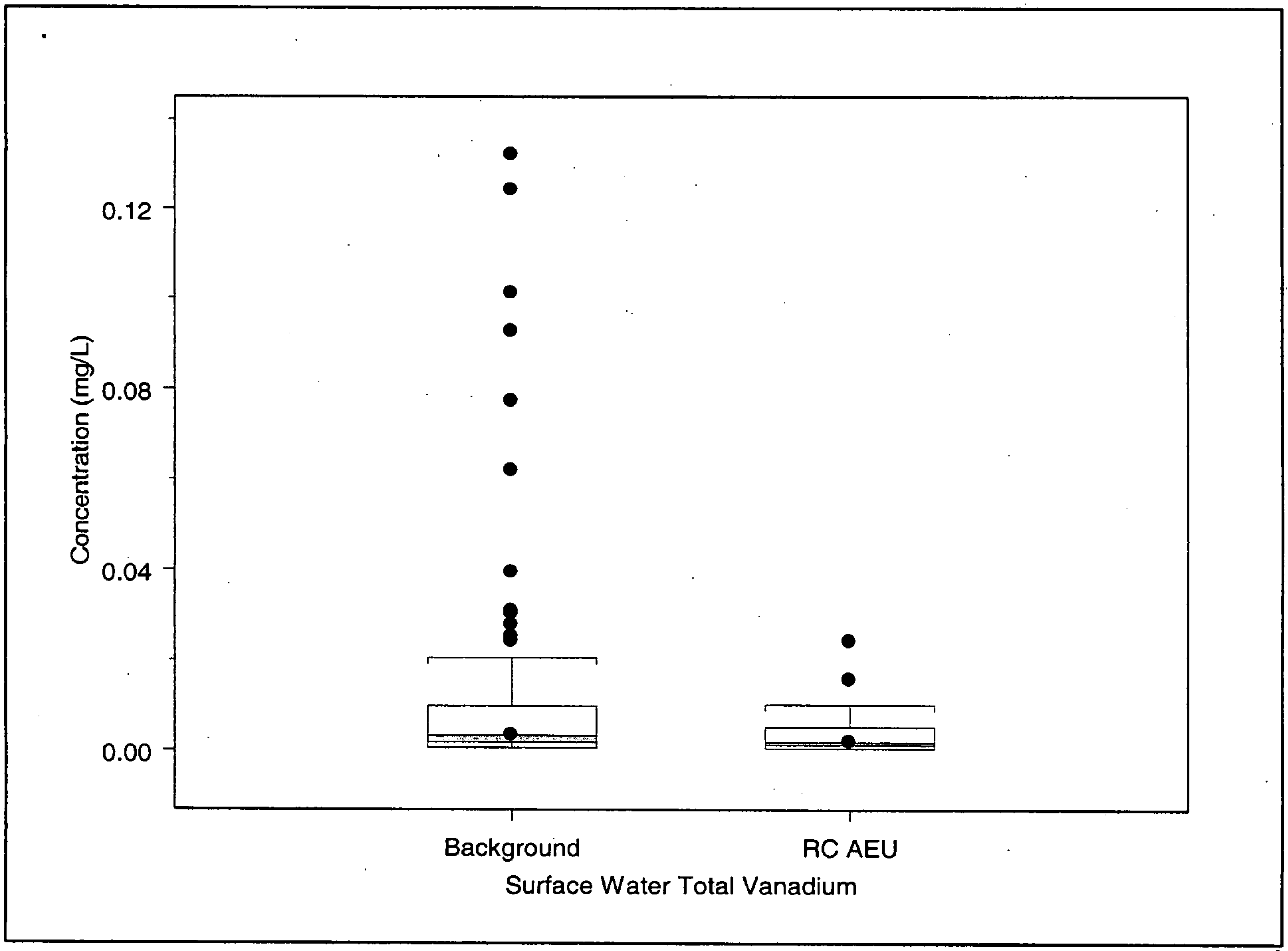
341

Figure A3.[illegible]C AEU.6
RC AEU Surface Water Total Box Plots for Selenium



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

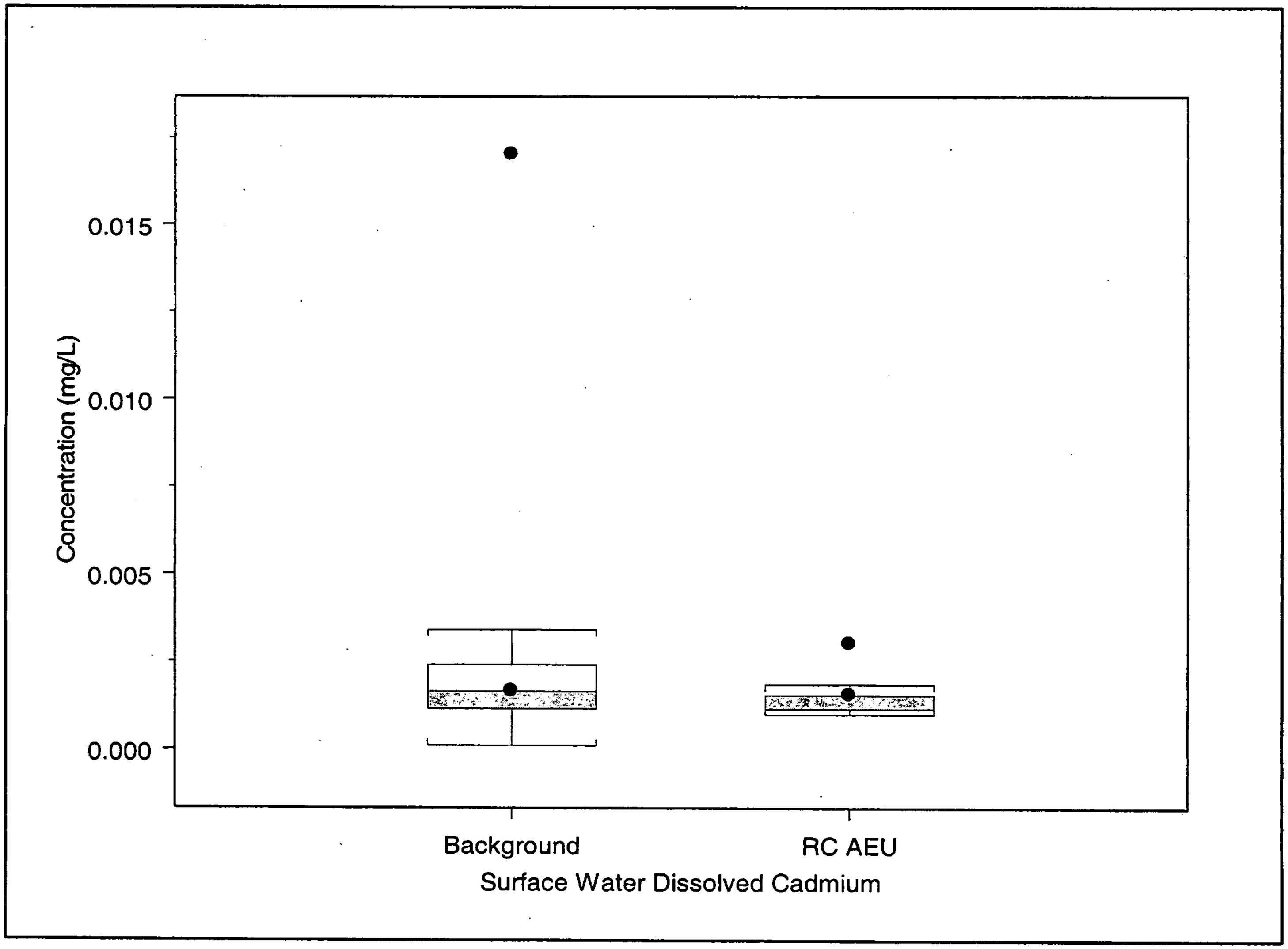
Figure A[illegible]RC AEU.7
RC AEU Surface Water Total Box Plots for Vanadium



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

343

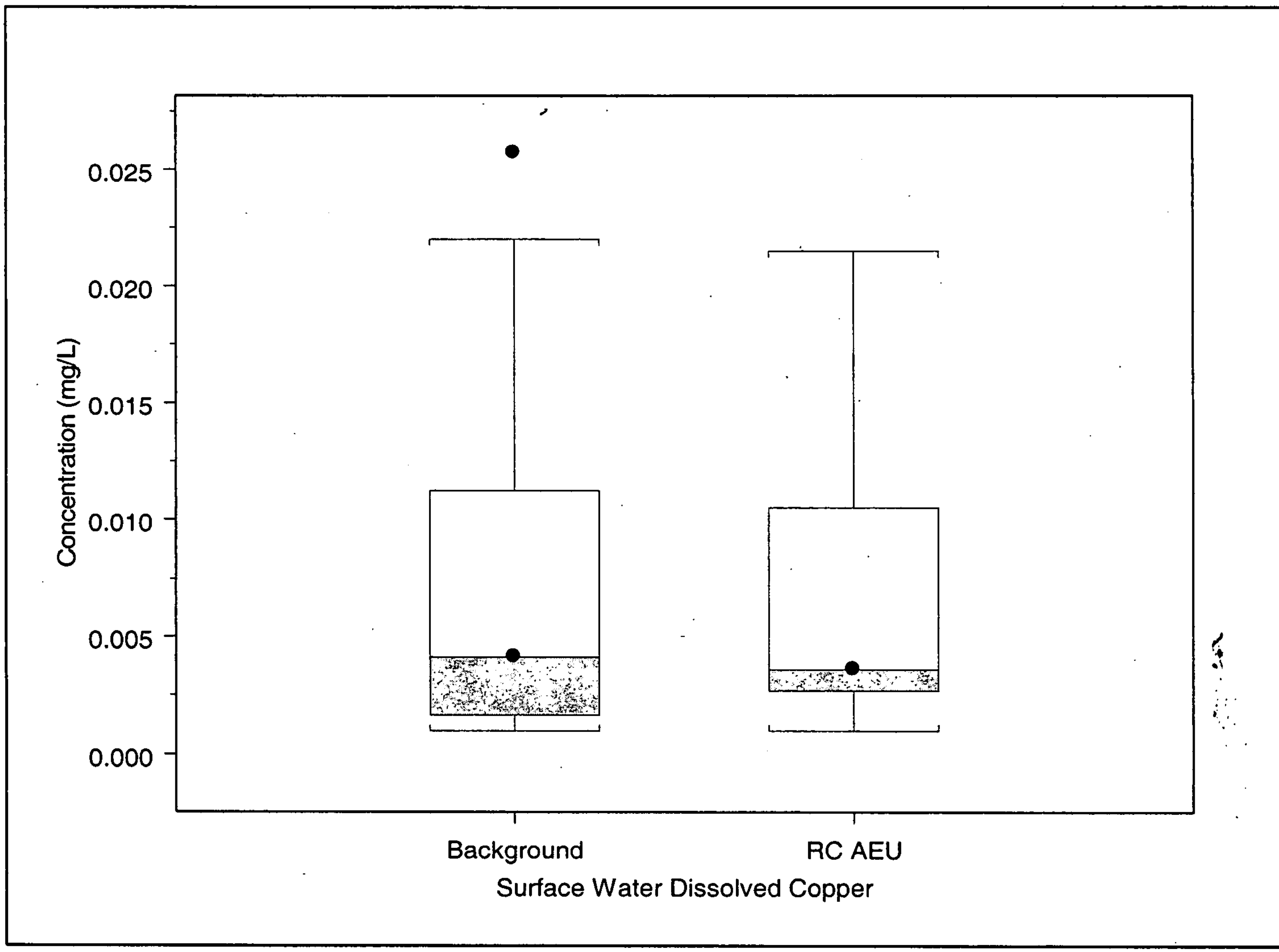
Figure A3.[illegible]C AEU.8
RC AEU Surface Water Dissolved Box Plots for Cadmium



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

344

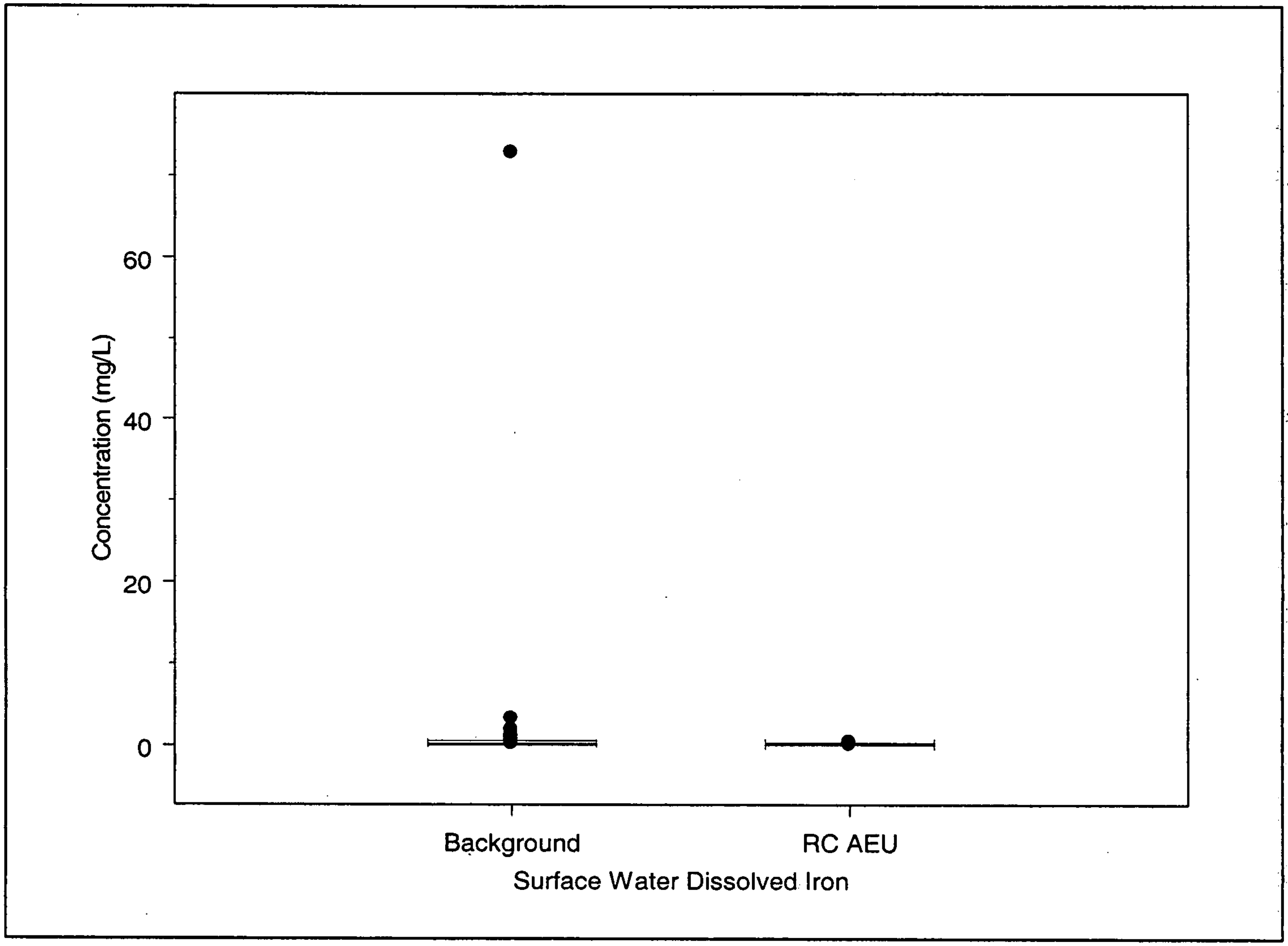
Figure A3.2.RC AEU.9
RC AEU Surface Water Dissolved Box Plots for Copper



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

345

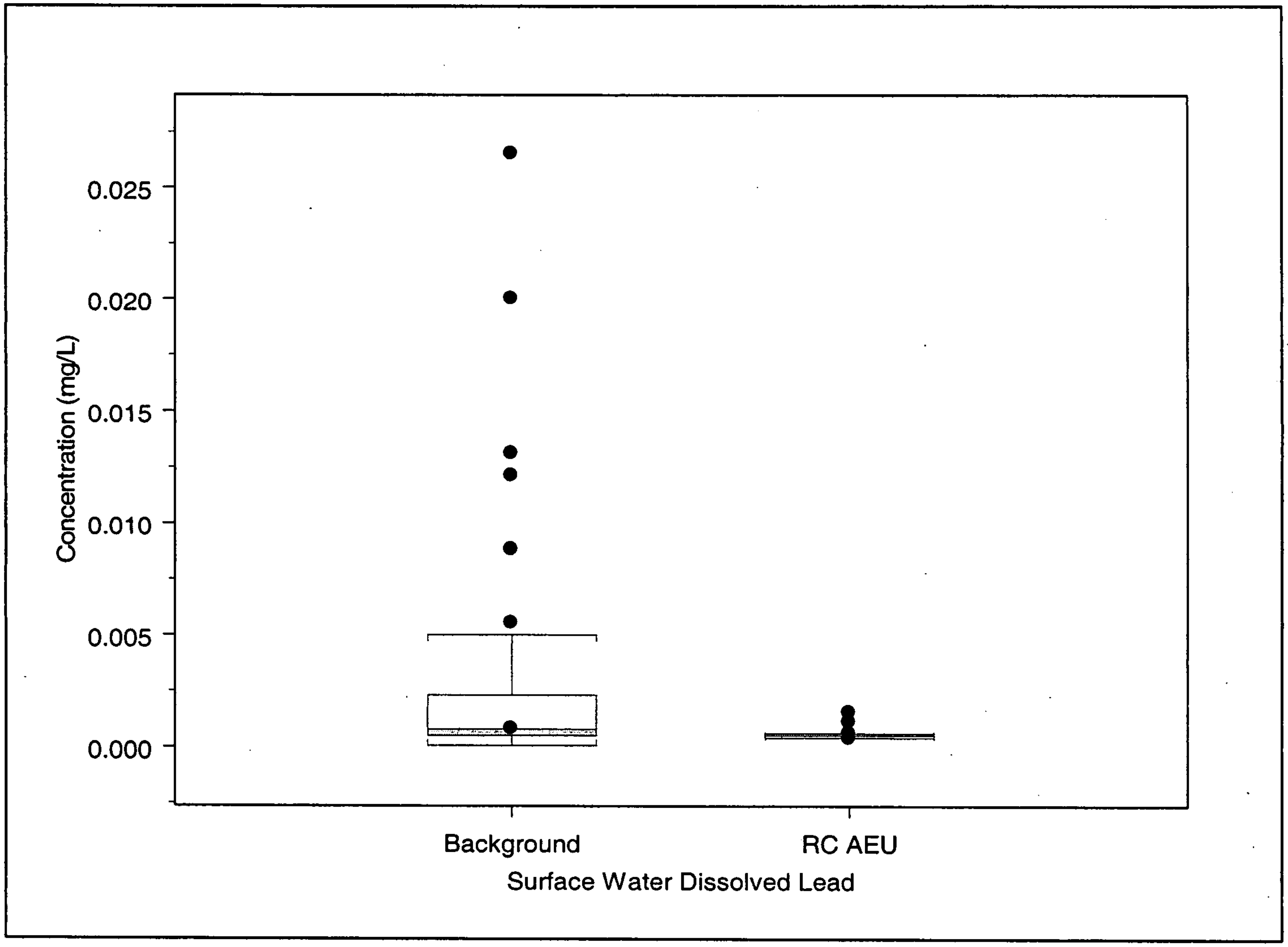
Figure A3.2.RC AEU.10
RC AEU Surface Water Dissolved Box Plots for Iron



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

346

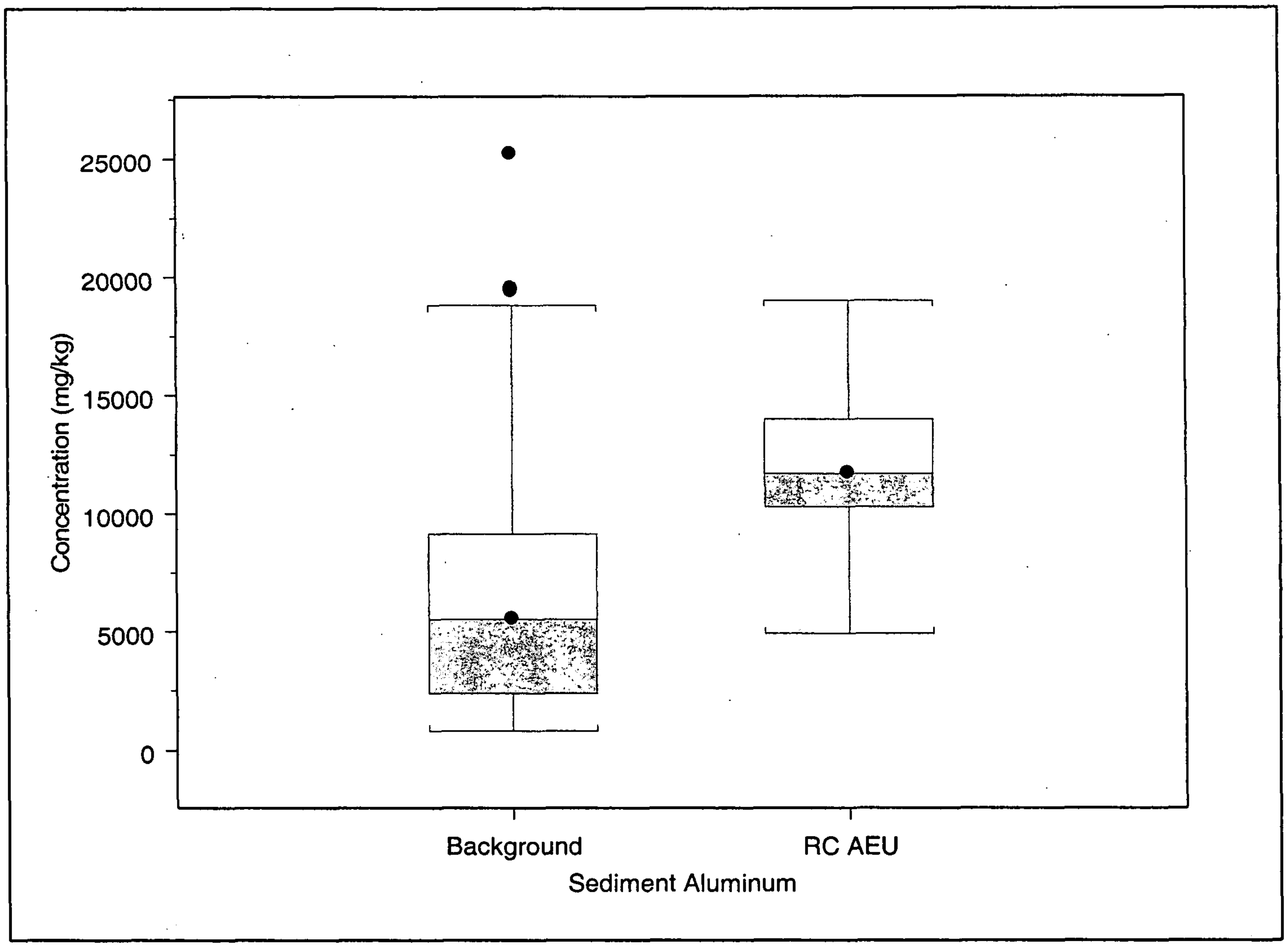
Figure A3.[illegible]C AEU.11
RC AEU Surface Water Dissolved Box Plots for Lead



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

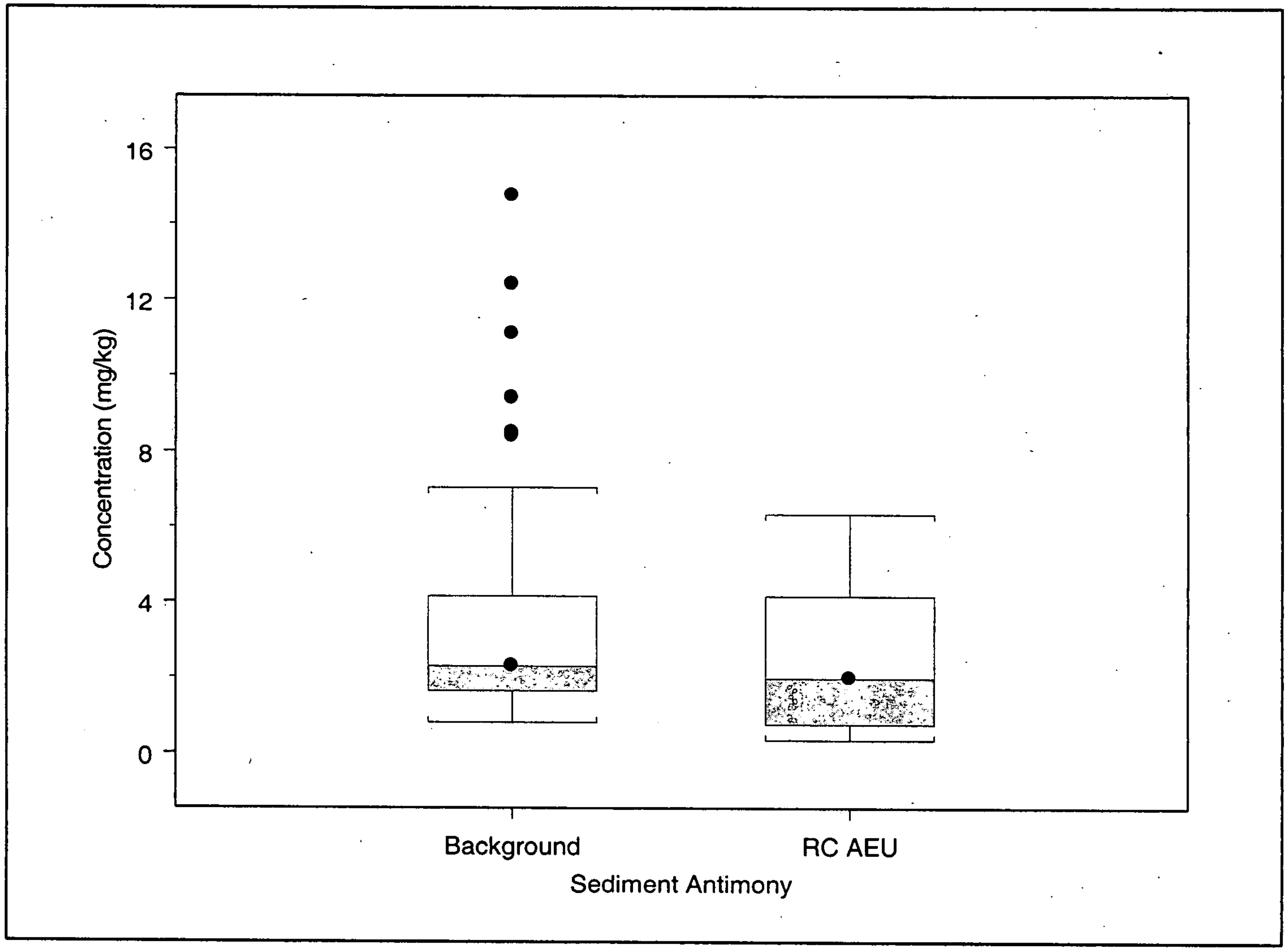
347

Figure A3[illegible]C AEU.12
RC AEU Sediment Box Plots for Aluminum



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

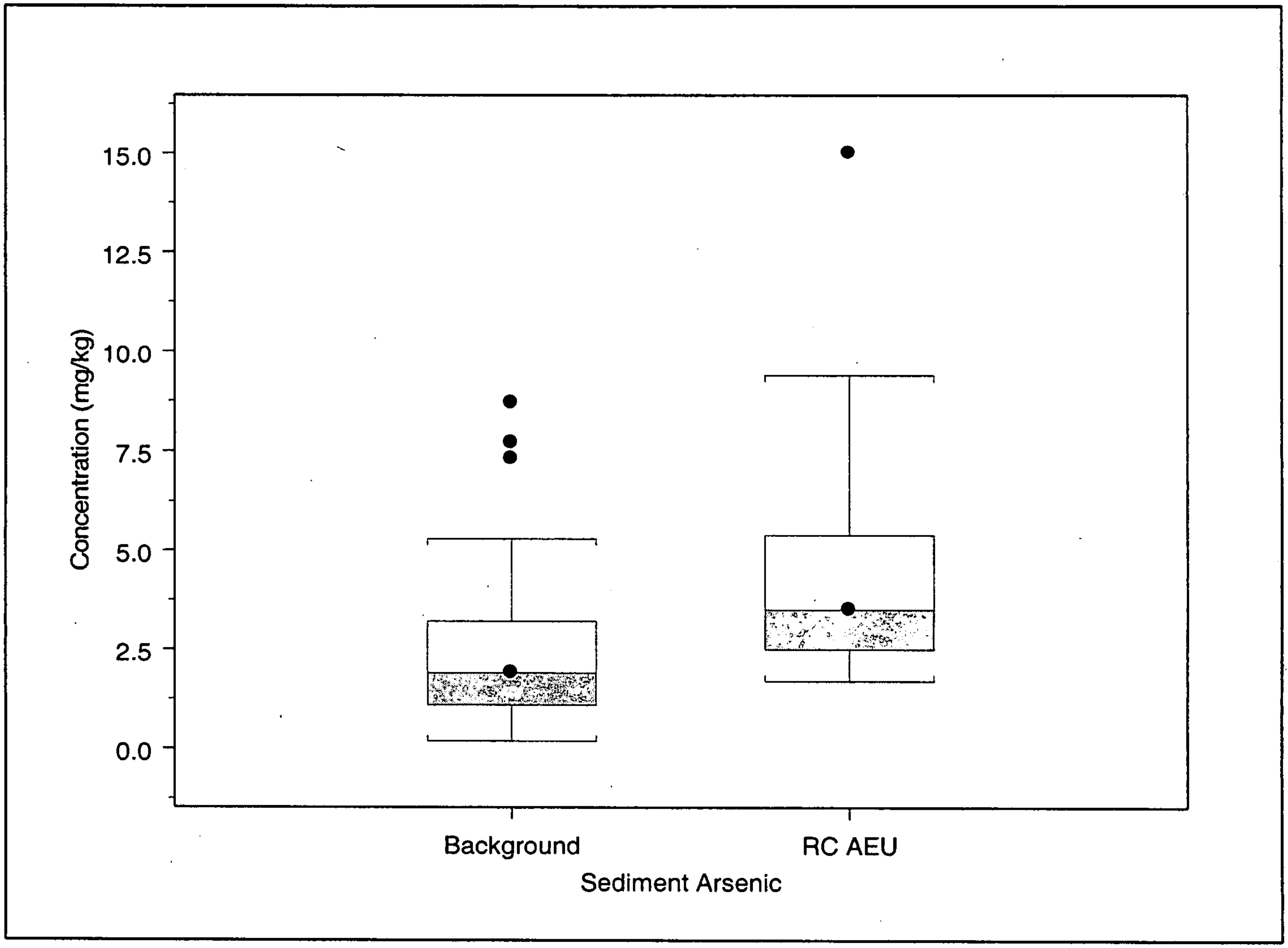
Figure A3.RC AEU.13
RC AEU Sediment Box Plots for Antimony



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

349

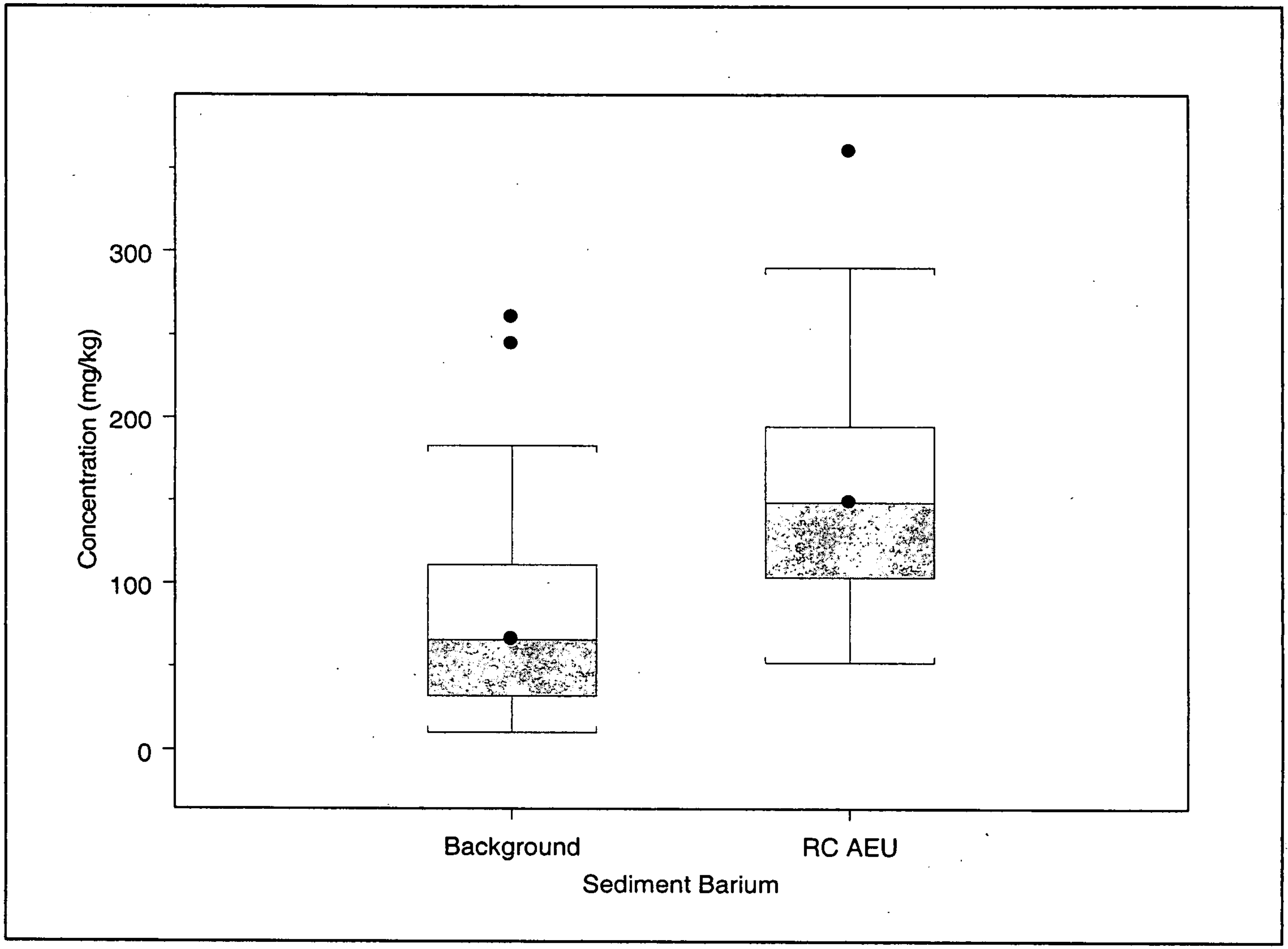
Figure A3.2.RC AEU.14
RC AEU Sediment Box Plots for Arsenic



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

350

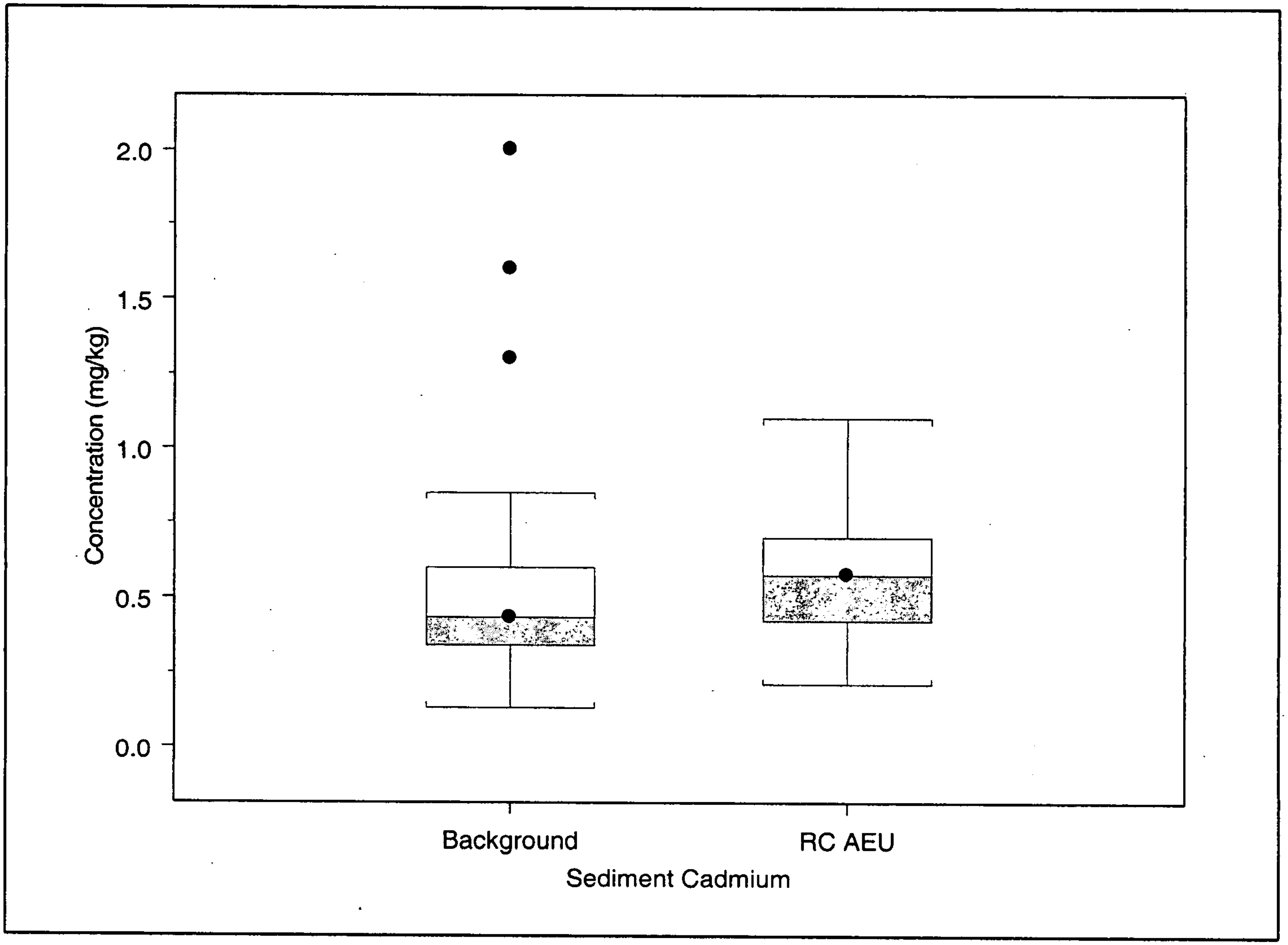
Figure A3.2.RC AEU.15
RC AEU Sediment Box Plots for Barium



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

351

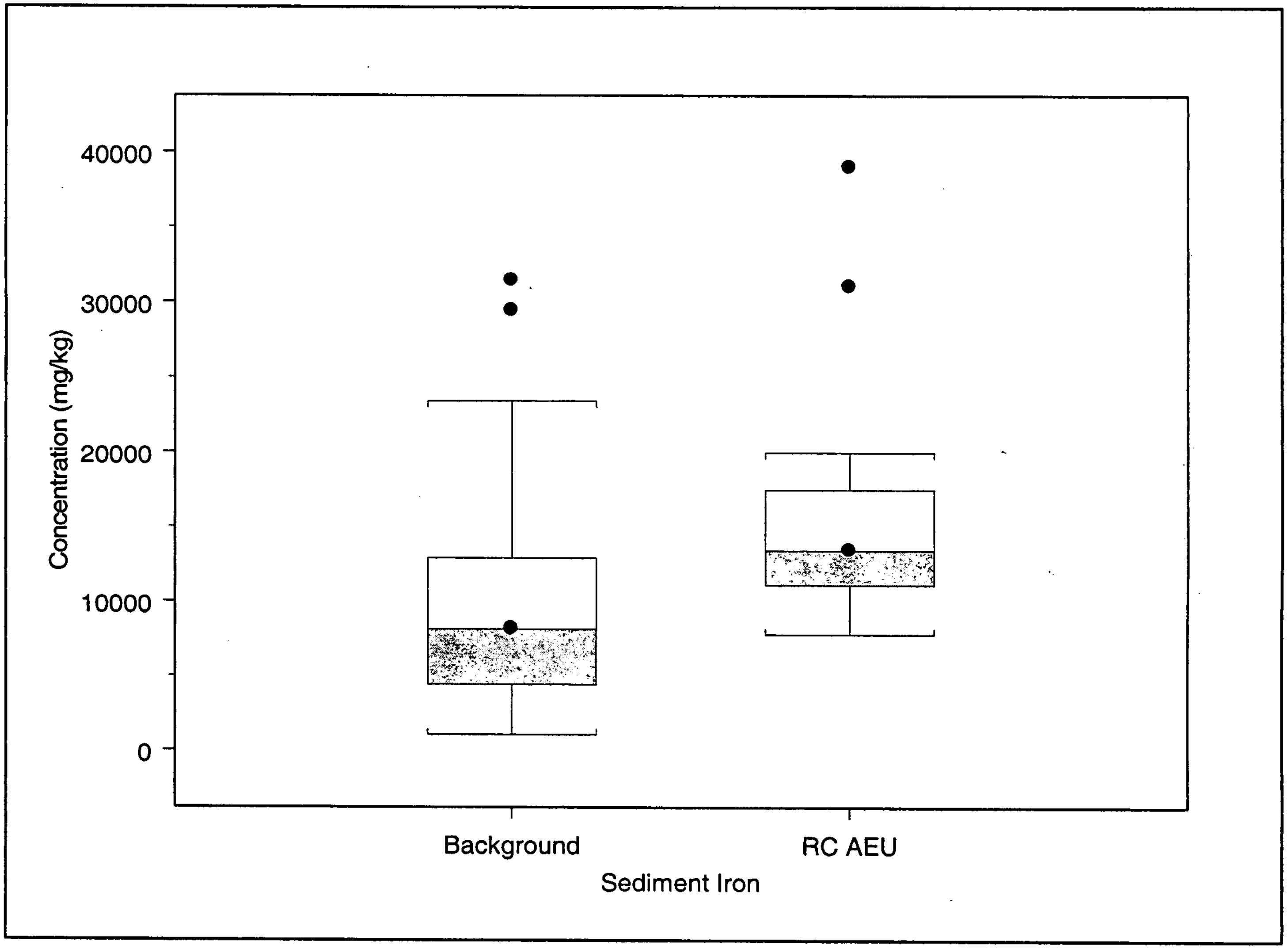
Figure A3.[illegible]C AEU.16
RC AEU Sediment Box Plots for Cadmium



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

352

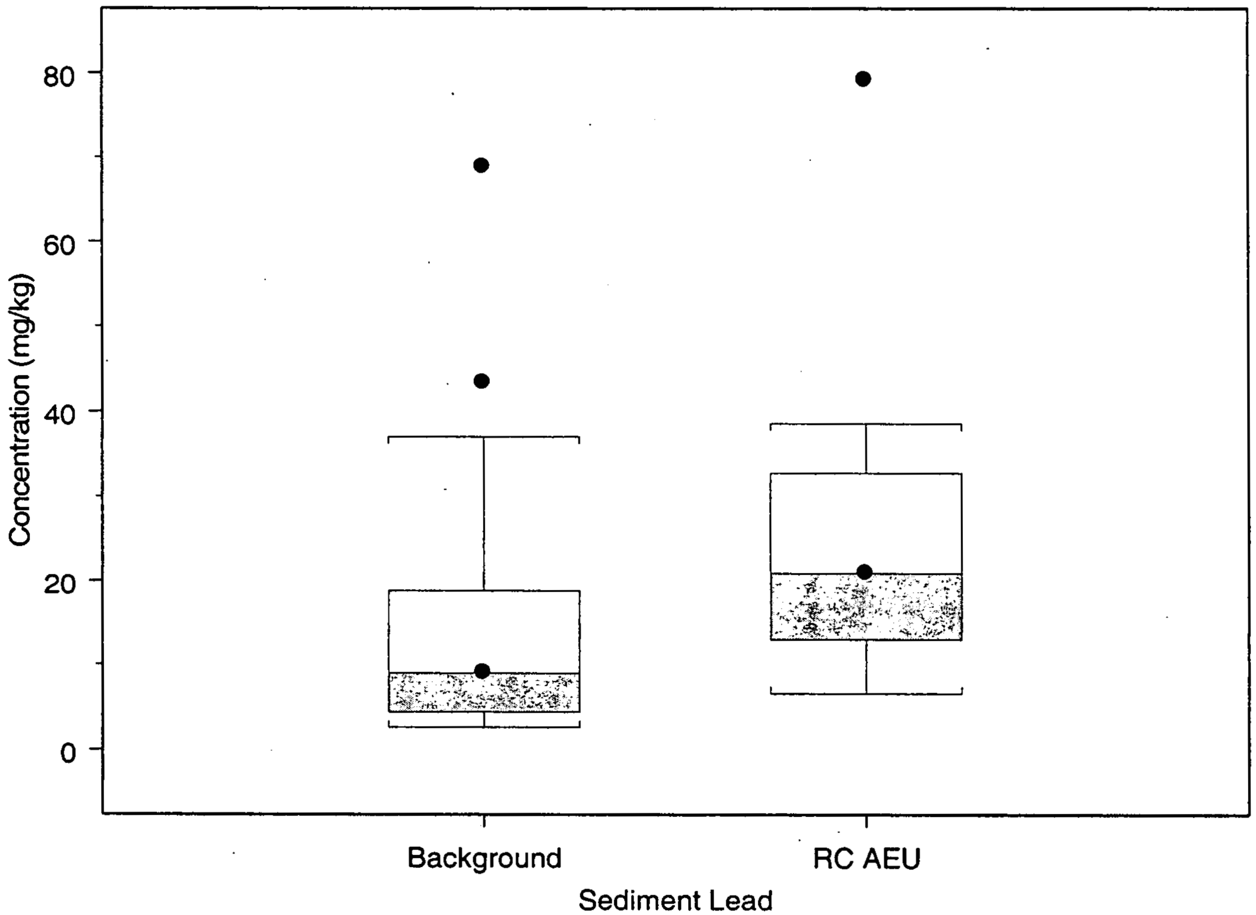
Figure A3.[illegible]C AEU.17
RC AEU Sediment Box Plots for Iron



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

353

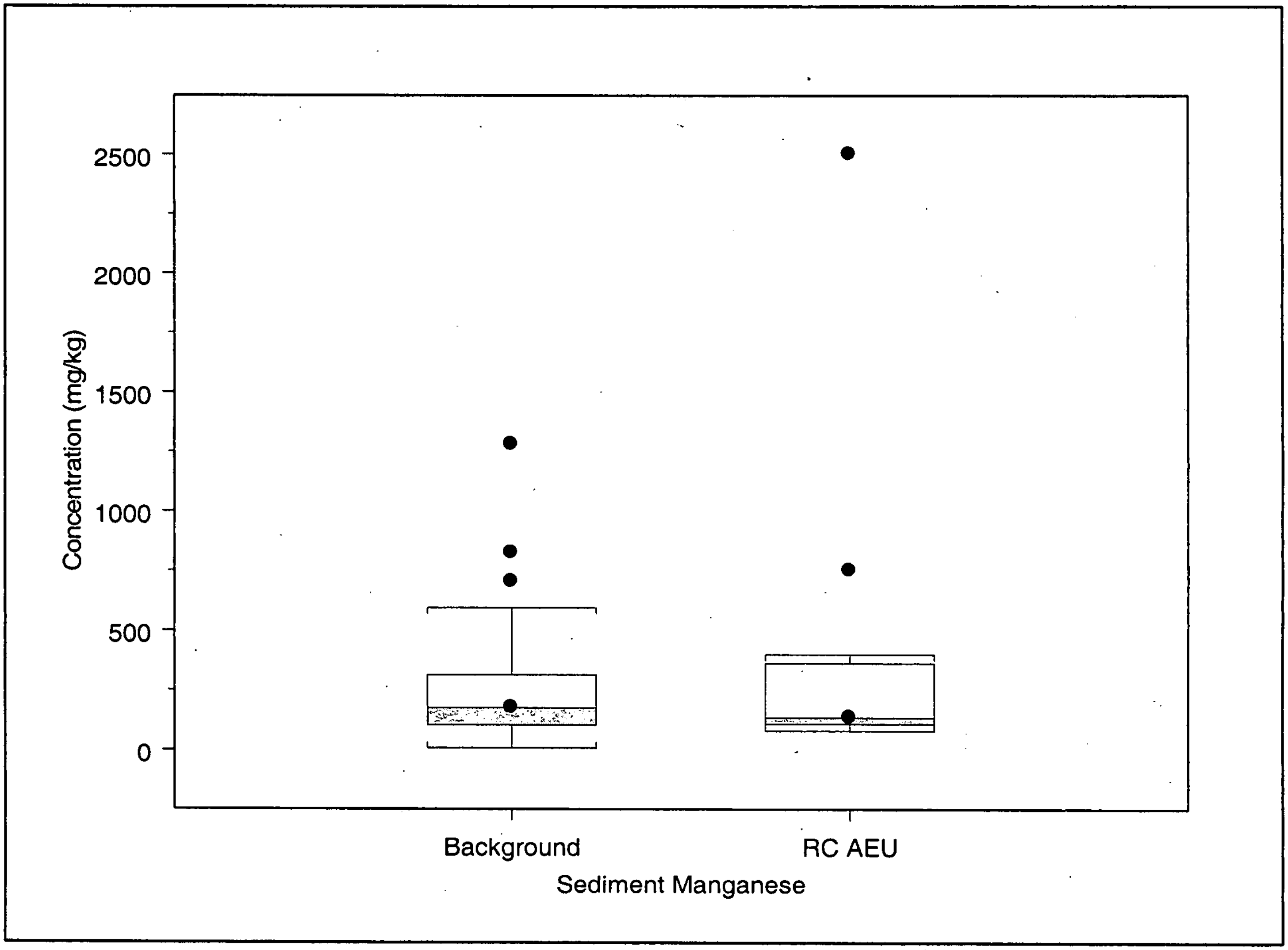
Figure A3.[illegible]C AEU.18
RC AEU Sediment Box Plots for Lead



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

354

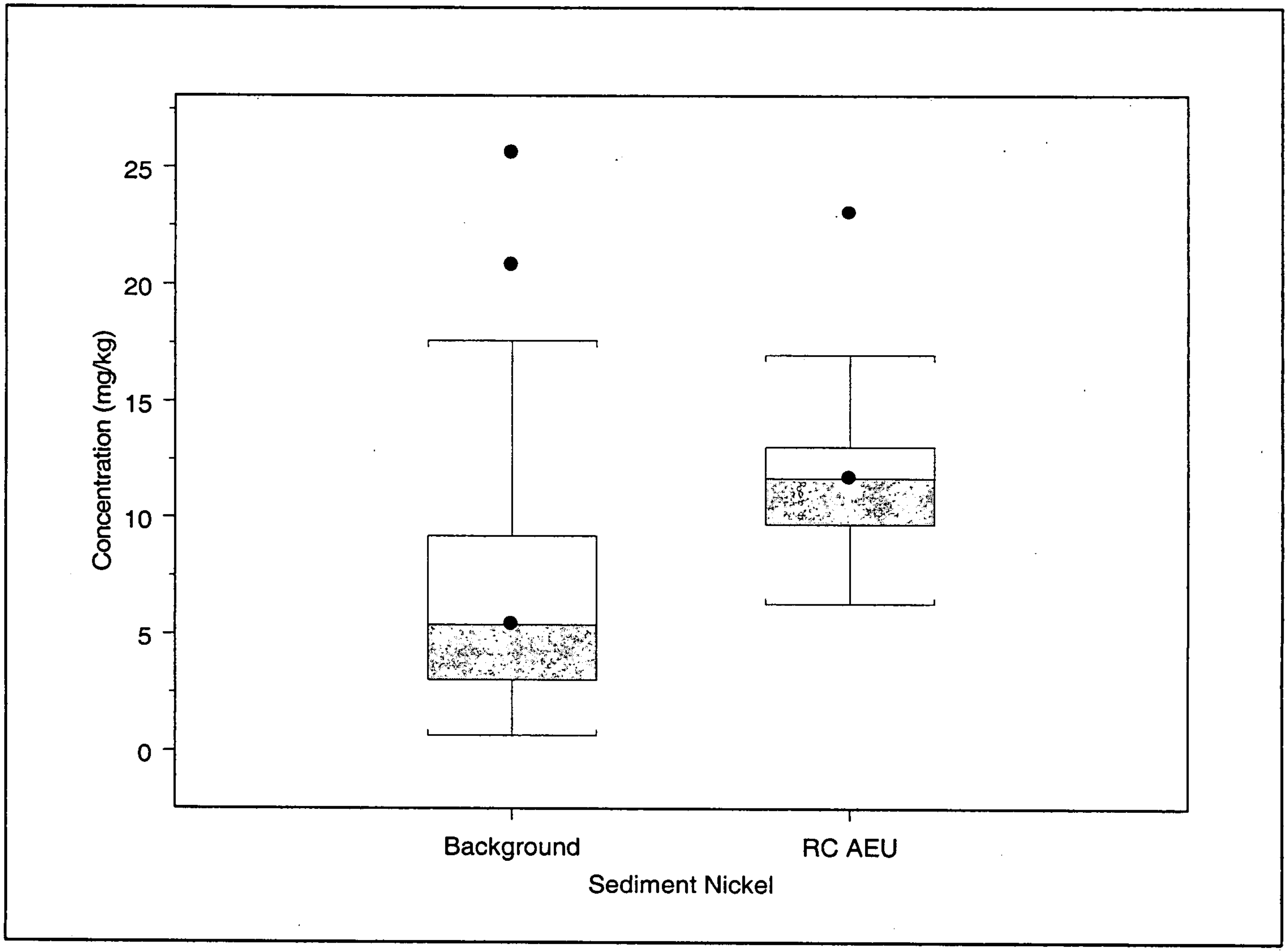
Figure A3.2.RC AEU.19
RC AEU Sediment Box Plots for Manganese



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

355

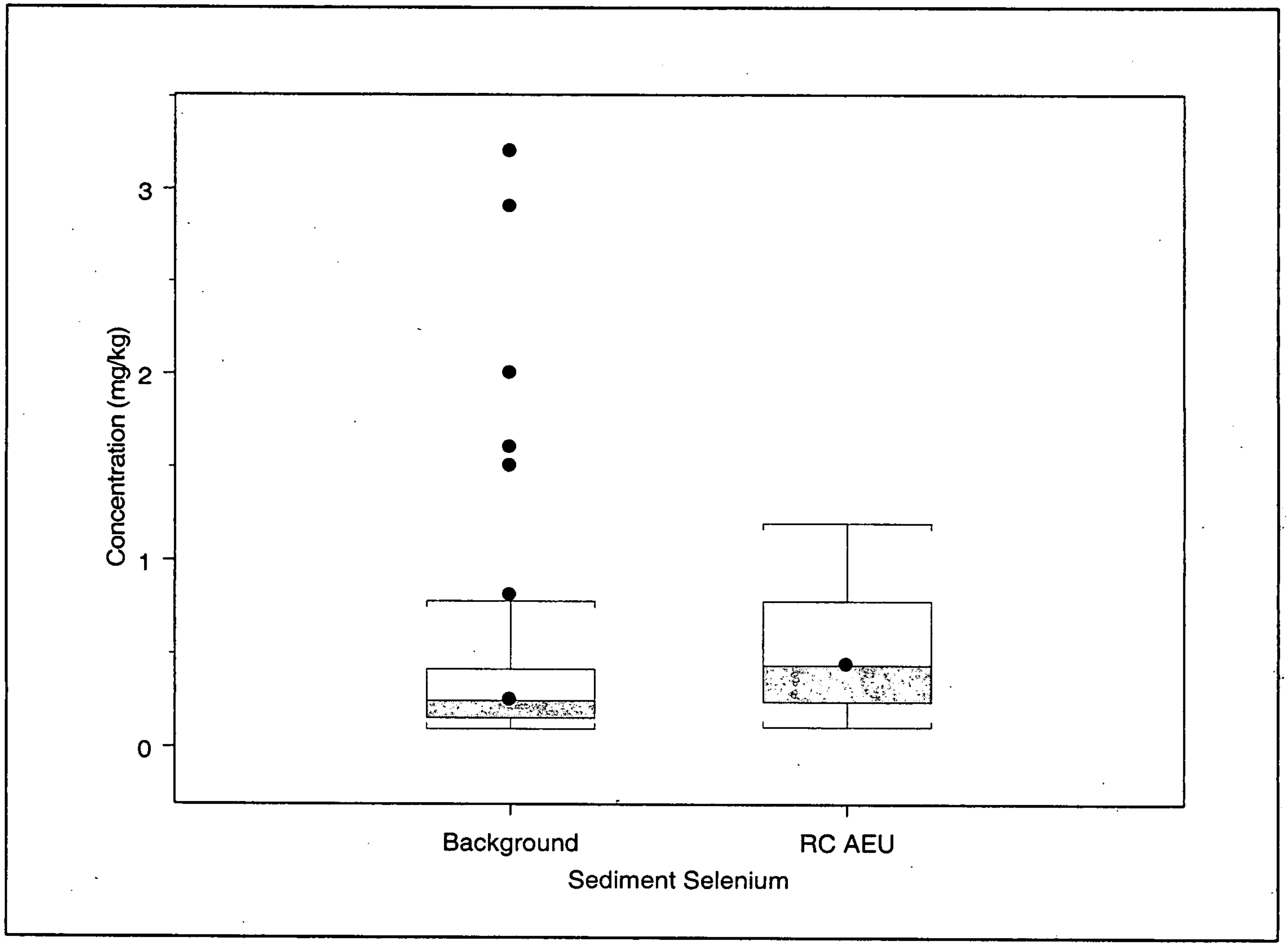
Figure A3.2.RC AEU.20
RC AEU Sediment Box Plots for Nickel



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

356

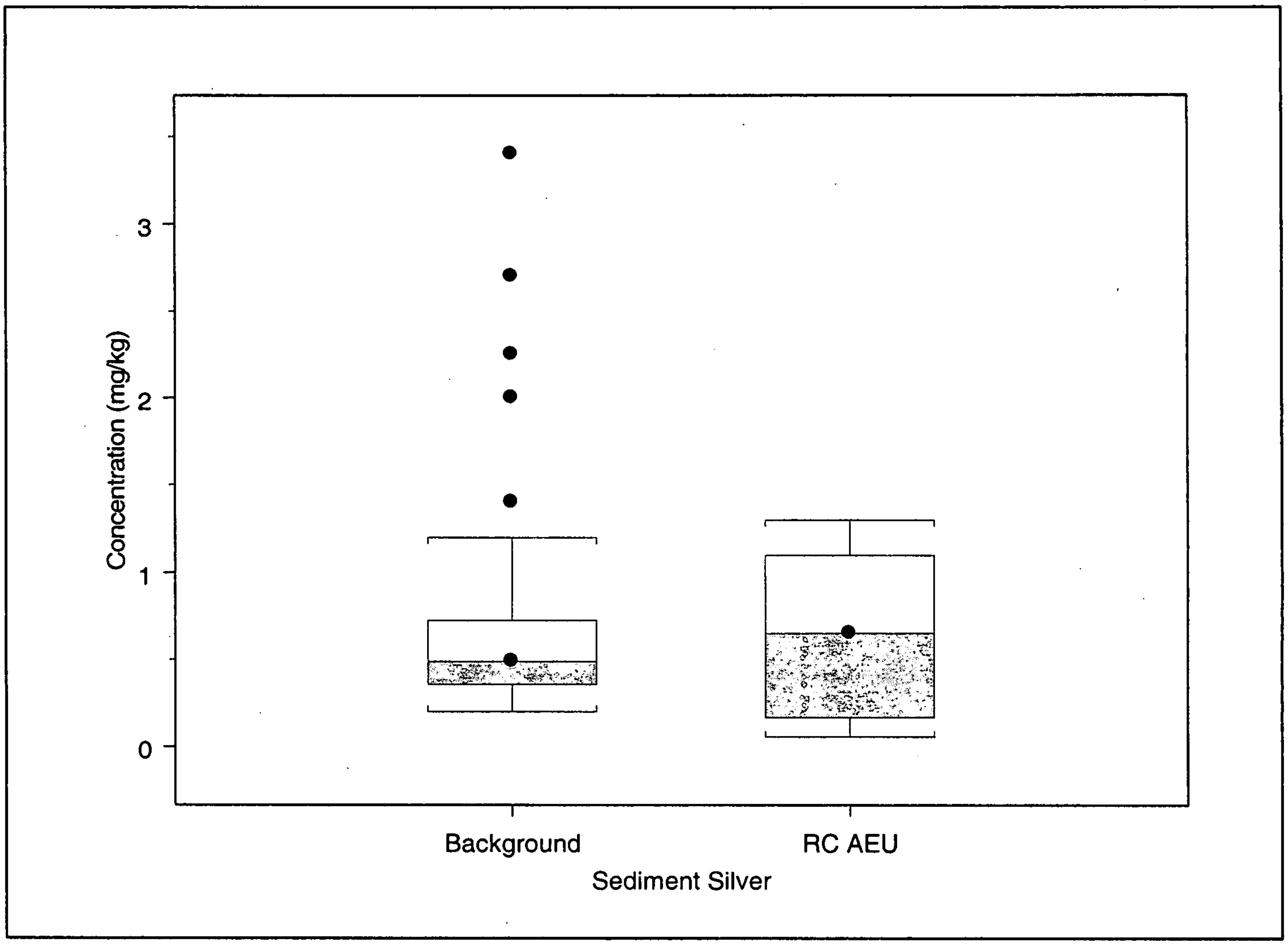
Figure A3.2.RC AEU.21
RC AEU Sediment Box Plots for Selenium



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

357

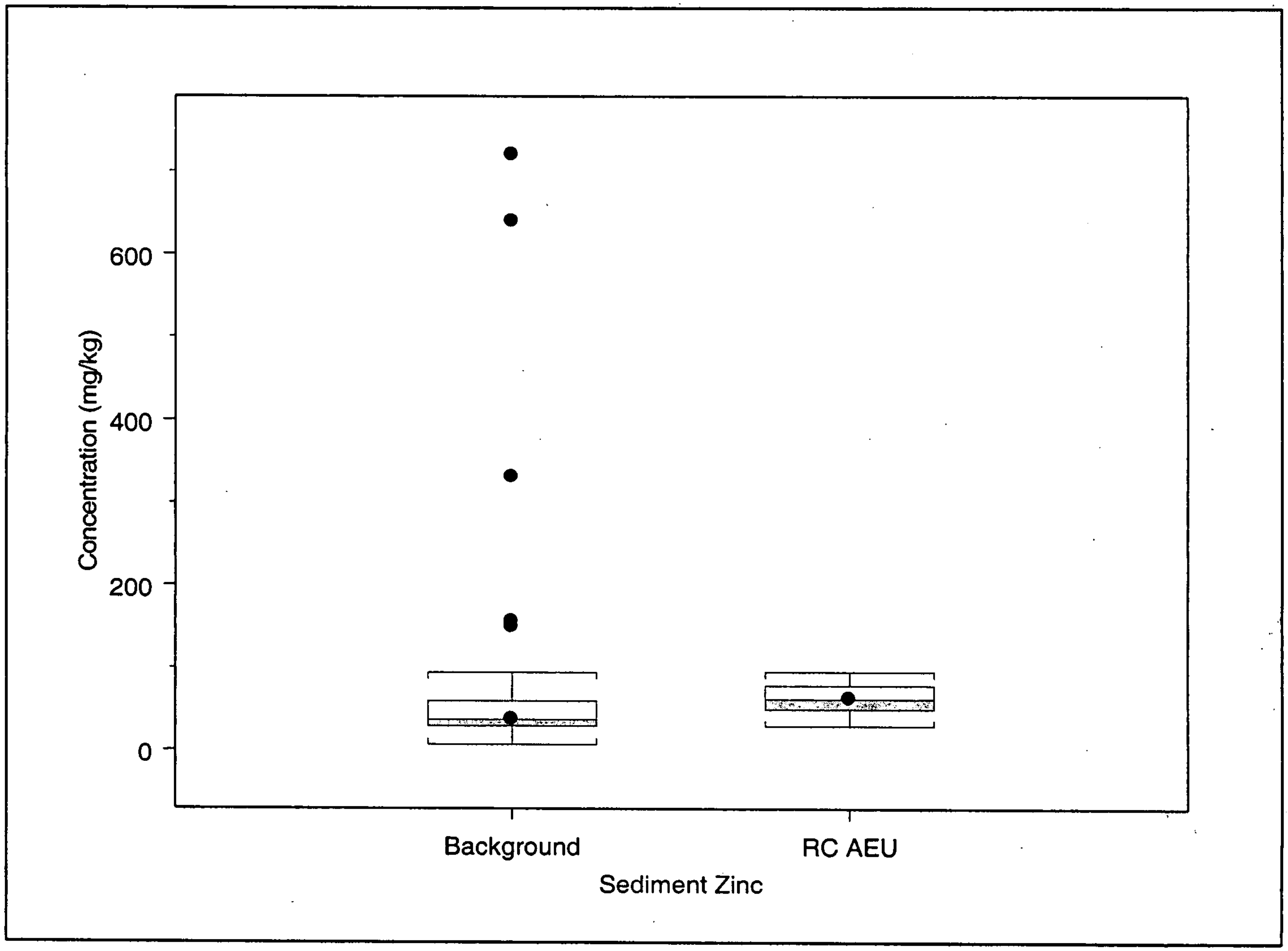
Figure A3.2[illegible]C AEU.22
RC AEU Sediment Box Plots for Silver



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

358

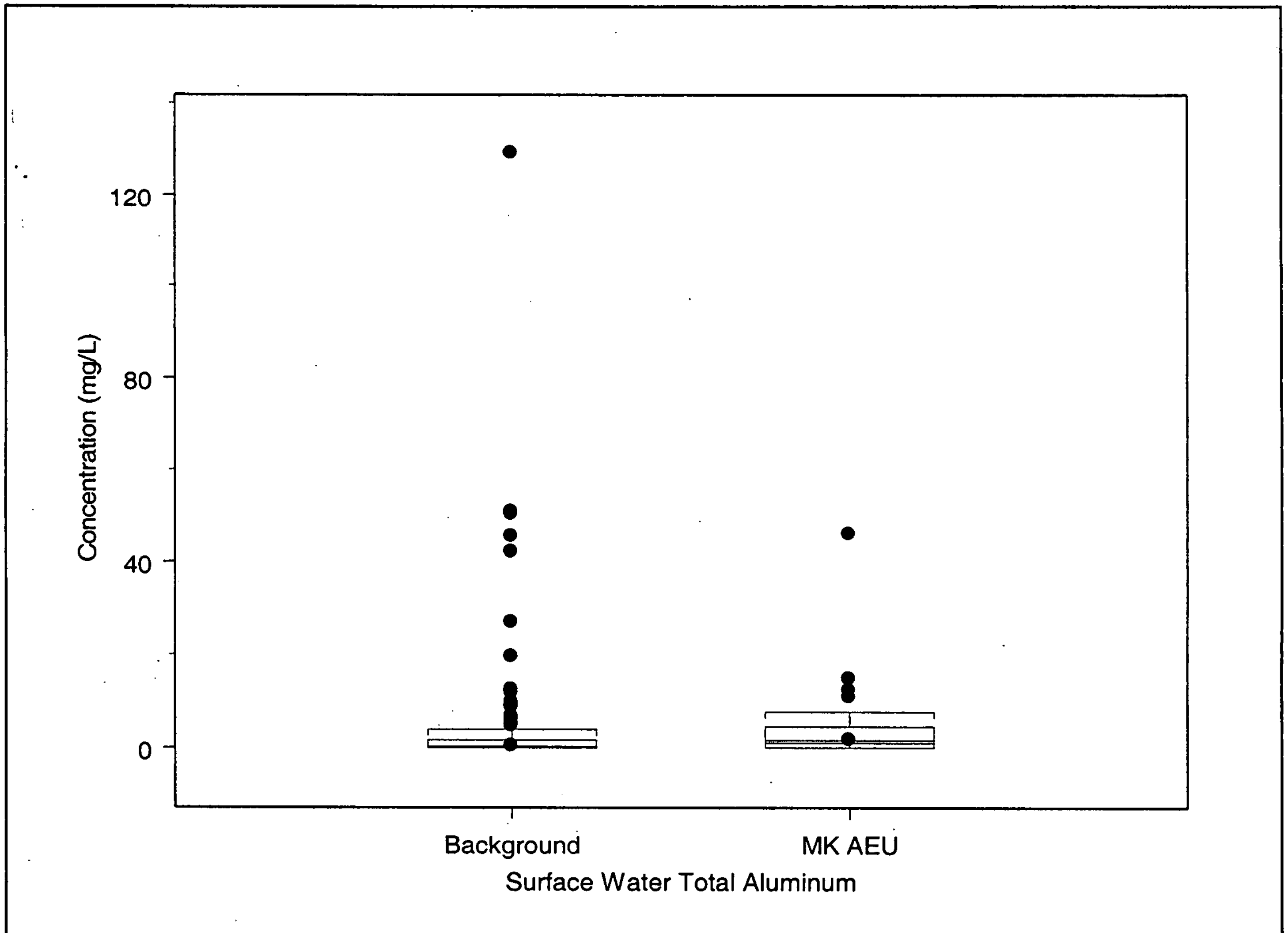
Figure A3.2.RC AEU.23
RC AEU Sediment Box Plots for Zinc



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

359

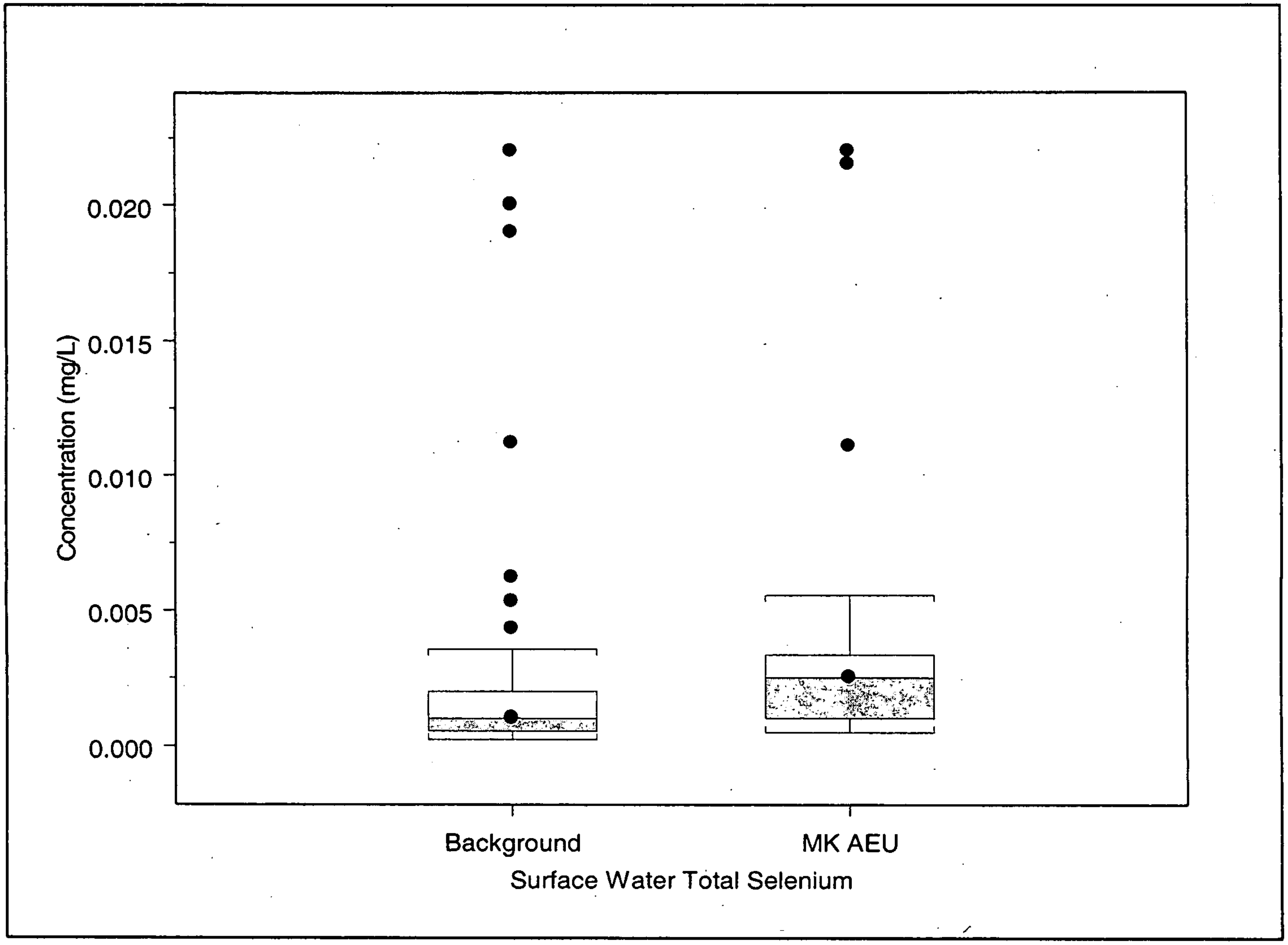
Figure A3.2.MK AEU.1
MK AEU Surface Water Total Box Plots for Aluminum



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

360

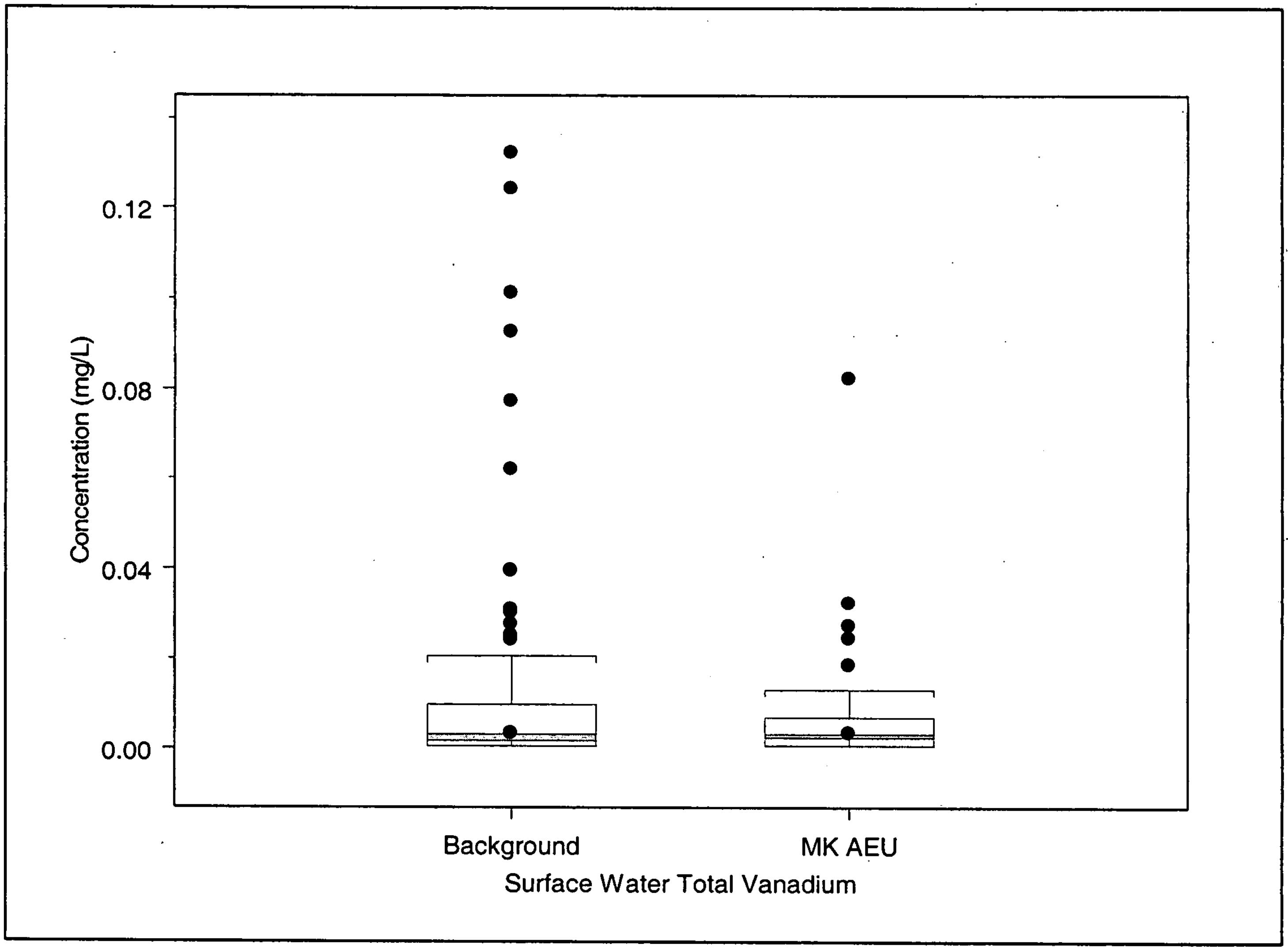
Figure A3.2.MK AEU.2
MK AEU Surface Water Total Box Plots for Selenium



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

361

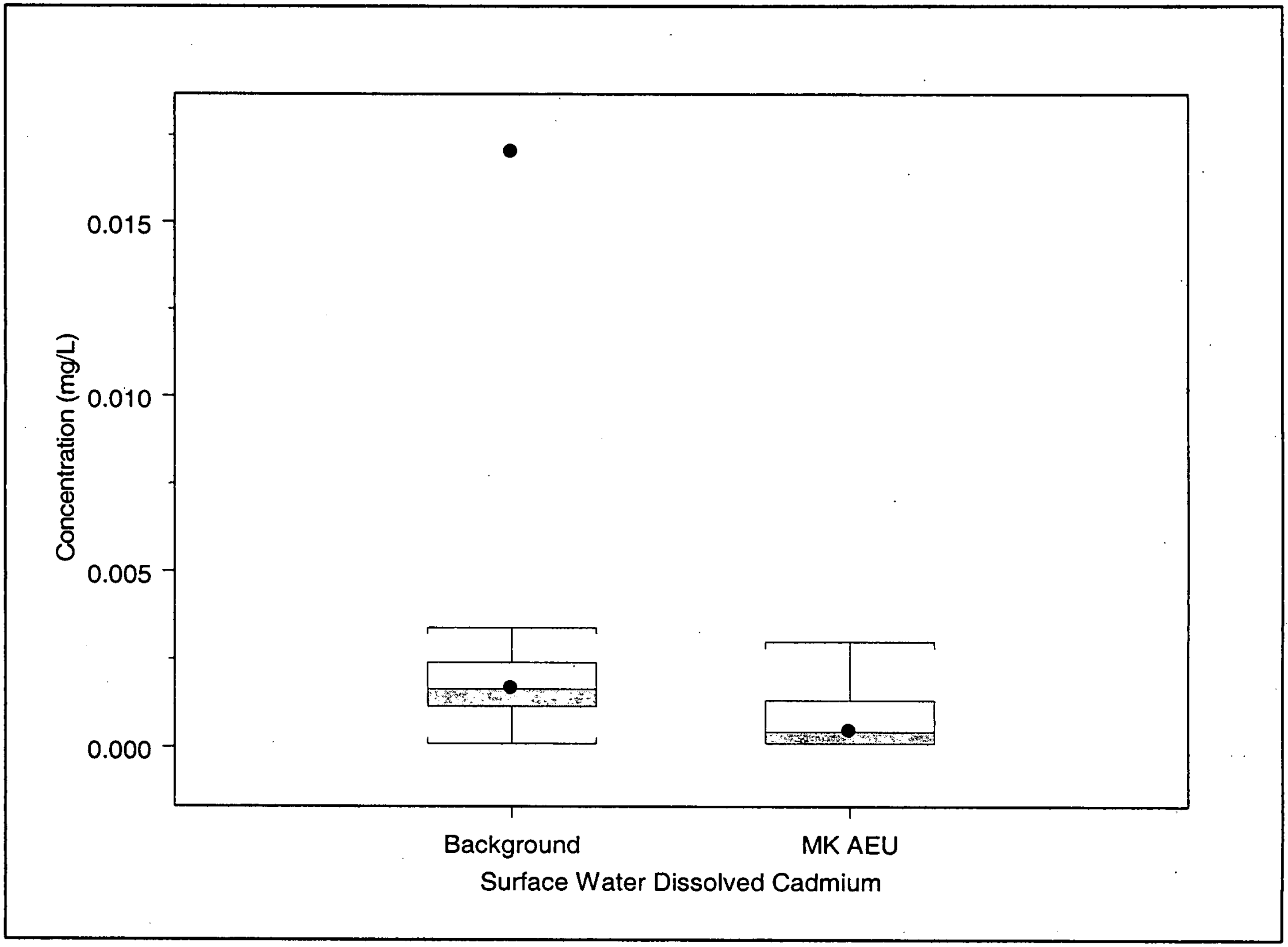
Figure A3.[illegible]K AEU.3
MK AEU Surface Water Total Box Plots for Vanadium



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

362

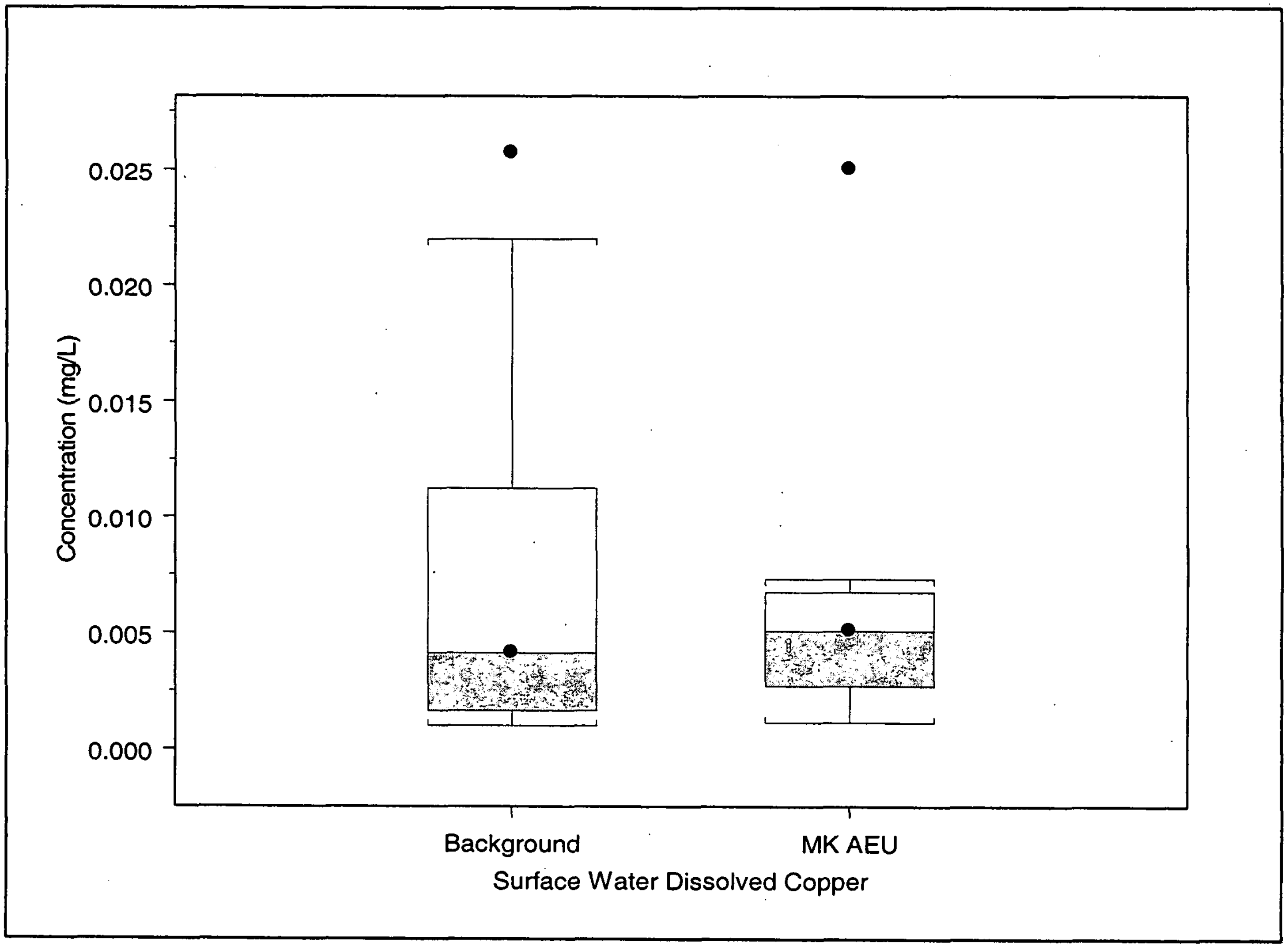
Figure A3.[illegible]K AEU.4
MK AEU Surface Water Dissolved Box Plots for Cadmium



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

363

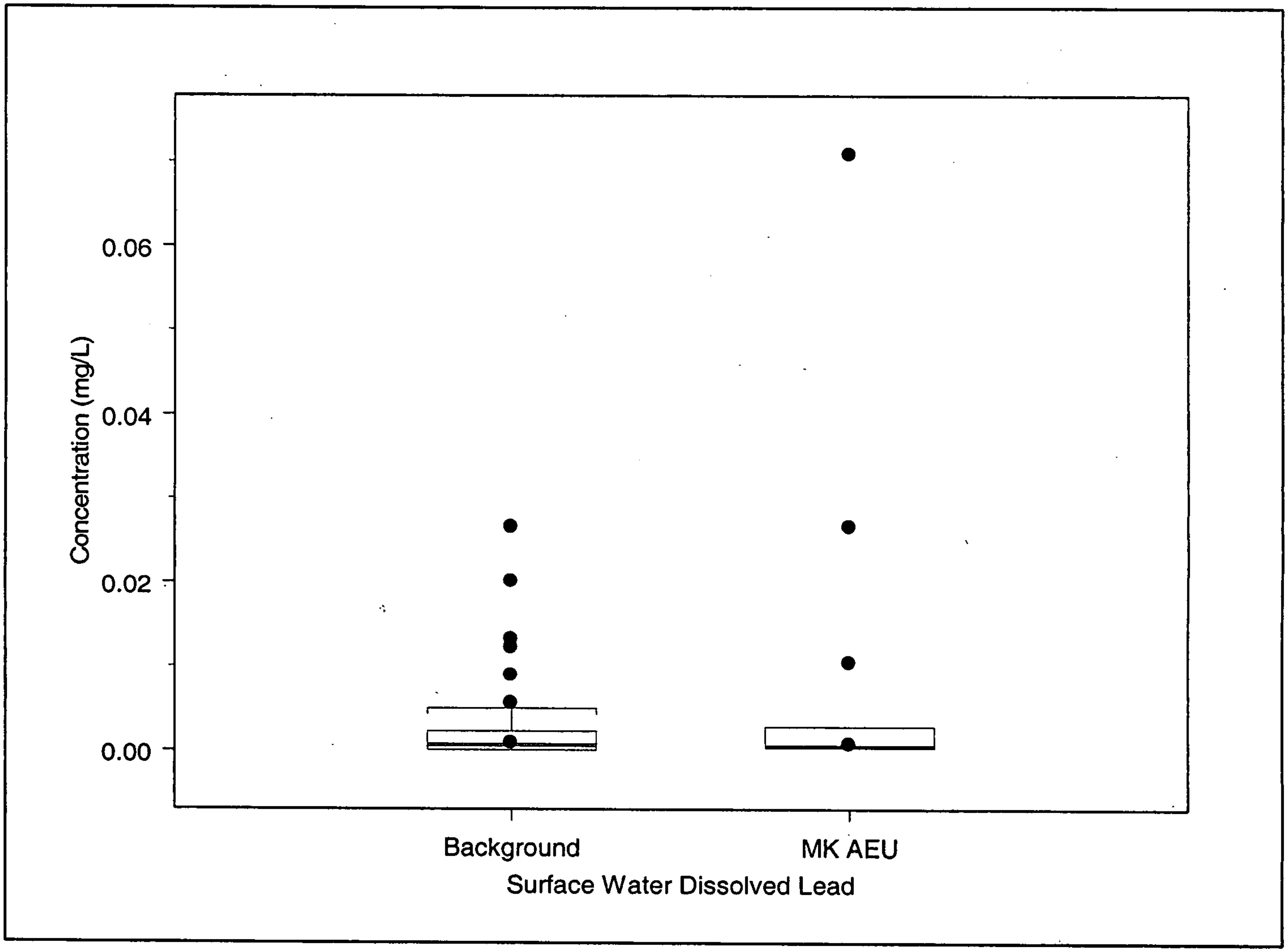
Figure A3.2.MK AEU.5
MK AEU Surface Water Dissolved Box Plots for Copper



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

364

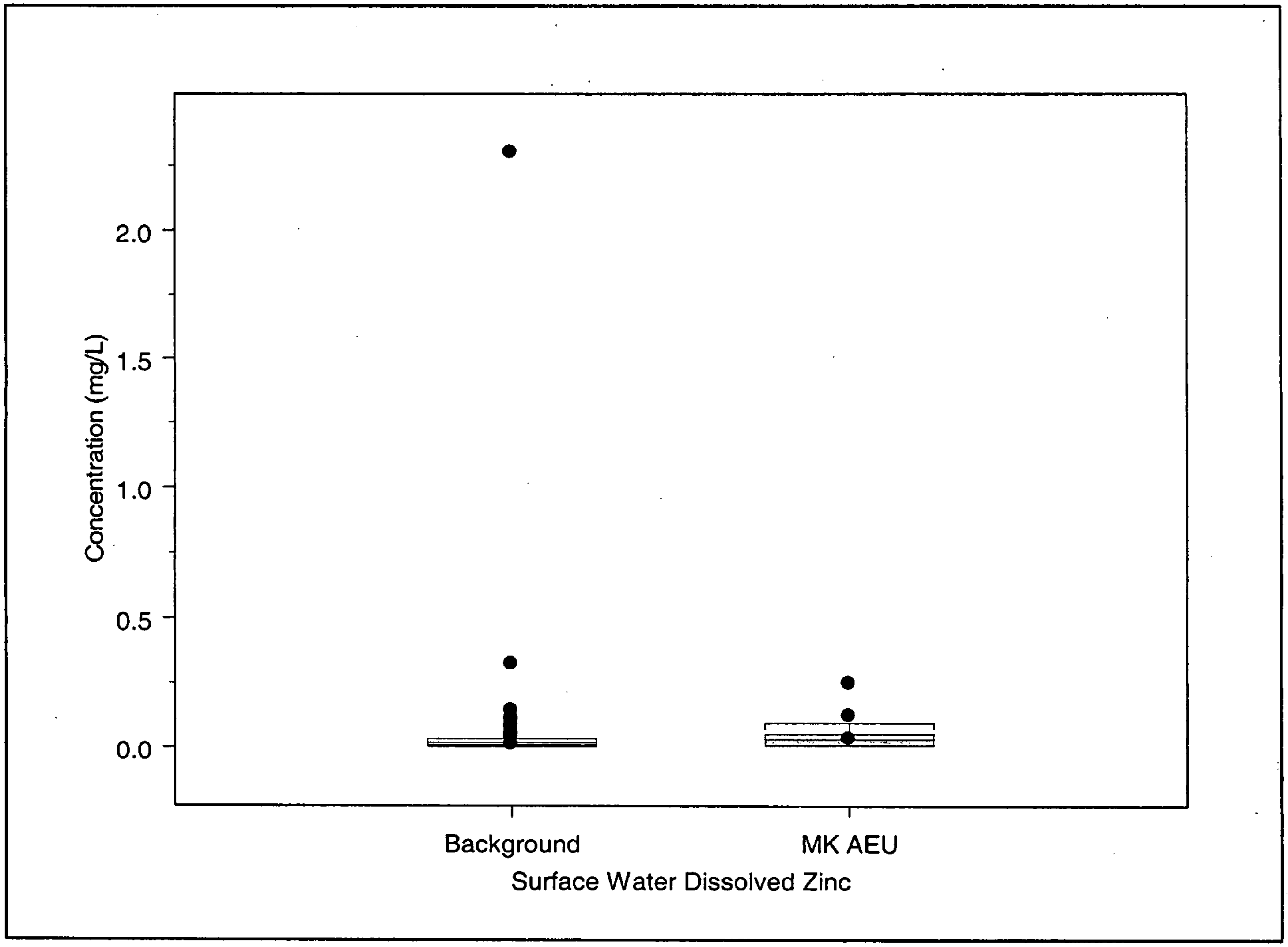
Figure A3.[illegible]MK AEU.6
MK AEU Surface Water Dissolved Box Plots for Lead



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

365

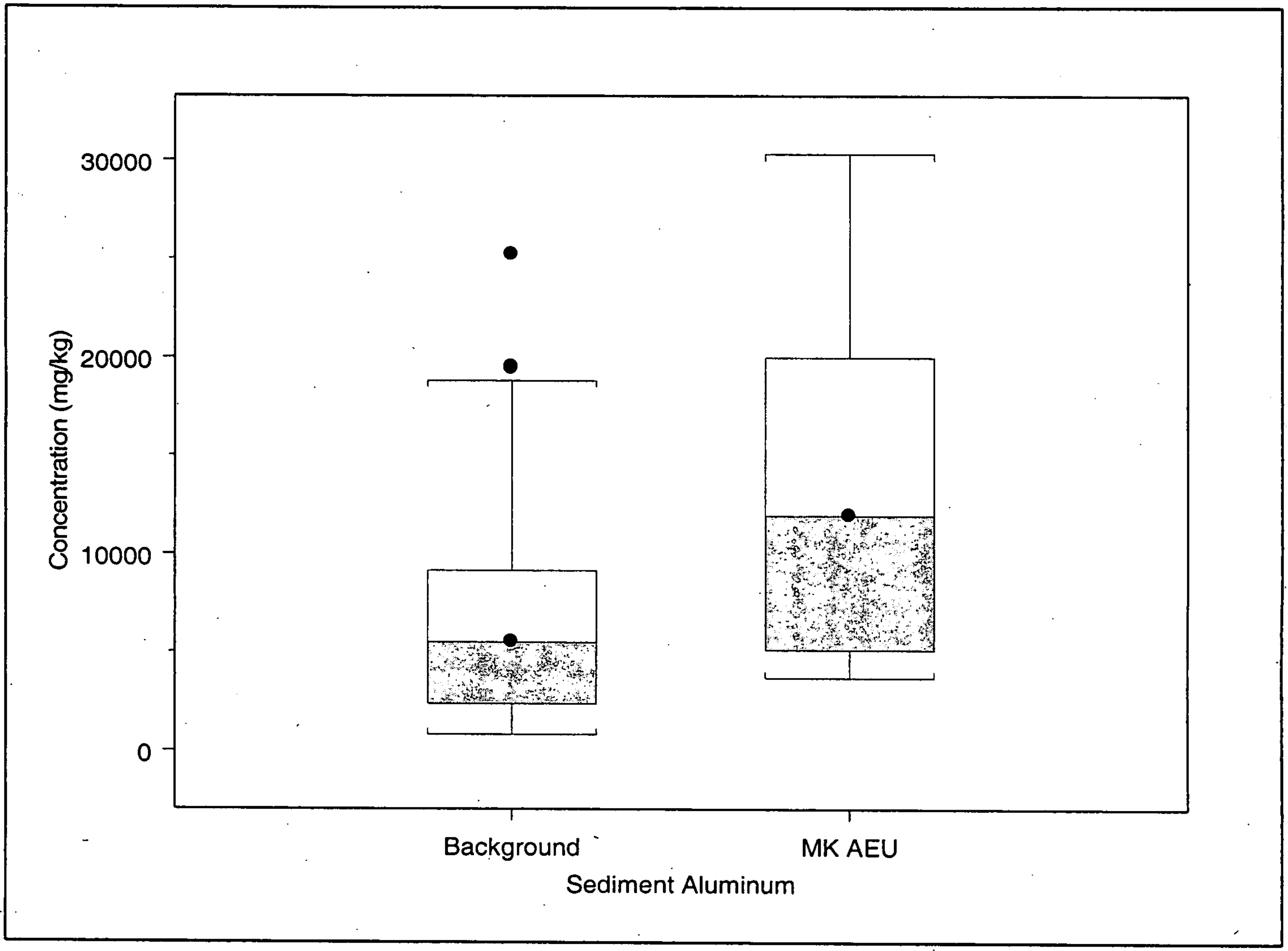
Figure A3.2.MK AEU.7
MK AEU Surface Water Dissolved Box Plots for Zinc



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

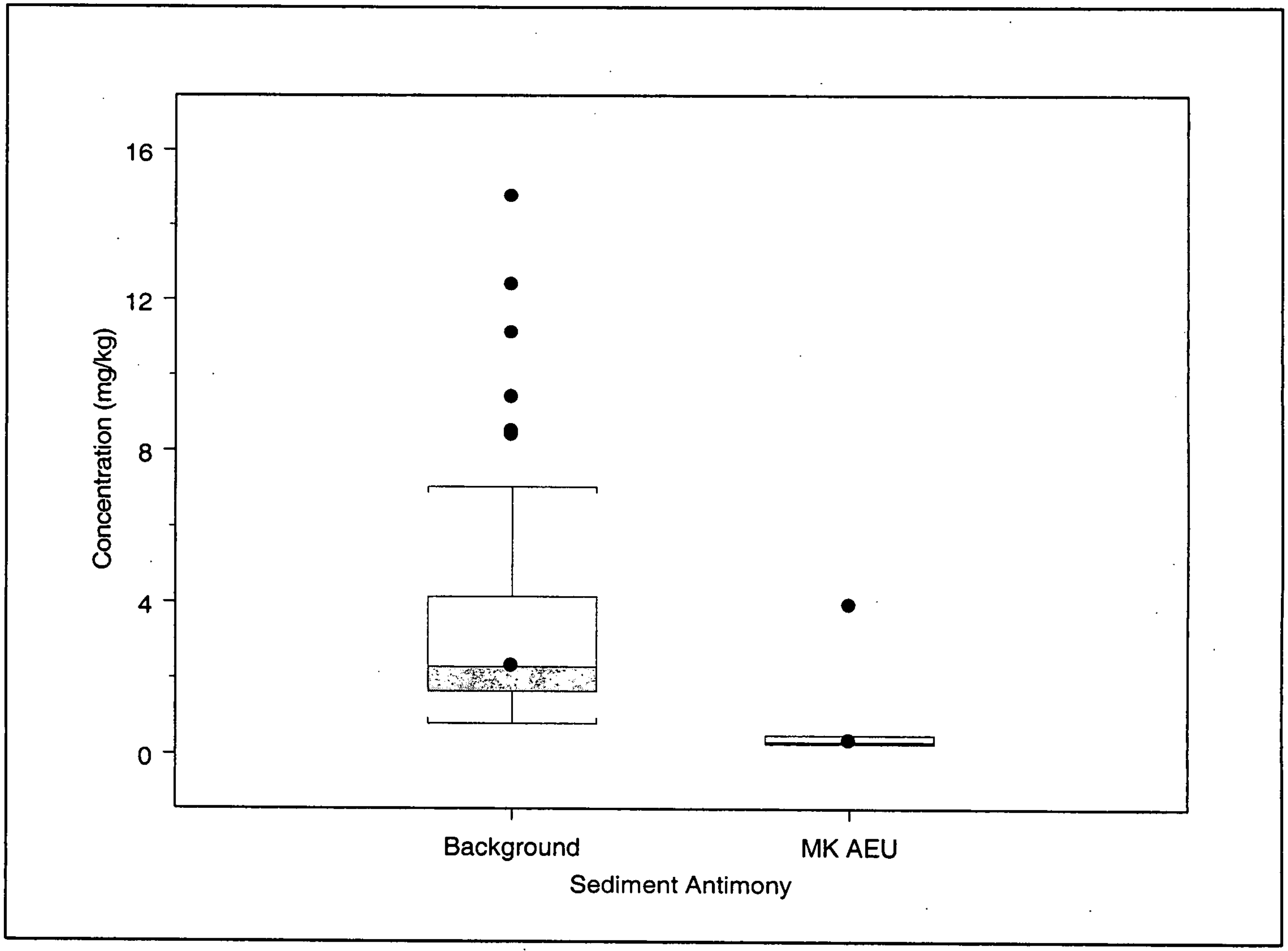
366

Figure A[illegible]MK AEU.8
MK AEU Sediment Box Plots for Aluminum



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

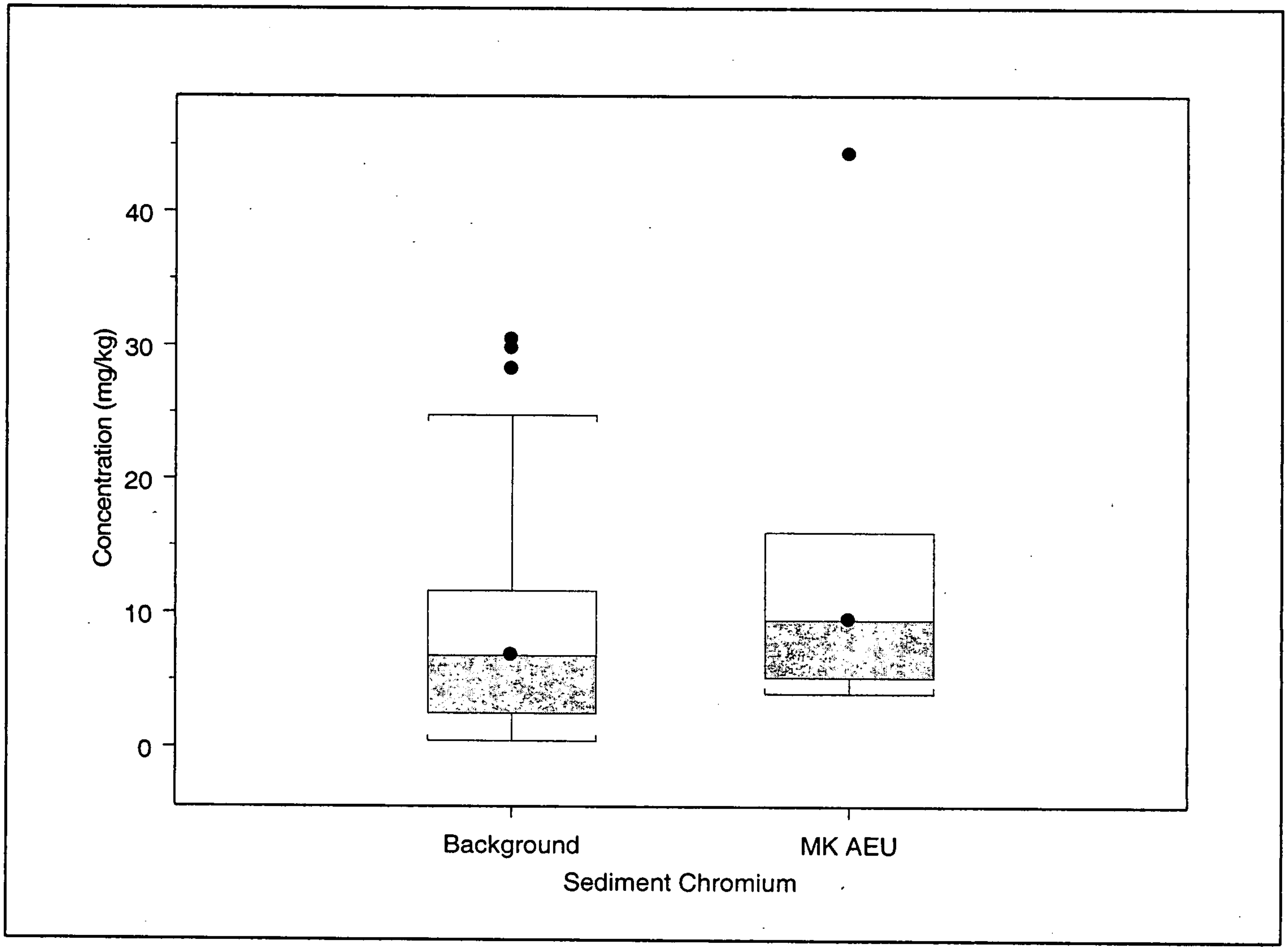
Figure A3.[illegible]K AEU.9
MK AEU Sediment Box Plots for Antimony



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

368

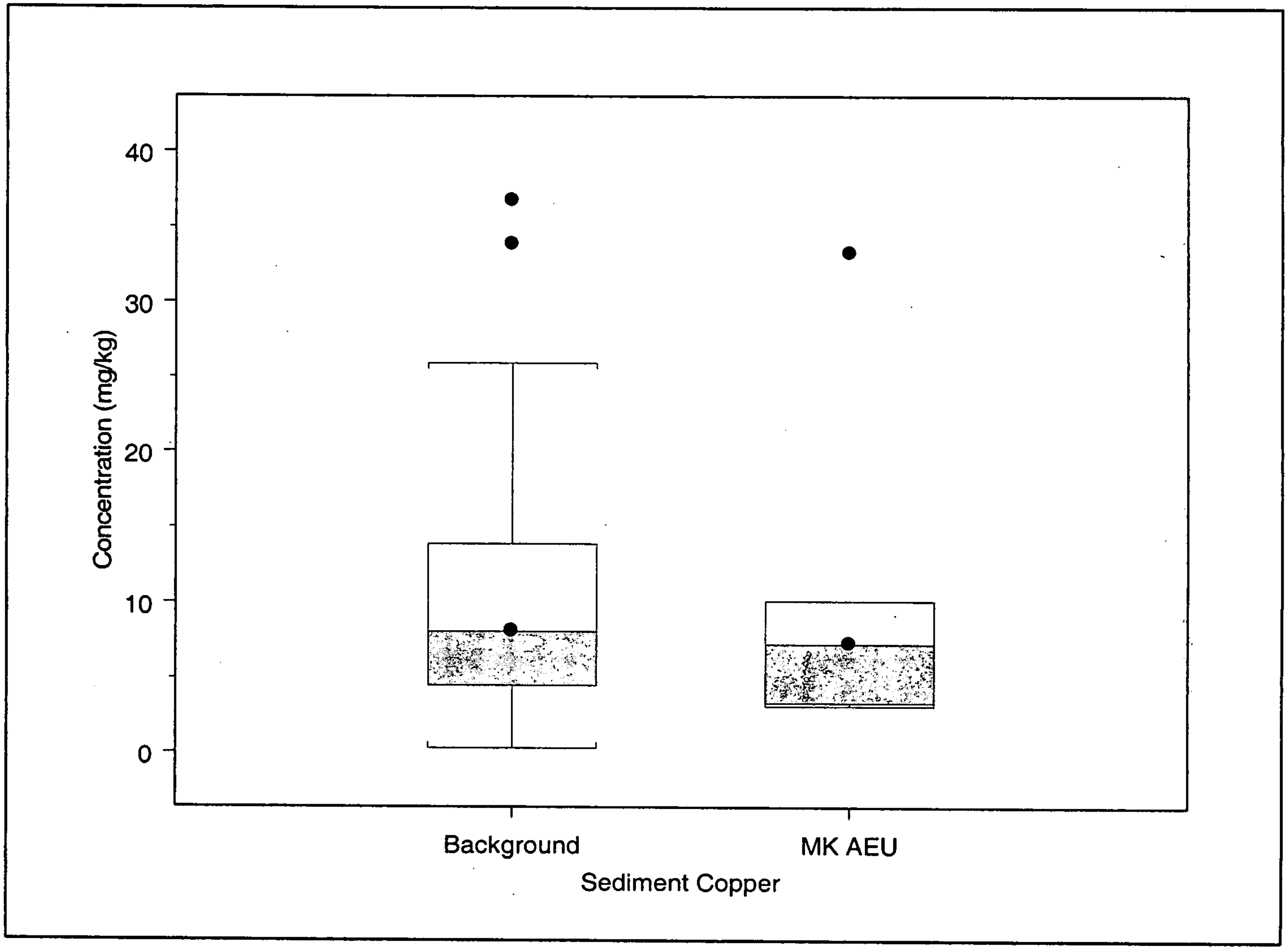
Figure A[illegible]MK AEU.10
MK AEU Sediment Box Plots for Chromium



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

369

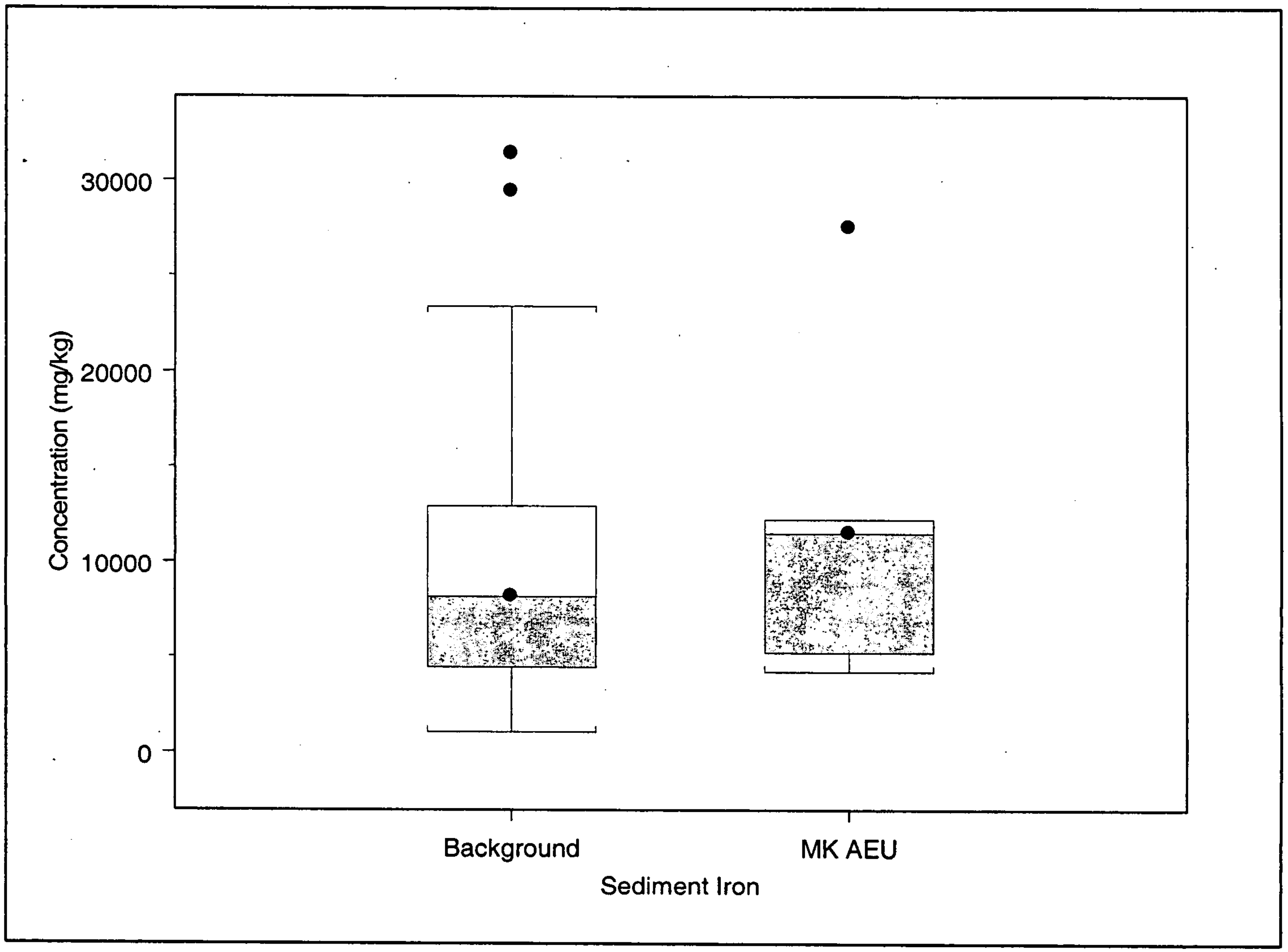
Figure A3.2.MK AEU.11
MK AEU Sediment Box Plots for Copper



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

370

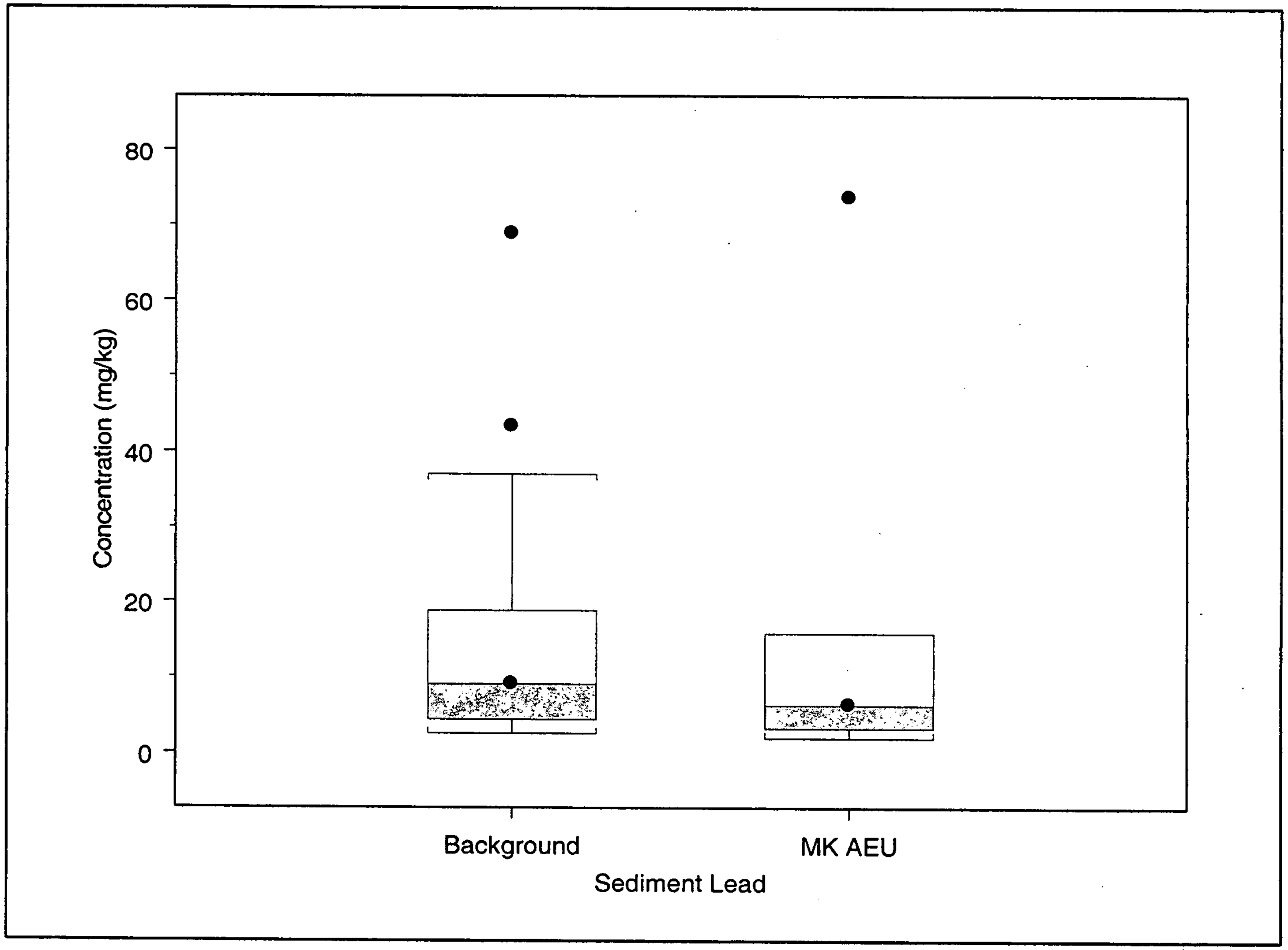
Figure A3.2.MK AEU.12
MK AEU Sediment Box Plots for Iron



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

371

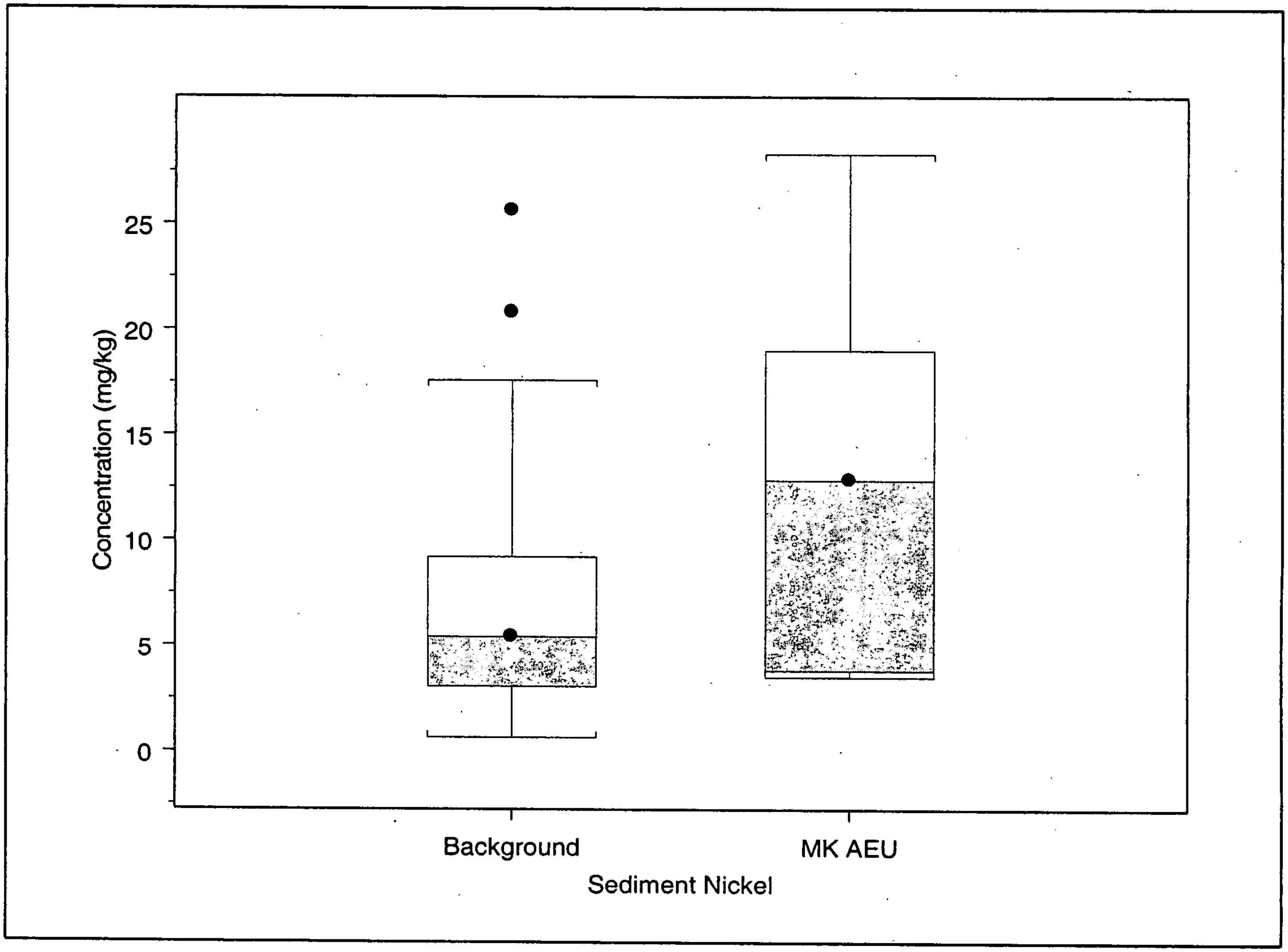
Figure A3.[illegible]K AEU.13
MK AEU Sediment Box Plots for Lead



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

372

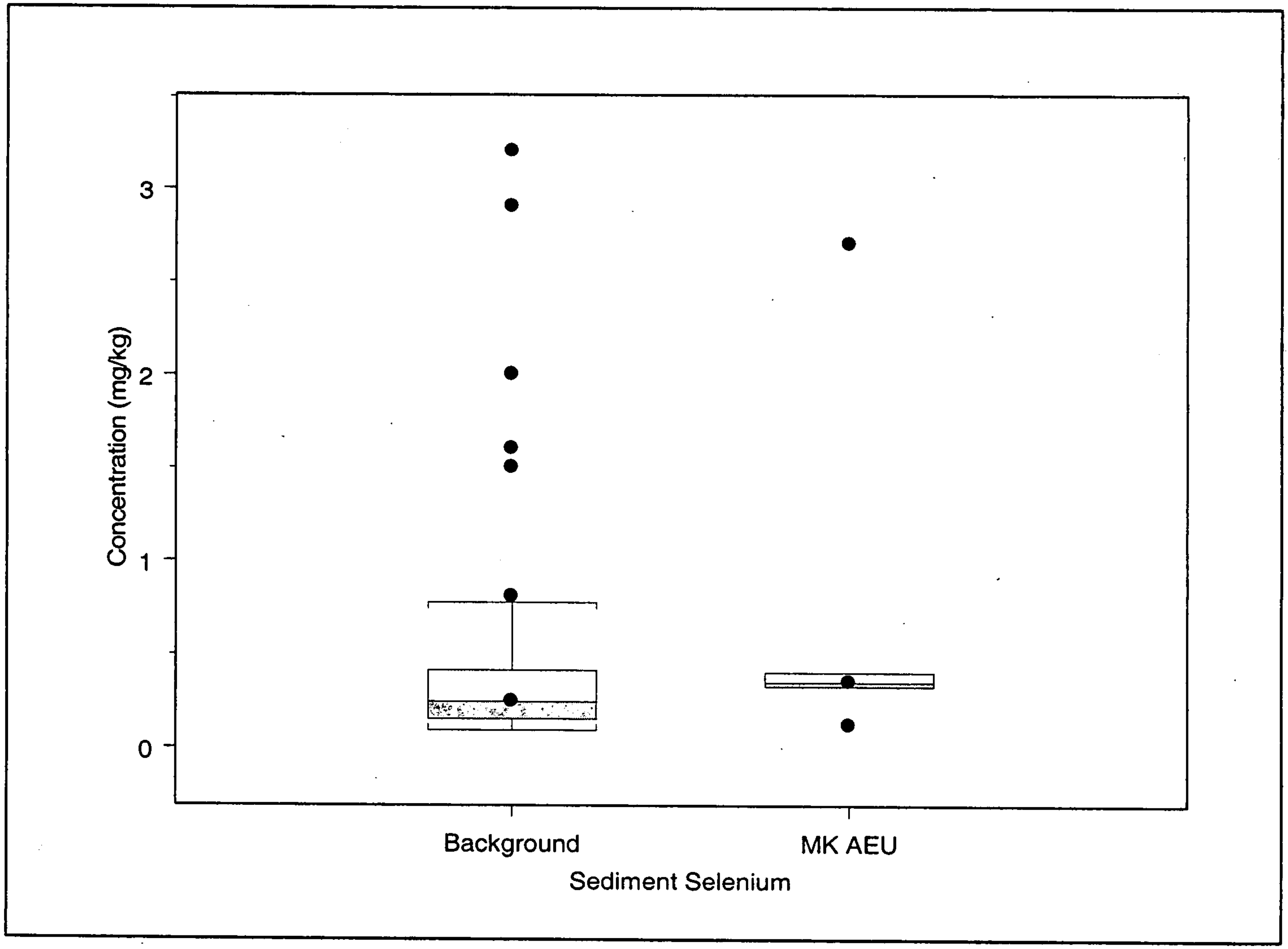
Figure A3.[illegible]K AEU.14
MK AEU Sediment Box Plots for Nickel



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

373

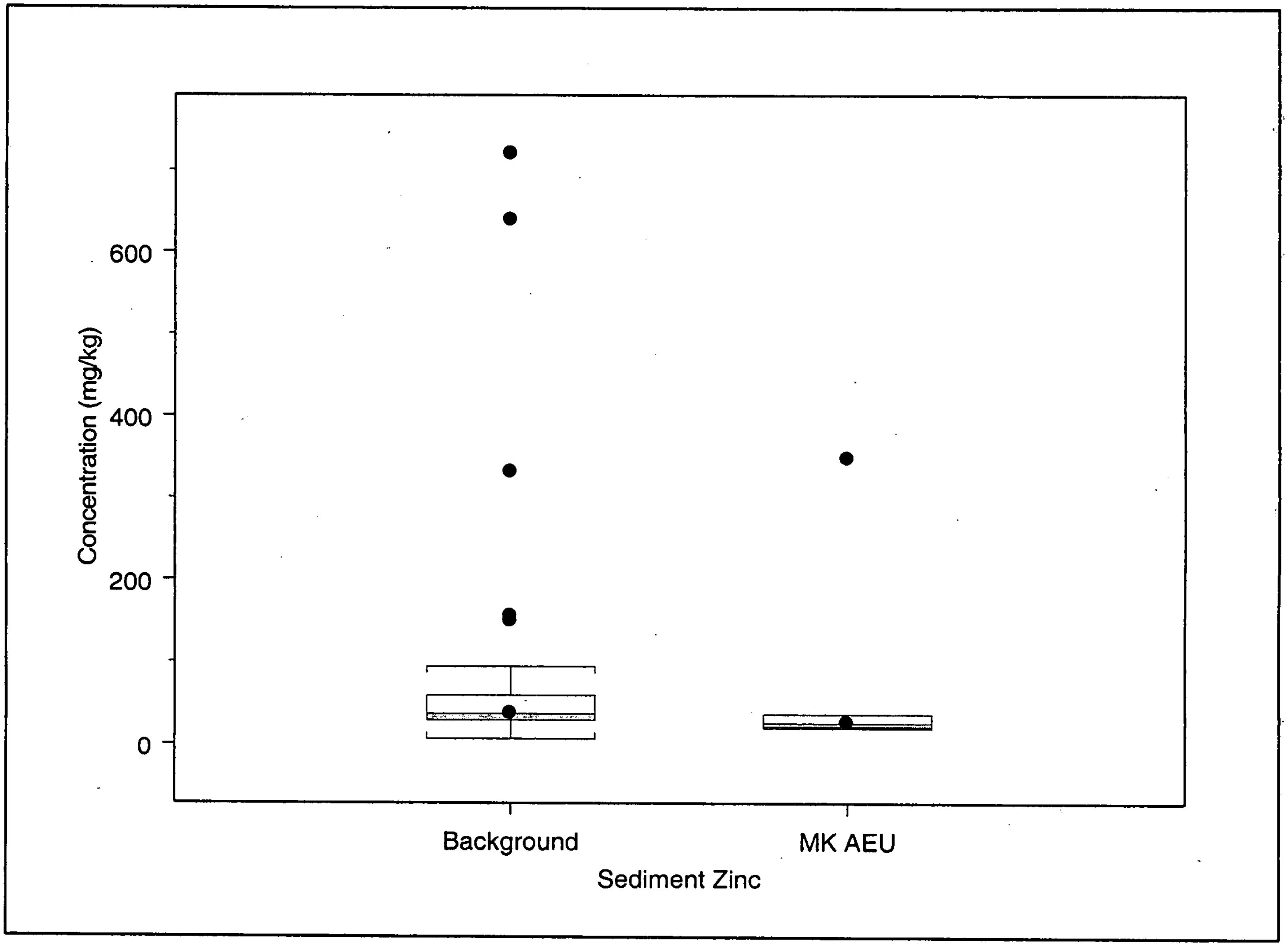
Figure A3.2.MK AEU.15
MK AEU Sediment Box Plots for Selenium



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

374

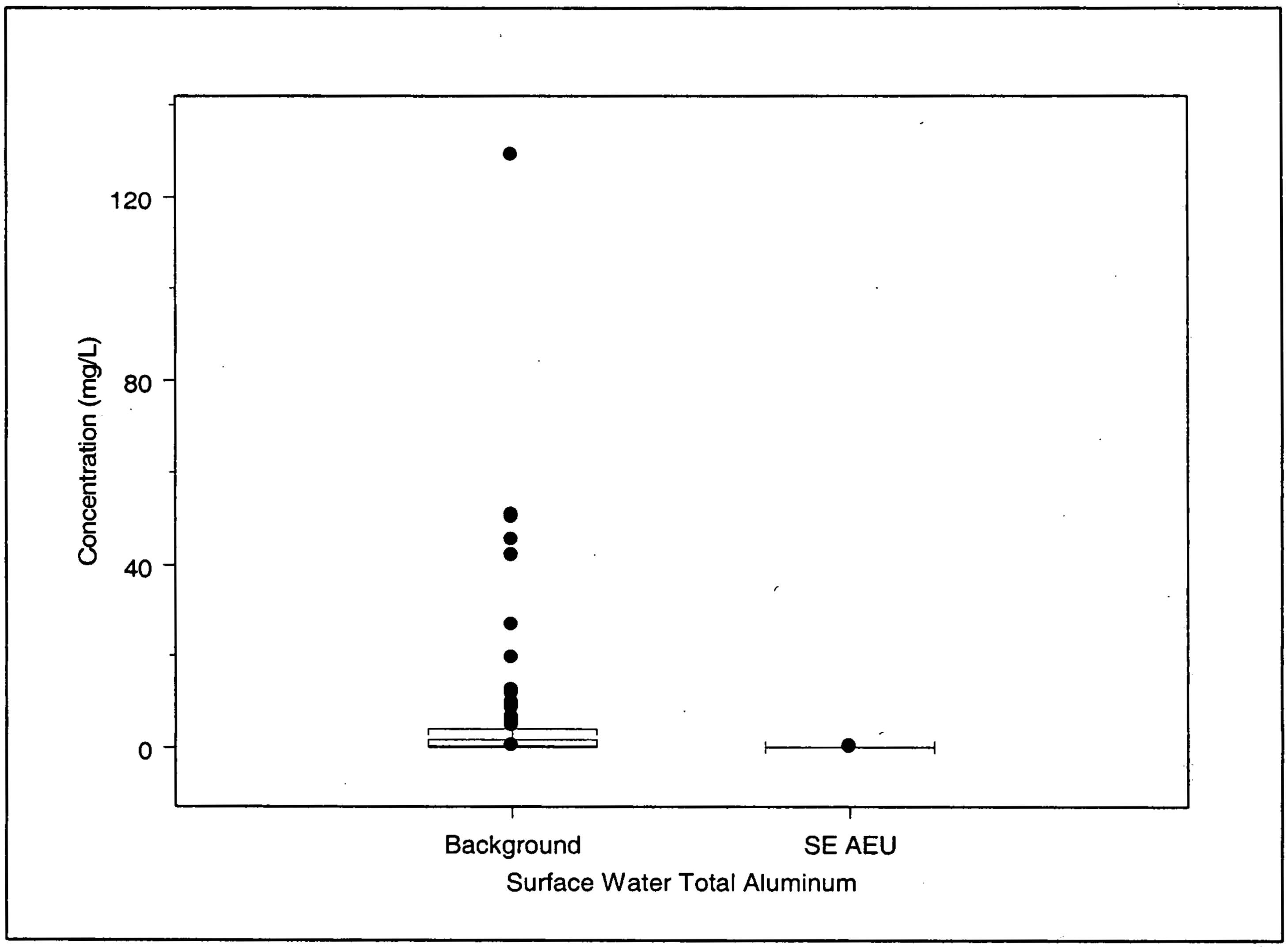
Figure A3.2.MK AEU.16
MK AEU Sediment Box Plots for Zinc



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

375

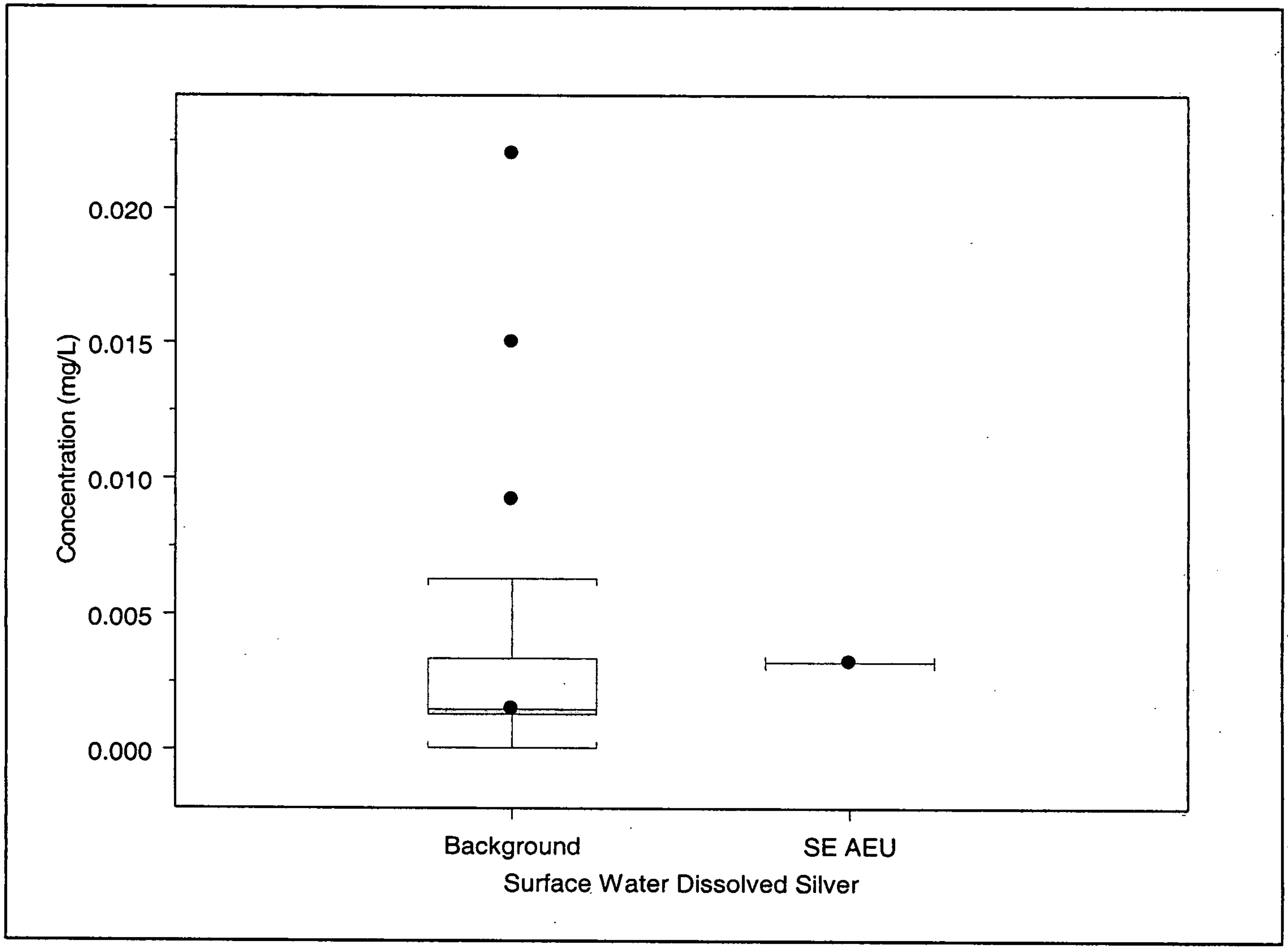
Figure A3.2.SE AEU.1
SE AEU Surface Water Total Box Plots for Aluminum



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

376

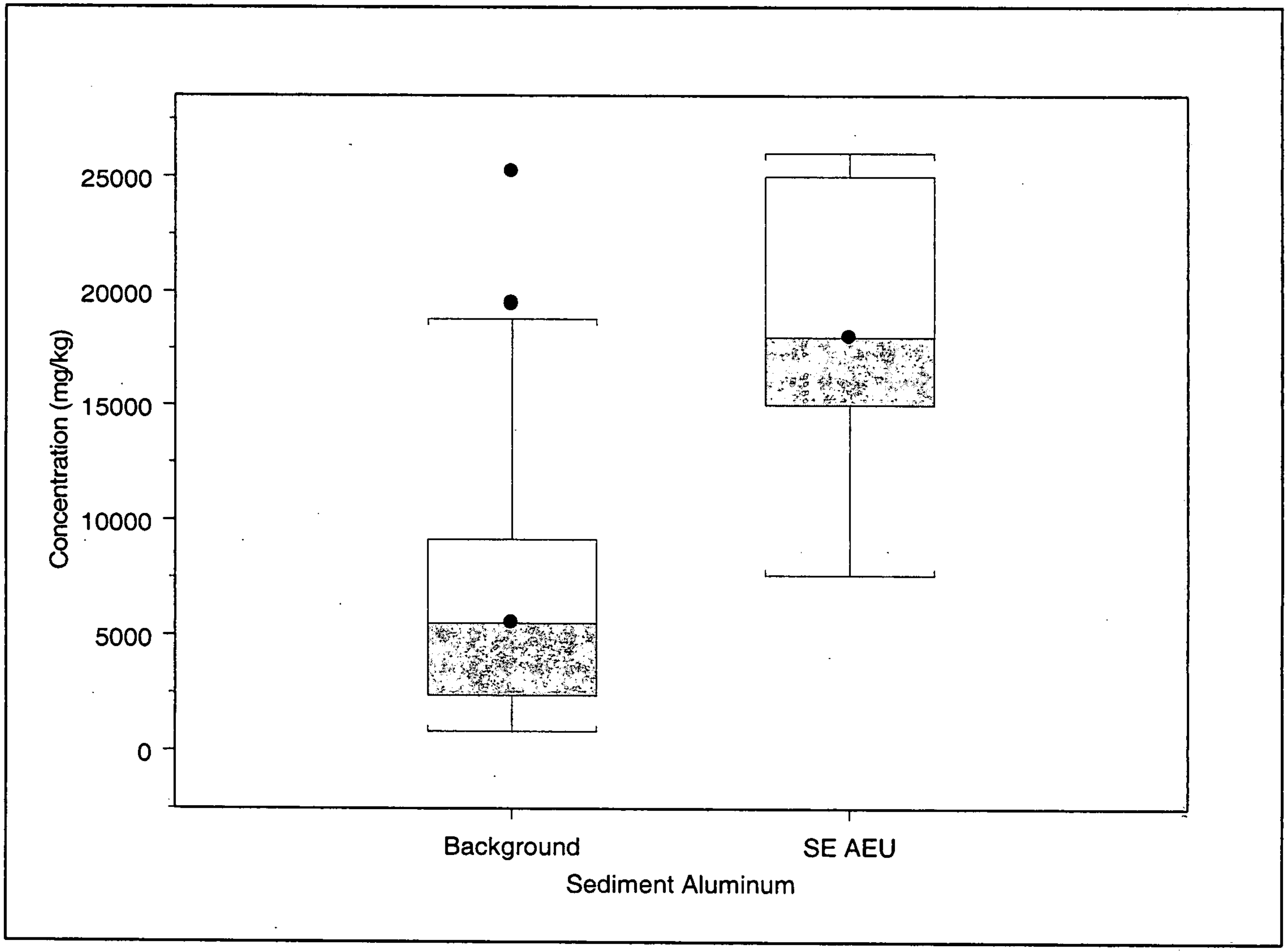
Figure A3.2[illegible]AEU.2
SE AEU Surface Water Dissolved Box Plots for Silver



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

377

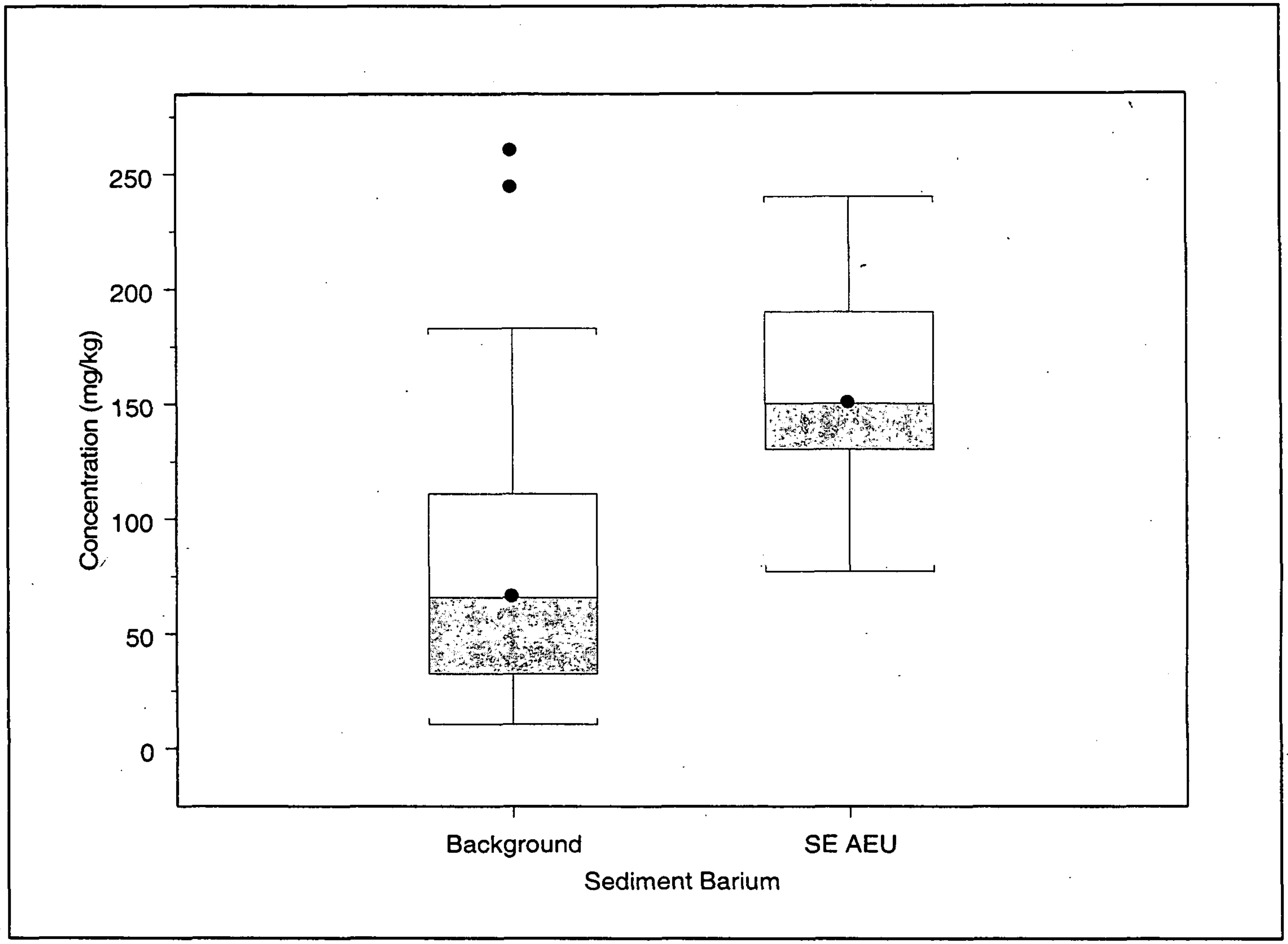
Figure A3.2 AEU.3
SE AEU Sediment Box Plots for Aluminum



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

378

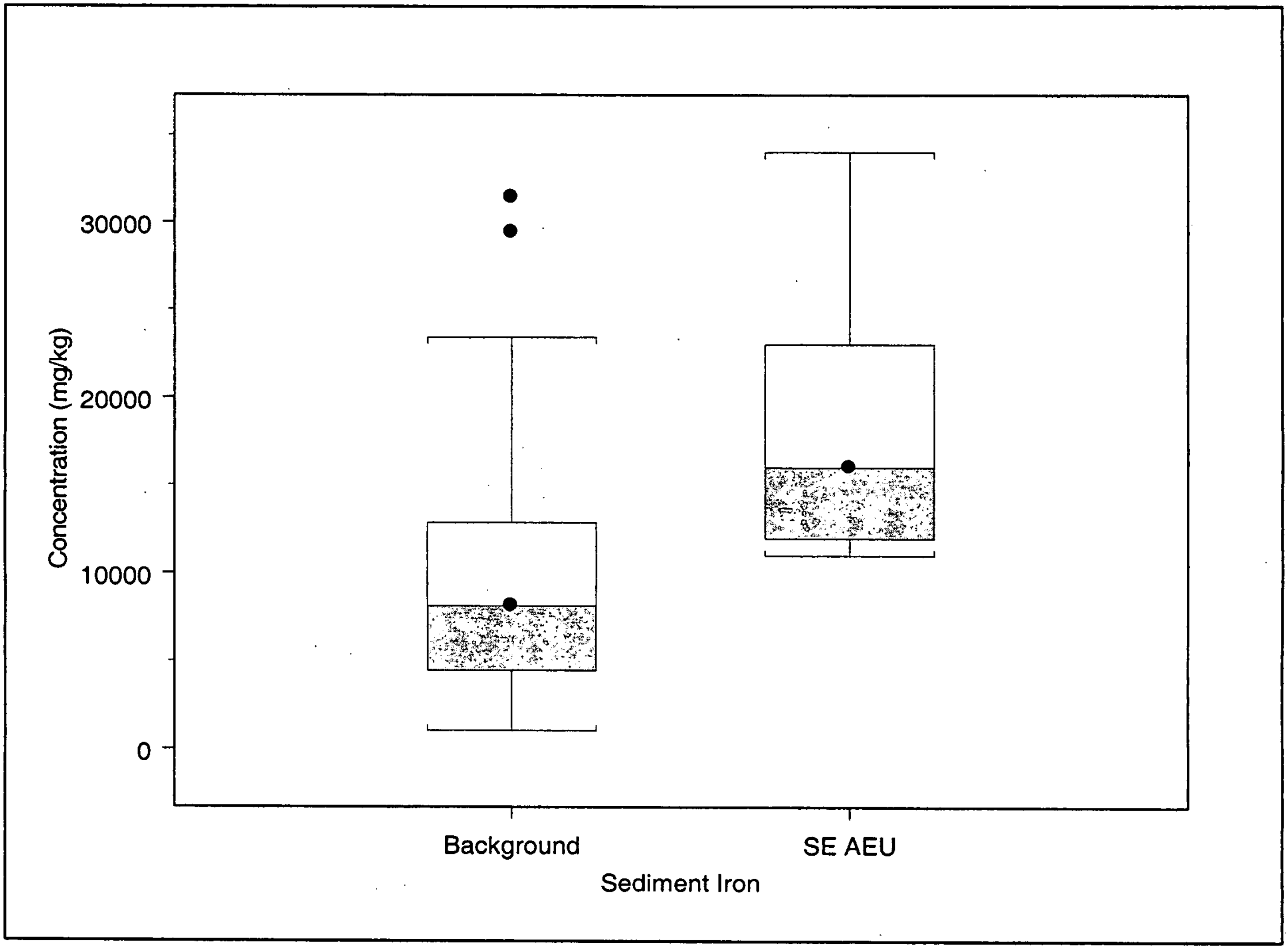
Figure A3.[illegible]E AEU.4
SE AEU Sediment Box Plots for Barium



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

379

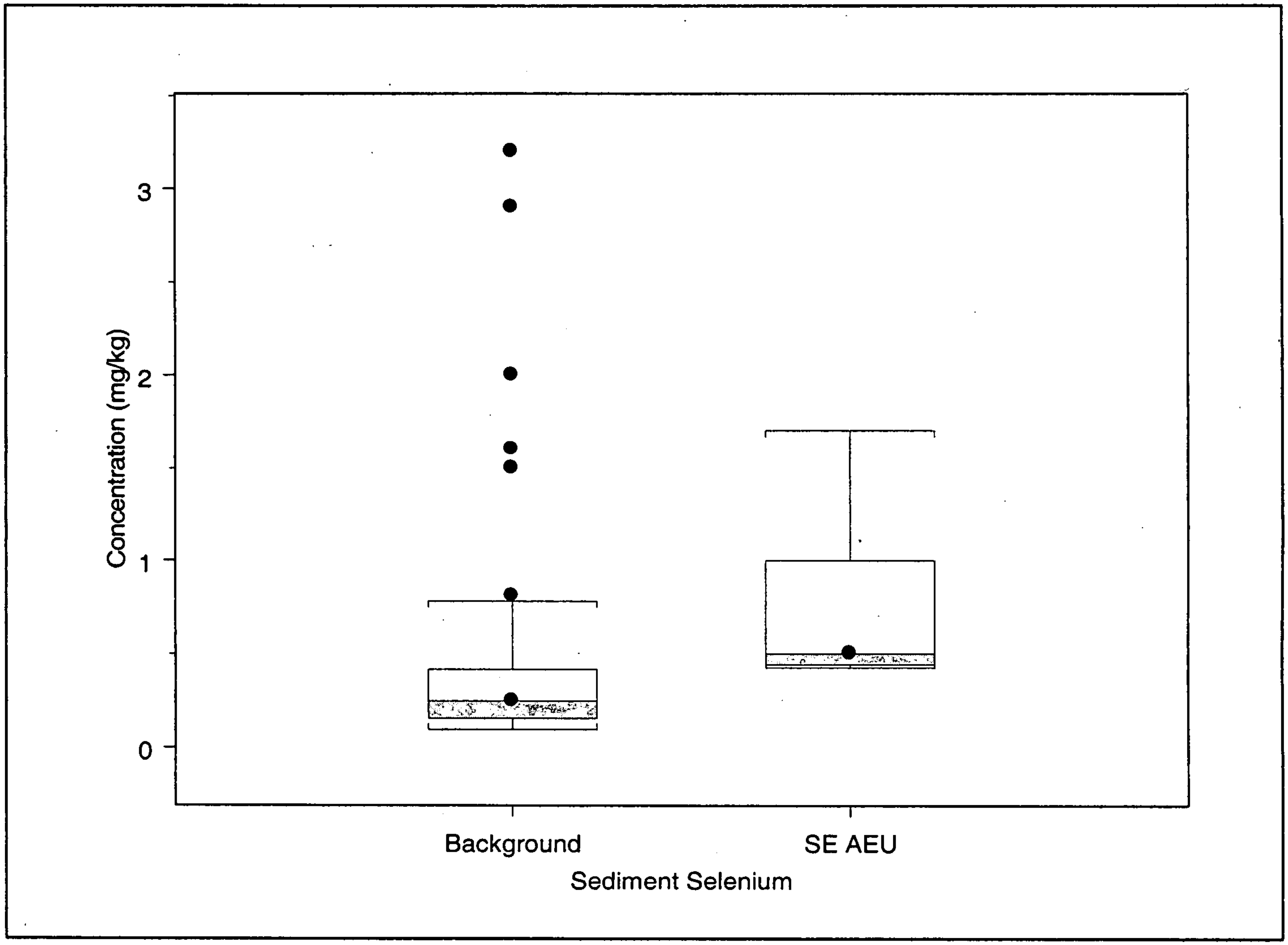
Figure A3.2.SE AEU.5
SE AEU Sediment Box Plots for Iron



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

380

Figure A3.2.SE AEU.6
SE AEU Sediment Box Plots for Selenium



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

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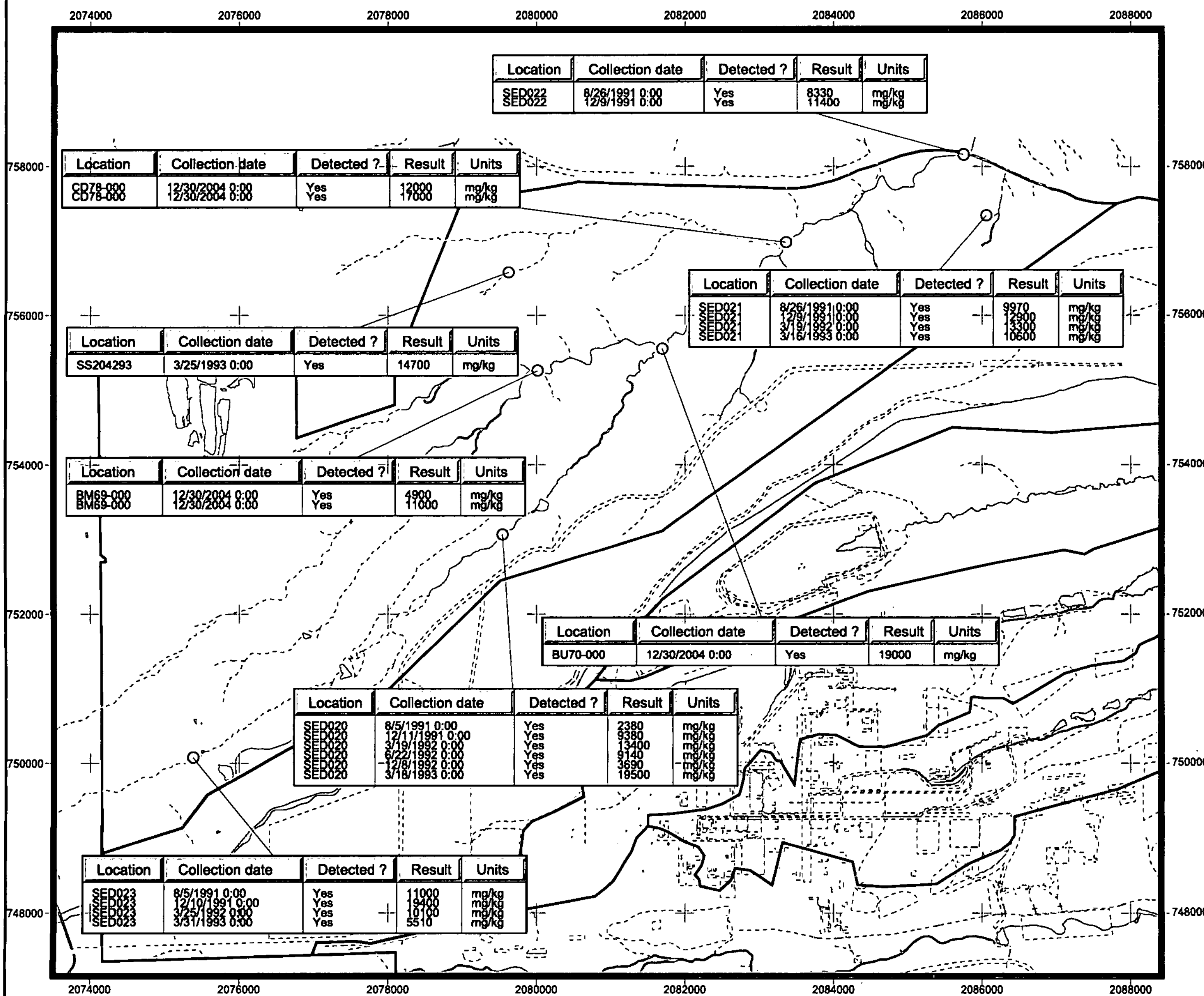
Figure A3.4.RC AEU.1
Rock Creek AEU
Sediment Sampling Locations for Aluminum



Location	Collection date	Detected ?	Result	Units
SED022	8/26/1991 0:00	Yes	8330	mg/kg
SED022	12/9/1991 0:00	Yes	11400	mg/kg

Location	Collection date	Detected ?	Result	Units
CD78-000	12/30/2004 0:00	Yes	12000	mg/kg
CD78-000	12/30/2004 0:00	Yes	17000	mg/kg

Location	Collection date	Detected ?	Result	Units
SED021	8/26/1991 0:00	Yes	9970	mg/kg
SED021	12/9/1991 0:00	Yes	12900	mg/kg
SED021	3/19/1992 0:00	Yes	13300	mg/kg
SED021	3/16/1993 0:00	Yes	10600	mg/kg

Location	Collection date	Detected ?	Result	Units
SS204293	3/25/1993 0:00	Yes	14700	mg/kg

Location	Collection date	Detected ?	Result	Units
BM69-000	12/30/2004 0:00	Yes	4900	mg/kg
BM69-000	12/30/2004 0:00	Yes	11000	mg/kg

Location	Collection date	Detected ?	Result	Units
BU70-000	12/30/2004 0:00	Yes	19000	mg/kg

Location	Collection date	Detected ?	Result	Units
SED020	8/5/1991 0:00	Yes	2380	mg/kg
SED020	12/11/1991 0:00	Yes	9380	mg/kg
SED020	3/19/1992 0:00	Yes	13400	mg/kg
SED020	6/22/1992 0:00	Yes	9140	mg/kg
SED020	12/8/1992 0:00	Yes	3690	mg/kg
SED020	3/18/1993 0:00	Yes	19500	mg/kg

Location	Collection date	Detected ?	Result	Units
SED023	8/5/1991 0:00	Yes	11000	mg/kg
SED023	12/10/1991 0:00	Yes	19400	mg/kg
SED023	3/25/1992 0:00	Yes	10100	mg/kg
SED023	3/31/1993 0:00	Yes	5510	mg/kg

KEY

Sampling location

- Detect >= ESL >= Maximum background
- Detect >=ESL < Maximum Background
- Detect < ESL < Maximum Background
- Nondetect

ESL = 15900 mg/kg

Maximum background = 25200 mg/kg

Standard Map Features

- Rock Creek AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

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0 1000 2000 Feet

Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

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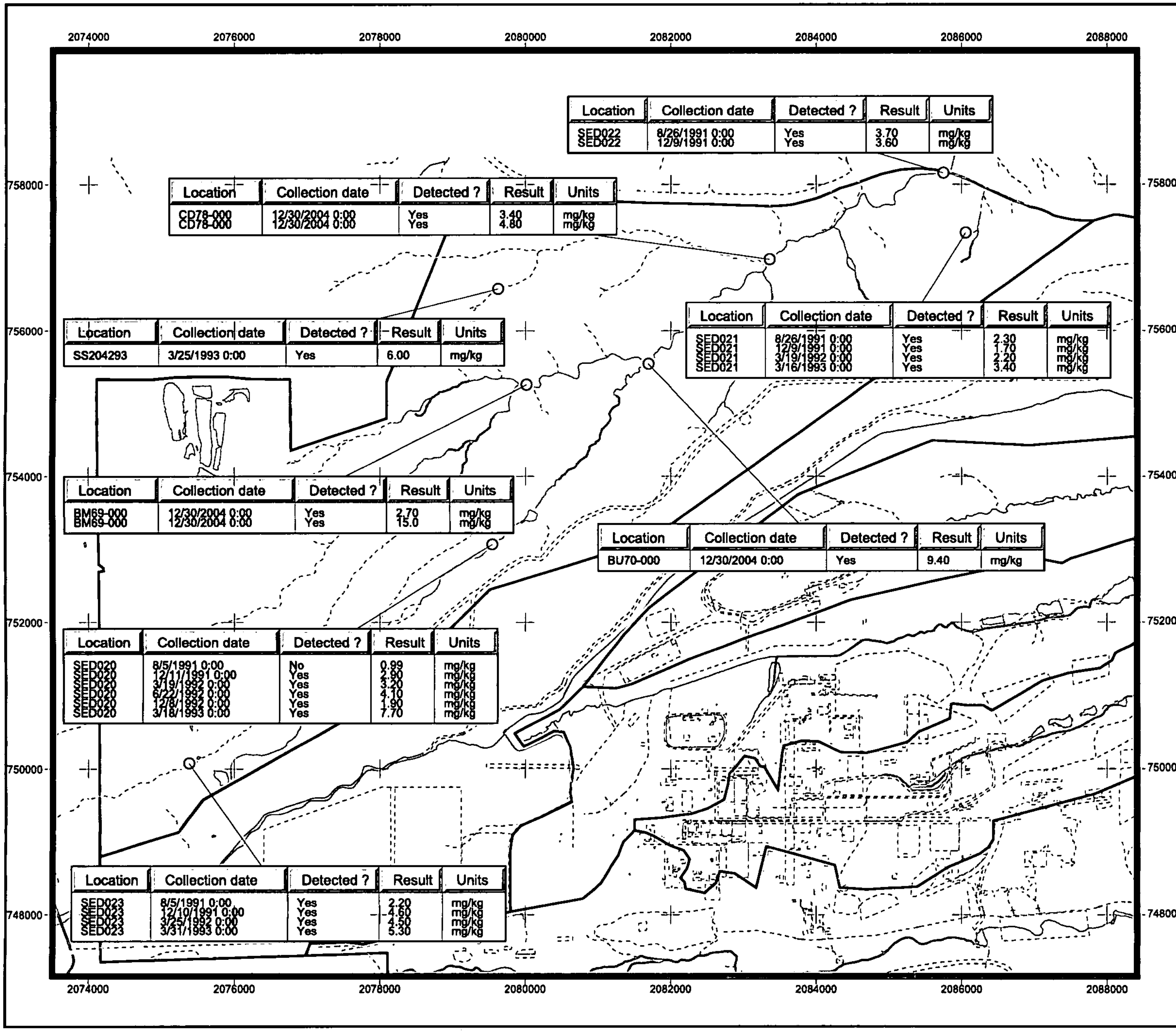
Figure A3.4.RC AEU.2
Rock Creek AEU
Sediment Sampling Locations for Arsenic



Location	Collection date	Detected ?	Result	Units
SED022	8/26/1991 0:00	Yes	3.70	mg/kg
SED022	12/9/1991 0:00	Yes	3.60	mg/kg

Location	Collection date	Detected ?	Result	Units
CD78-000	12/30/2004 0:00	Yes	3.40	mg/kg
CD78-000	12/30/2004 0:00	Yes	4.80	mg/kg

Location	Collection date	Detected ?	Result	Units
SS204293	3/25/1993 0:00	Yes	6.00	mg/kg

Location	Collection date	Detected ?	Result	Units
SED021	8/26/1991 0:00	Yes	2.30	mg/kg
SED021	12/9/1991 0:00	Yes	1.70	mg/kg
SED021	3/19/1992 0:00	Yes	2.20	mg/kg
SED021	3/16/1993 0:00	Yes	3.40	mg/kg

Location	Collection date	Detected ?	Result	Units
BM69-000	12/30/2004 0:00	Yes	2.70	mg/kg
BM69-000	12/30/2004 0:00	Yes	15.0	mg/kg

Location	Collection date	Detected ?	Result	Units
BU70-000	12/30/2004 0:00	Yes	9.40	mg/kg

Location	Collection date	Detected ?	Result	Units
SED020	8/5/1991 0:00	No	0.99	mg/kg
SED020	12/11/1991 0:00	Yes	2.90	mg/kg
SED020	3/19/1992 0:00	Yes	3.20	mg/kg
SED020	6/22/1992 0:00	Yes	4.10	mg/kg
SED020	12/8/1992 0:00	Yes	1.90	mg/kg
SED020	3/18/1993 0:00	Yes	7.70	mg/kg

Location	Collection date	Detected ?	Result	Units
SED023	8/5/1991 0:00	Yes	2.20	mg/kg
SED023	12/10/1991 0:00	Yes	4.60	mg/kg
SED023	3/25/1992 0:00	Yes	4.50	mg/kg
SED023	3/31/1993 0:00	Yes	5.30	mg/kg

KEY

Sampling location

- Detect >= ESL >= Maximum background
- Detect >=Maximum Background < ESL
- Detect < ESL < Maximum Background
- Nondetect

ESL = 9.79 mg/kg

Maximum background = 8.7 mg/kg

Standard Map Features

- Rock Creek AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

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Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

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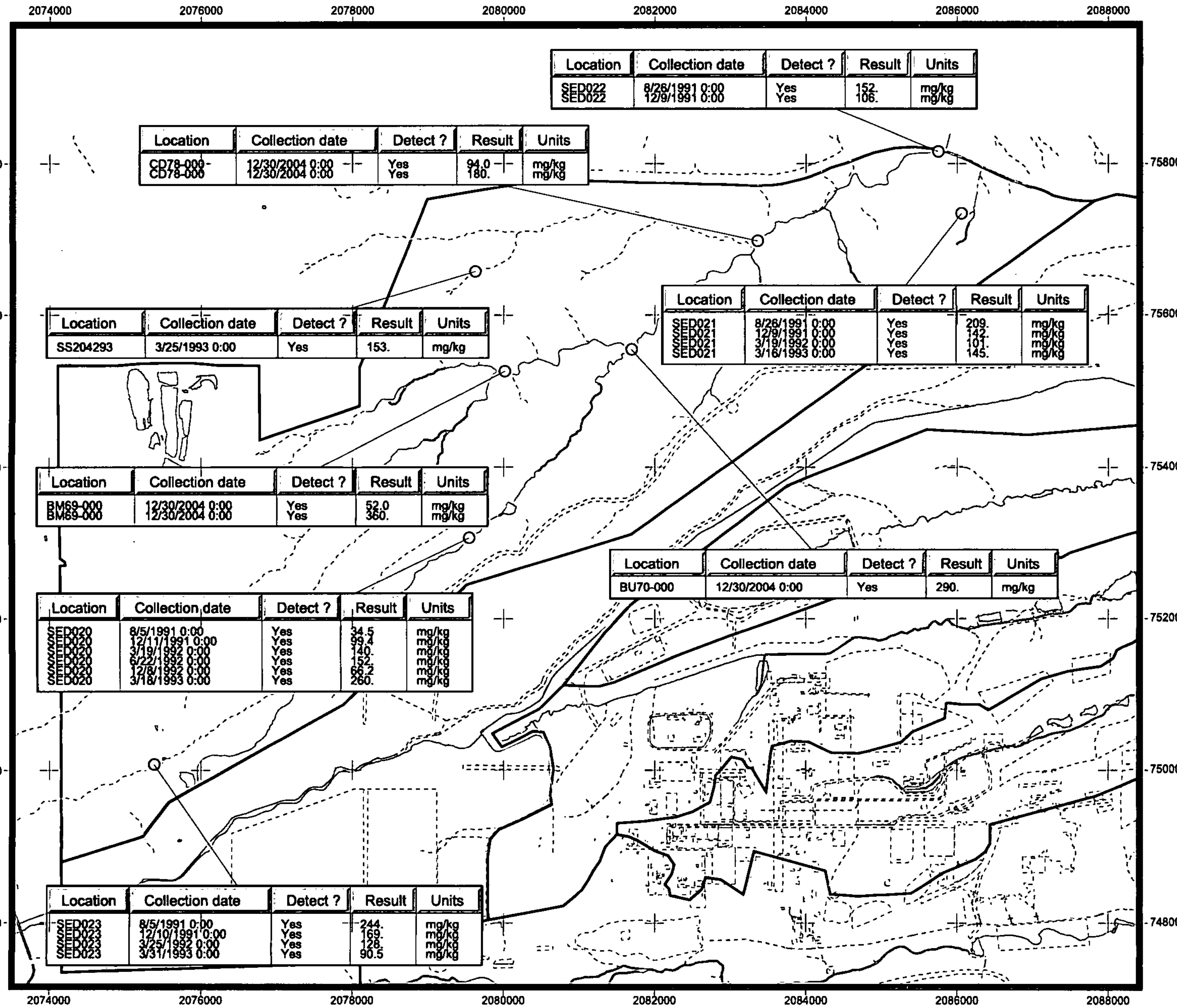
Figure A3.4.RC AEU.3
Rock Creek AEU
Sediment Sampling Locations for Barium



Location	Collection date	Detect ?	Result	Units
SED022	8/26/1991 0:00	Yes	152.	mg/kg
SED022	12/9/1991 0:00	Yes	106.	mg/kg

Location	Collection date	Detect ?	Result	Units
CD78-000	12/30/2004 0:00	Yes	94.0	mg/kg
CD78-000	12/30/2004 0:00	Yes	180.	mg/kg

Location	Collection date	Detect ?	Result	Units
SS204293	3/25/1993 0:00	Yes	153.	mg/kg

Location	Collection date	Detect ?	Result	Units
SED021	8/26/1991 0:00	Yes	209.	mg/kg
SED021	12/9/1991 0:00	Yes	142.	mg/kg
SED021	3/19/1992 0:00	Yes	101.	mg/kg
SED021	3/16/1993 0:00	Yes	145.	mg/kg

Location	Collection date	Detect ?	Result	Units
BM69-000	12/30/2004 0:00	Yes	52.0	mg/kg
BM69-000	12/30/2004 0:00	Yes	360.	mg/kg

Location	Collection date	Detect ?	Result	Units
BU70-000	12/30/2004 0:00	Yes	290.	mg/kg

Location	Collection date	Detect ?	Result	Units
SED020	8/5/1991 0:00	Yes	34.5	mg/kg
SED020	12/11/1991 0:00	Yes	99.4	mg/kg
SED020	3/19/1992 0:00	Yes	140.	mg/kg
SED020	6/22/1992 0:00	Yes	152.	mg/kg
SED020	12/8/1992 0:00	Yes	66.2	mg/kg
SED020	3/18/1993 0:00	Yes	260.	mg/kg

Location	Collection date	Detect ?	Result	Units
SED023	8/5/1991 0:00	Yes	244.	mg/kg
SED023	12/10/1991 0:00	Yes	169.	mg/kg
SED023	3/25/1992 0:00	Yes	128.	mg/kg
SED023	3/31/1993 0:00	Yes	90.5	mg/kg

KEY

Sampling location

- Detect >= ESL >= Maximum background
- Detect >=ESL < Maximum Background
- Detect < ESL < Maximum Background
- Nondetect

ESL = 189 mg/kg

Maximum background = 260 mg/kg

Standard Map Features

- Rock Creek AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

U.S. Department of Energy
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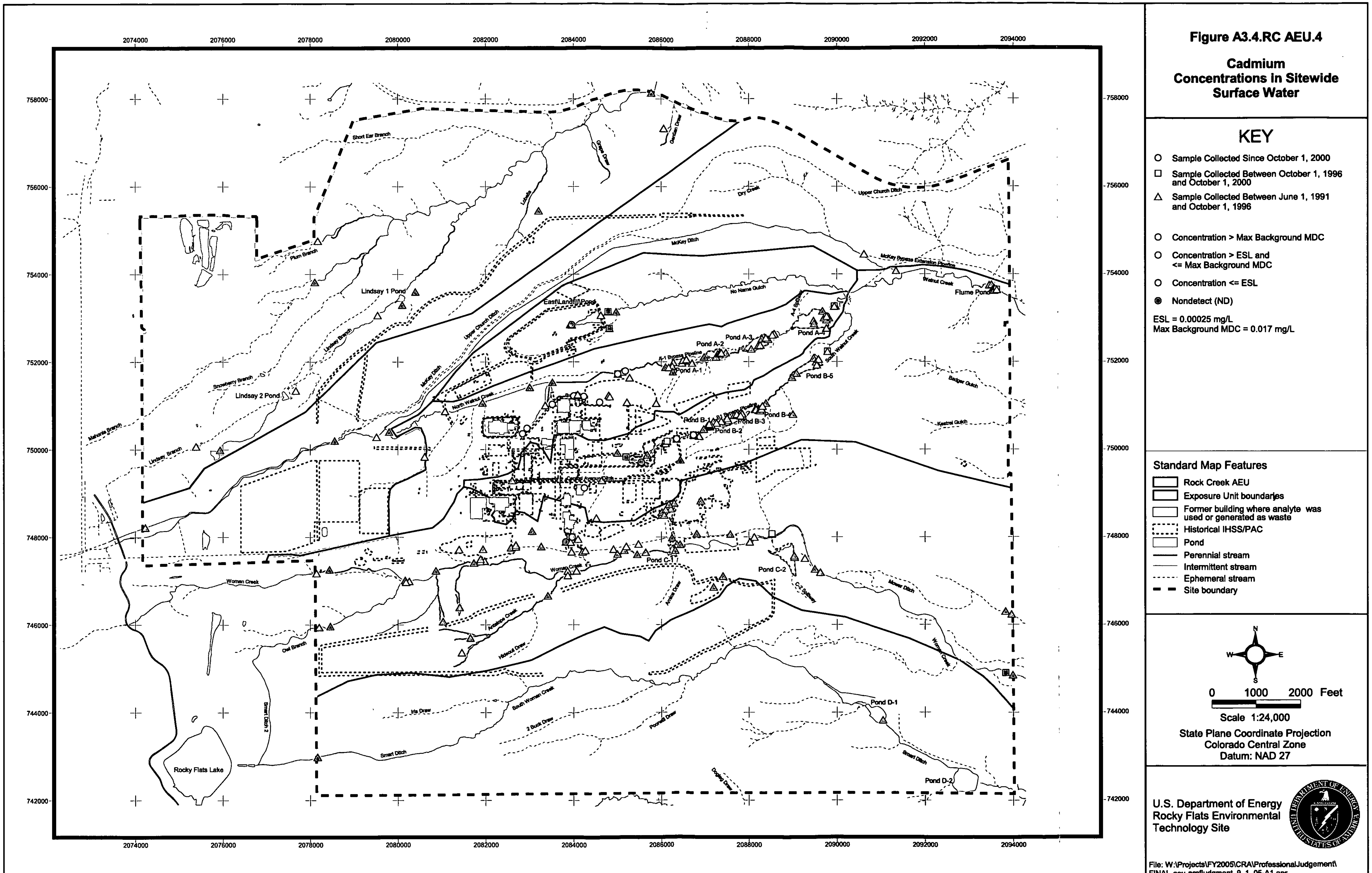
Figure A3.4.RC AEU.4
Cadmium Concentrations in Sitewide Surface Water
KEY
Sample Collected Since October 1, 2000
Sample Collected Between October 1, 1996 and October 1, 2000
Sample Collected Between June 1, 1991 and October 1, 1996
Concentration > Max Background MDC
Concentration > ESL and <= Max Background MDC
Concentration <= ESL
Nondetect (ND)
ESL = 0.00025 mg/L
Max Background MDC = 0.017 mg/L
Standard Map Features
Rock Creek AEU
Exposure Unit boundaries
Former building where analyte was used or generated as waste
Historical IHSS/PAC
Pond
Perennial stream
Intermittent stream
Ephemeral stream
Site boundary
0 1000 2000 Feet
Scale 1:24,000
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27
U.S. Department of Energy
Rocky Flats Environmental Technology Site
File: W:\Projects\FY2005\CRA\ProfessionalJudgement\FINAL-aeu-profjudgment_9_1_05-A1.apr
Rocky Flats Lake
Lindsay 1 Pond
Lindsay 2 Pond
Pond A-1
Pond A-2
Pond A-3
Pond A-4
Pond B-1
Pond B-2
Pond B-3
Pond B-4
Pond B-5
Pond C-1
Pond C-2
Pond D-1
Pond D-2
Flume Pond
East Landfill Pond
Woman Creek
Walnut Creek
McKay Ditch
Upper Church Ditch
Smart Ditch
Dry Creek
No Name Gulch
Antelope Creek
South Woman Creek
Short Ear Branch
Plum Branch
Lindsay Branch
Snowberry Branch
Mahonia Branch
Owl Branch
Iris Draw
2 Buck Draw
Kestrel Gulch
Badger Gulch
Mower Ditch
Smart Ditch 2

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Figure A3.4.RC AEU.5
Rock Creek Surface Water Sampling Location SW005 for Dissolved Cadmium

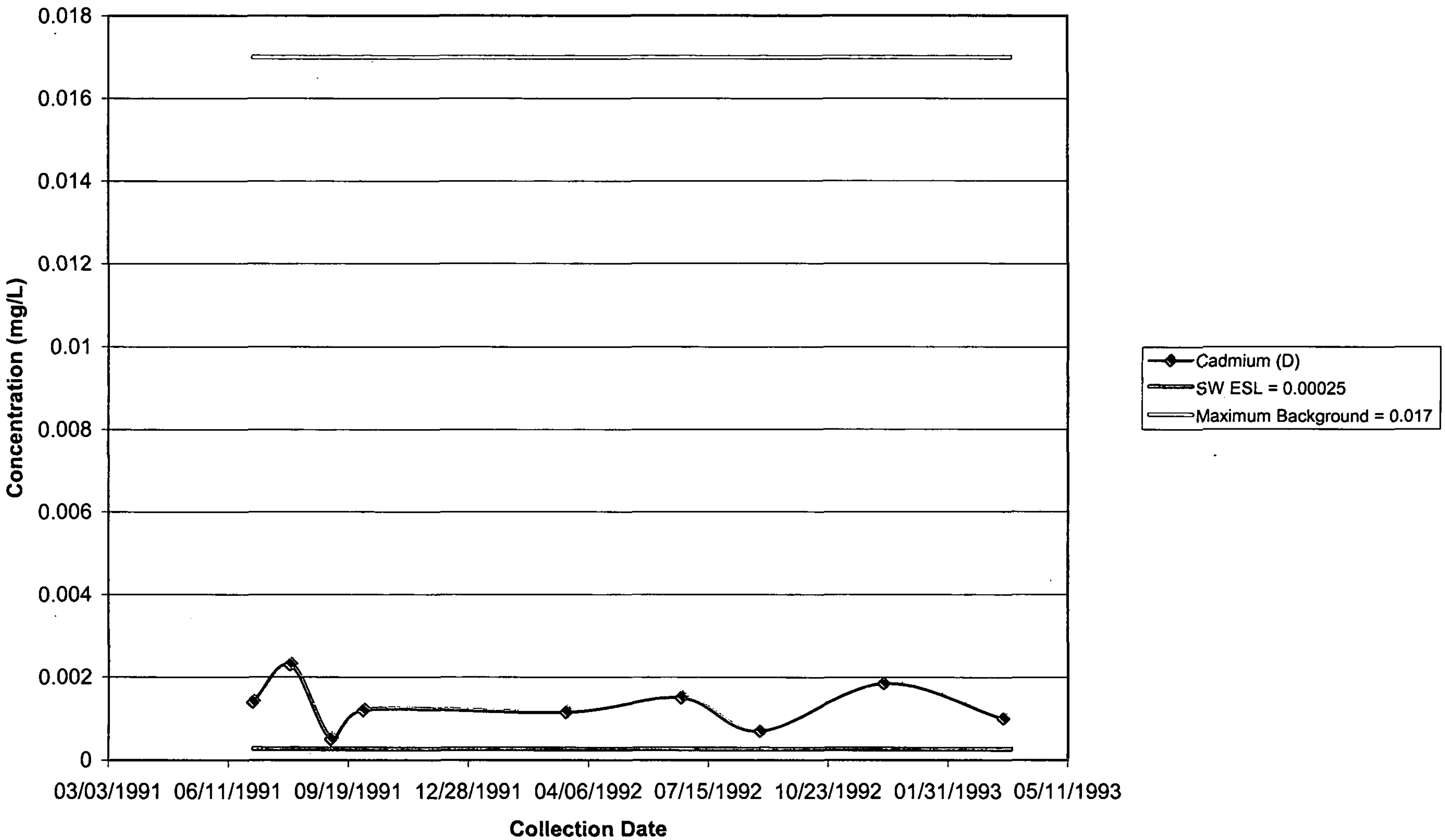

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Figure A3.4.RC AEU.6
Rock Creek Surface Water Sampling Location SW006 for Dissolved Cadmium

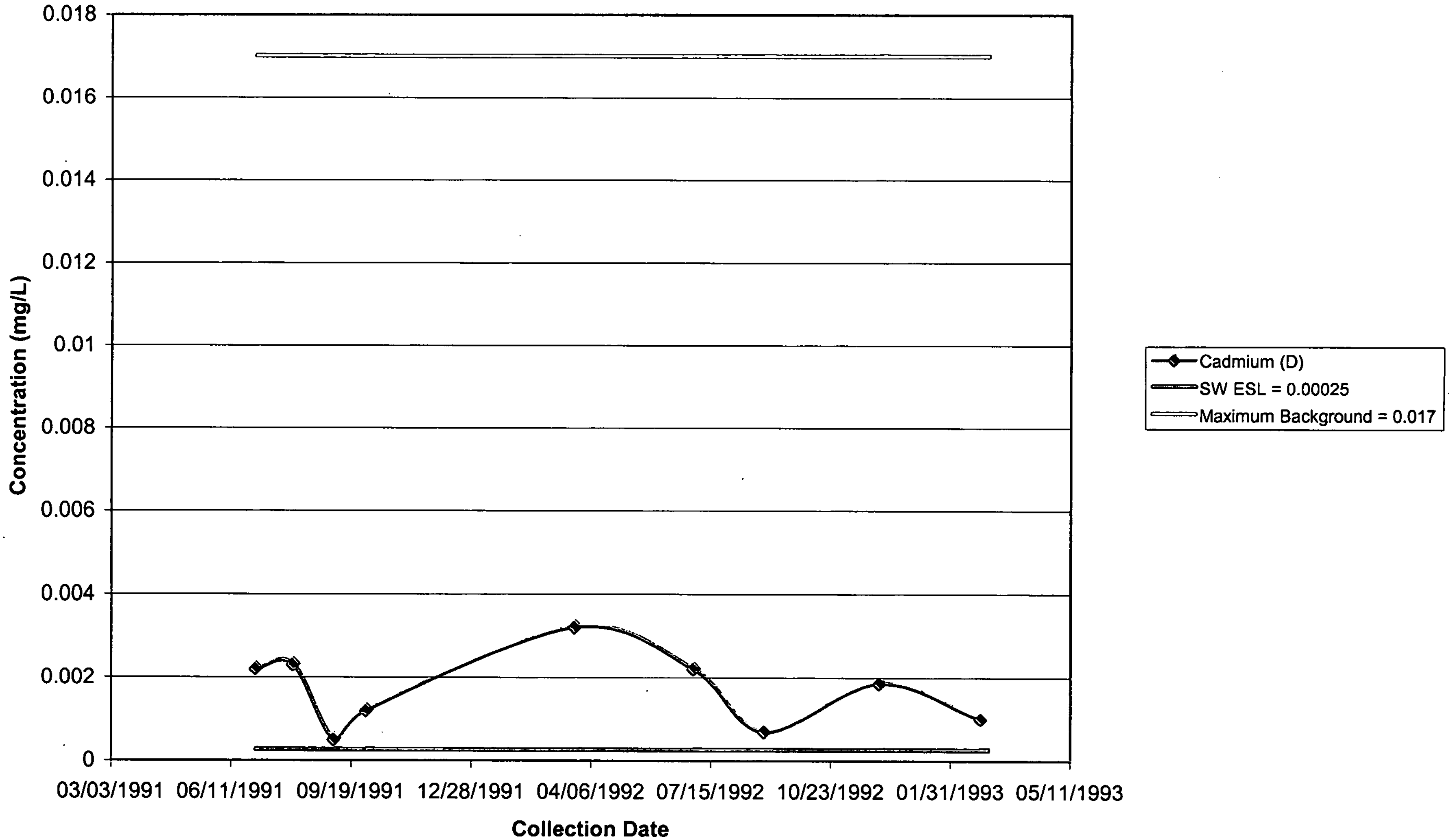

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Figure A3.4.RC AEU.7
Rock Creek Surface Water Sampling Location SW108 for Dissolved Cadmium

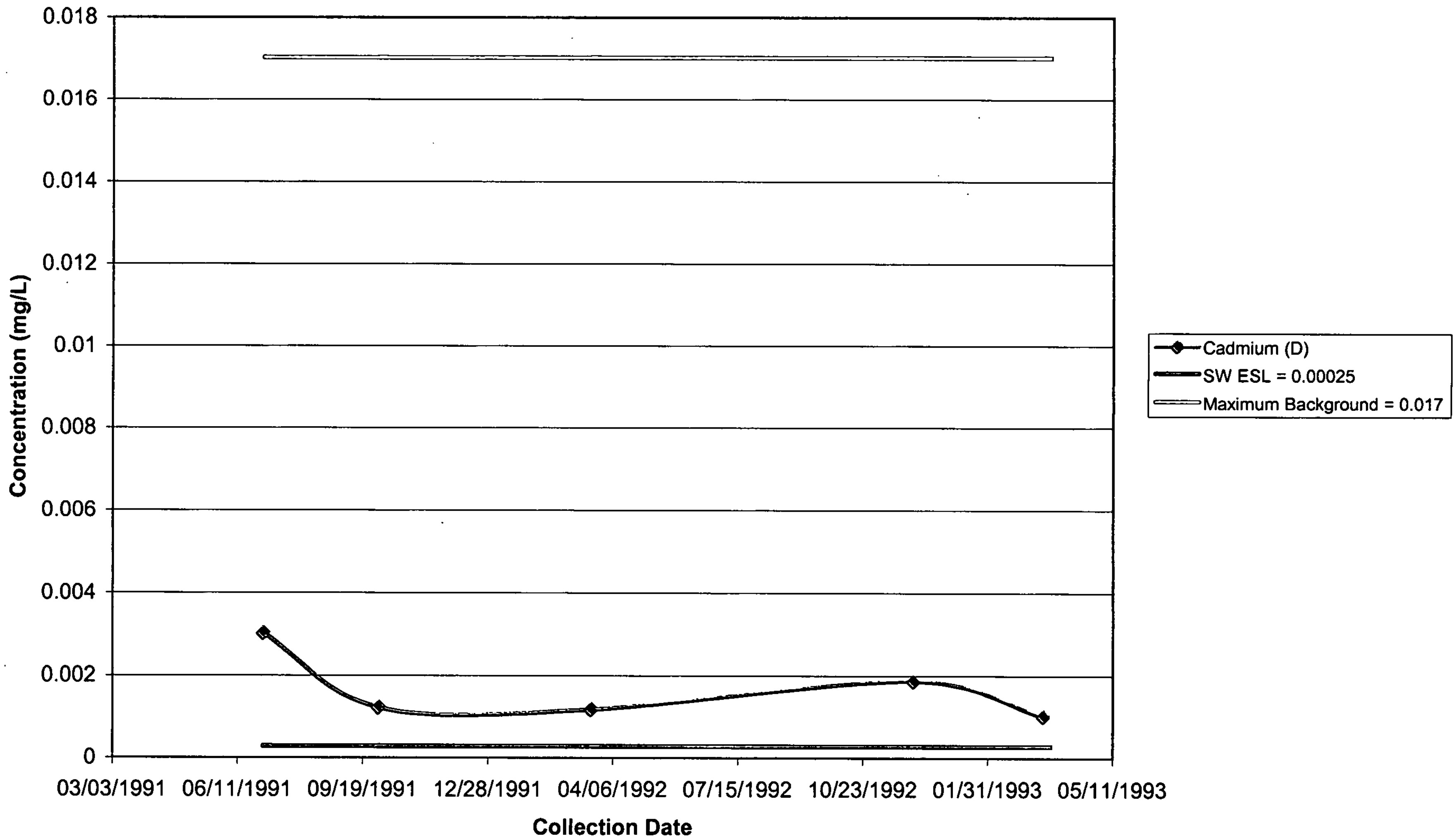

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Figure A3.4.RC AEU.8
Rock Creek Surface Water Sampling Location SW135 for Dissolved Cadmium

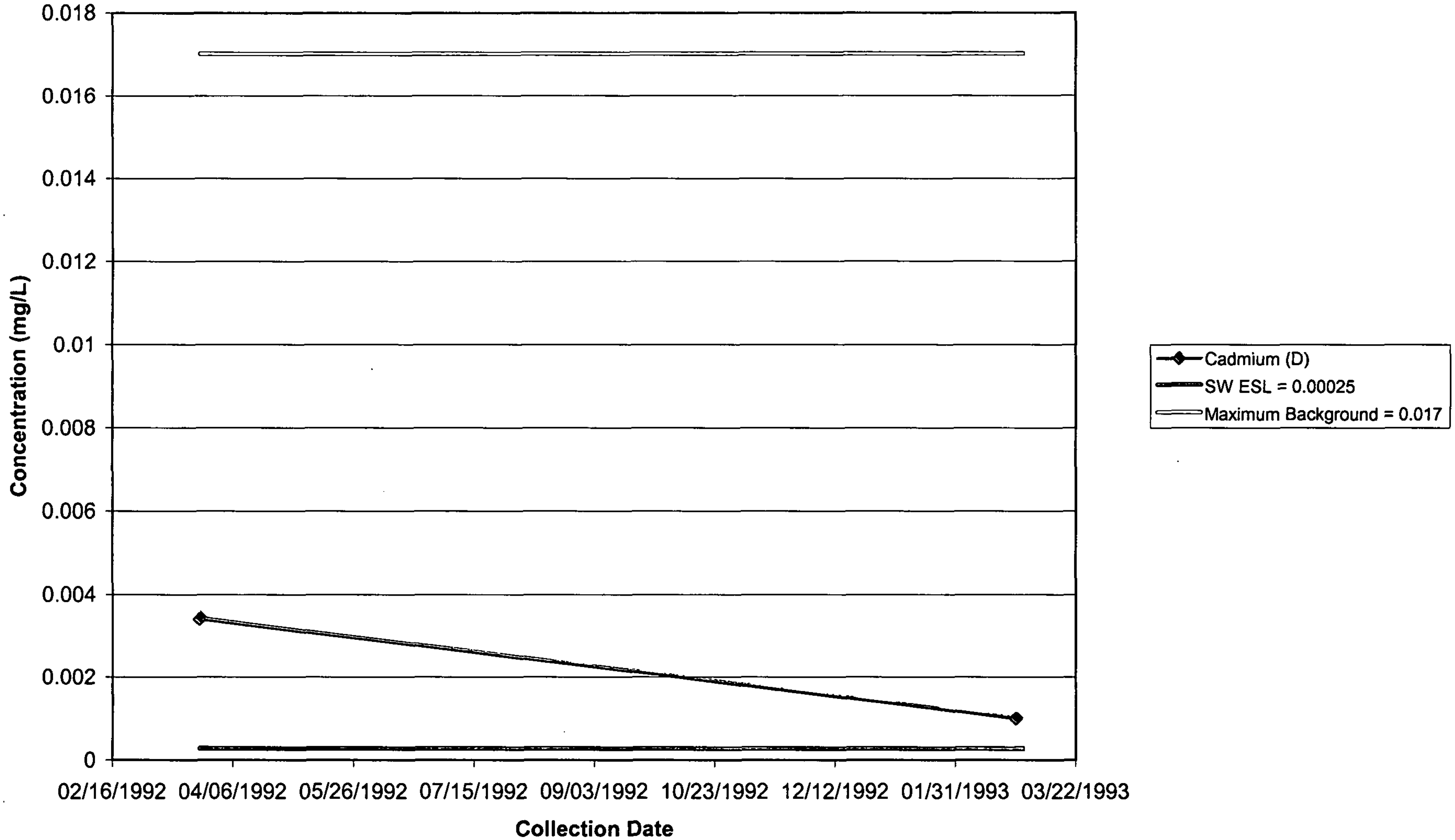
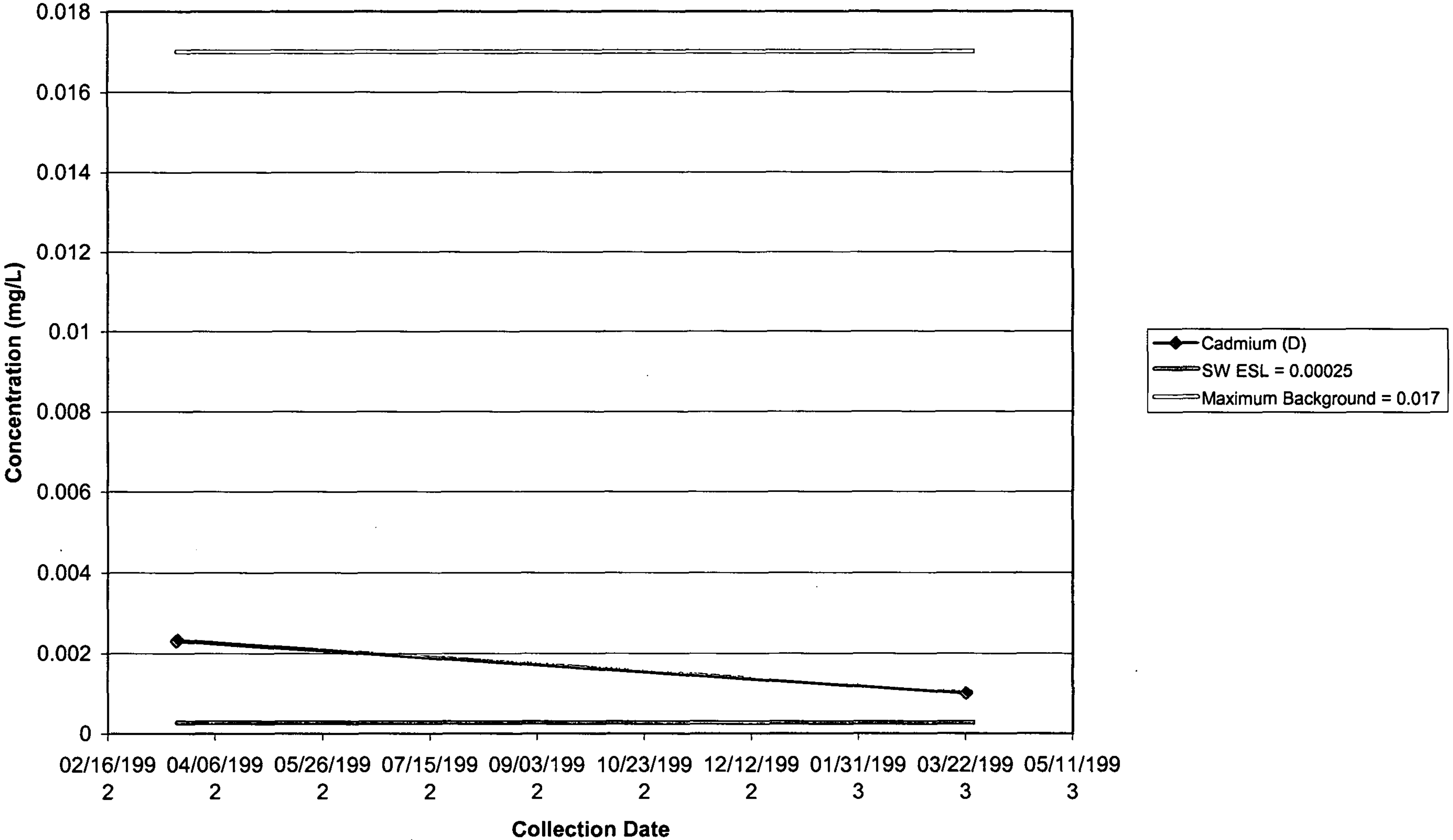


Figure A3.4.RC AEU.9
Rock Creek Surface Water Sampling Location SW137 for Dissolved Cadmium



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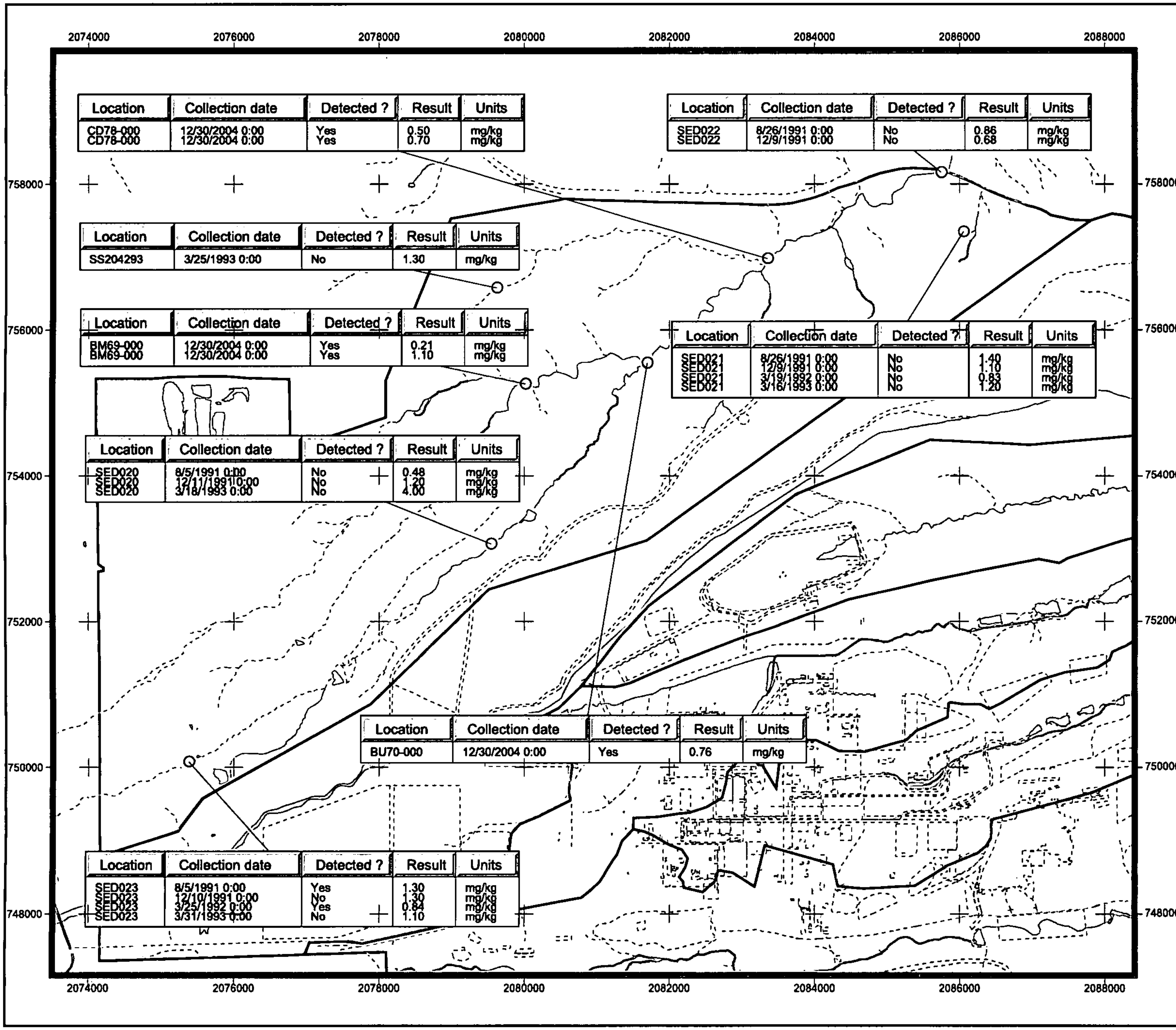

Location	Collection date	Detected ?	Result	Units
CD78-000	12/30/2004 0:00	Yes	0.50	mg/kg
CD78-000	12/30/2004 0:00	Yes	0.70	mg/kg

Location	Collection date	Detected ?	Result	Units
SED022	8/26/1991 0:00	No	0.86	mg/kg
SED022	12/9/1991 0:00	No	0.68	mg/kg

Location	Collection date	Detected ?	Result	Units
SS204293	3/25/1993 0:00	No	1.30	mg/kg

Location	Collection date	Detected ?	Result	Units
BM69-000	12/30/2004 0:00	Yes	0.21	mg/kg
BM69-000	12/30/2004 0:00	Yes	1.10	mg/kg

Location	Collection date	Detected ?	Result	Units
SED021	8/26/1991 0:00	No	1.40	mg/kg
SED021	12/9/1991 0:00	No	1.10	mg/kg
SED021	3/19/1992 0:00	No	0.83	mg/kg
SED021	3/16/1993 0:00	No	1.20	mg/kg

Location	Collection date	Detected ?	Result	Units
SED020	8/5/1991 0:00	No	0.48	mg/kg
SED020	12/11/1991 0:00	No	1.20	mg/kg
SED020	3/18/1993 0:00	No	4.00	mg/kg

Location	Collection date	Detected ?	Result	Units
BU70-000	12/30/2004 0:00	Yes	0.76	mg/kg

Location	Collection date	Detected ?	Result	Units
SED023	8/5/1991 0:00	Yes	1.30	mg/kg
SED023	12/10/1991 0:00	No	1.30	mg/kg
SED023	3/25/1992 0:00	Yes	0.84	mg/kg
SED023	3/31/1993 0:00	No	1.10	mg/kg

Figure A 3.4.RC AEU.10
Rock Creek AEU
Sediment Sampling Locations for Cadmium

KEY

Sampling location

- Detect >= ESL >= Maximum background
- Detect >=ESL < Maximum Background
- Detect < ESL < Maximum Background
- Nondetect

ESL = 0.99 mg/kg

Maximum background = 1.3 mg/kg

Standard Map Features

- Rock Creek AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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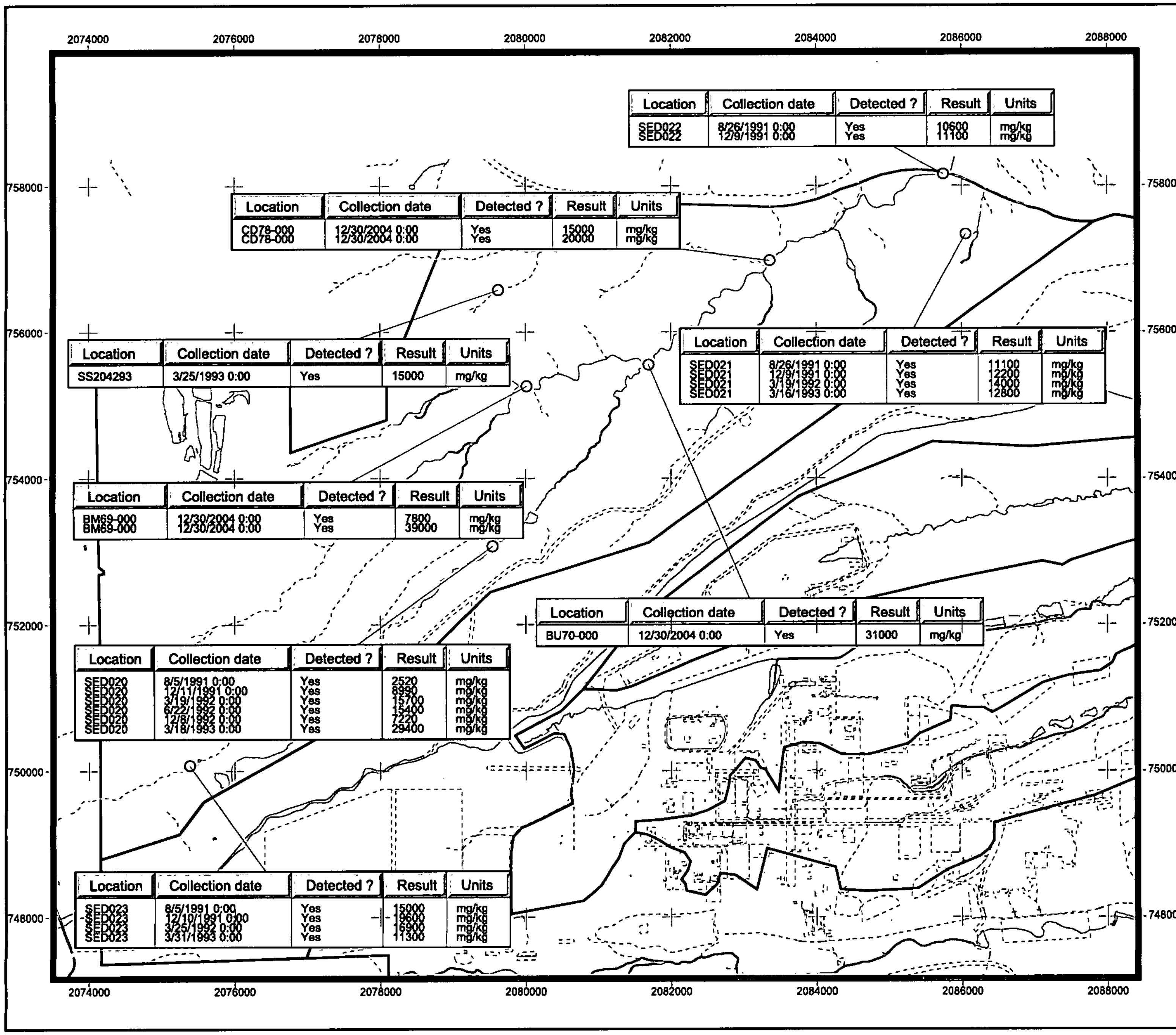

Location	Collection date	Detected ?	Result	Units
SED022	8/26/1991 0:00	Yes	10600	mg/kg
SED022	12/9/1991 0:00	Yes	11100	mg/kg

Location	Collection date	Detected ?	Result	Units
CD78-000	12/30/2004 0:00	Yes	15000	mg/kg
CD78-000	12/30/2004 0:00	Yes	20000	mg/kg

Location	Collection date	Detected ?	Result	Units
SS204293	3/25/1993 0:00	Yes	15000	mg/kg

Location	Collection date	Detected ?	Result	Units
SED021	8/26/1991 0:00	Yes	11100	mg/kg
SED021	12/9/1991 0:00	Yes	12200	mg/kg
SED021	3/19/1992 0:00	Yes	14000	mg/kg
SED021	3/16/1993 0:00	Yes	12800	mg/kg

Location	Collection date	Detected ?	Result	Units
BM69-000	12/30/2004 0:00	Yes	7800	mg/kg
BM69-000	12/30/2004 0:00	Yes	39000	mg/kg

Location	Collection date	Detected ?	Result	Units
BU70-000	12/30/2004 0:00	Yes	31000	mg/kg

Location	Collection date	Detected ?	Result	Units
SED020	8/5/1991 0:00	Yes	2520	mg/kg
SED020	12/11/1991 0:00	Yes	8990	mg/kg
SED020	3/19/1992 0:00	Yes	15700	mg/kg
SED020	6/22/1992 0:00	Yes	15400	mg/kg
SED020	12/8/1992 0:00	Yes	7220	mg/kg
SED020	3/18/1993 0:00	Yes	29400	mg/kg

Location	Collection date	Detected ?	Result	Units
SED023	8/5/1991 0:00	Yes	15000	mg/kg
SED023	12/10/1991 0:00	Yes	19600	mg/kg
SED023	3/25/1992 0:00	Yes	16900	mg/kg
SED023	3/31/1993 0:00	Yes	11300	mg/kg

Figure A3.4.RC AEU.11
Rock Creek AEU
Sediment Sampling Locations for Iron

KEY

Sampling location

- Detect >= ESL >= Maximum background
- Detect >=ESL < Maximum Background
- Detect < ESL < Maximum Background
- Nondetect

ESL = 20000 mg/kg

Maximum background = 31400 mg/kg

Standard Map Features

- Rock Creek AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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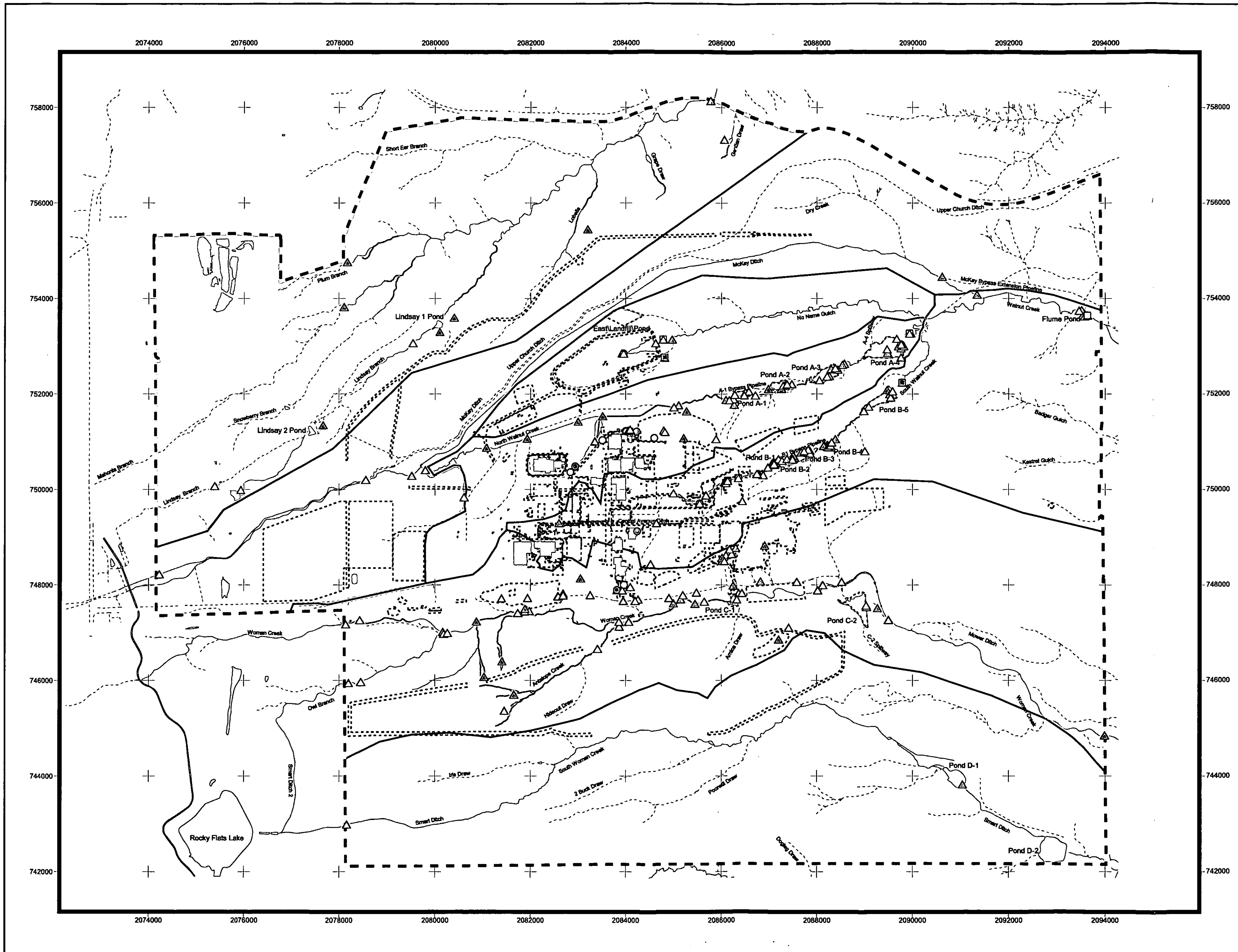

Figure A3.4.RC AEU.12

Lead Concentrations in Sitewide Surface Water

KEY

- Sample Collected Since October 1, 2000
- Sample Collected Between October 1, 1996 and October 1, 2000
- Sample Collected Between June 1, 1991 and October 1, 1996
- Concentration > Max Background MDC
- Concentration > ESL and <= Max Background MDC
- Concentration <= ESL
- Nondetect (ND)

ESL = 0.003 mg/L
Max Background MDC = 0.013 mg/L

Standard Map Features

- Rock Creek AEU
- Exposure Unit boundaries
- Former building where analyte was used or generated as waste
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

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Scale 1:24,000
State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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Figure A3.4.RC AEU.13
Rock Creek Surface Water Sampling Location SW005 for Dissolved Lead

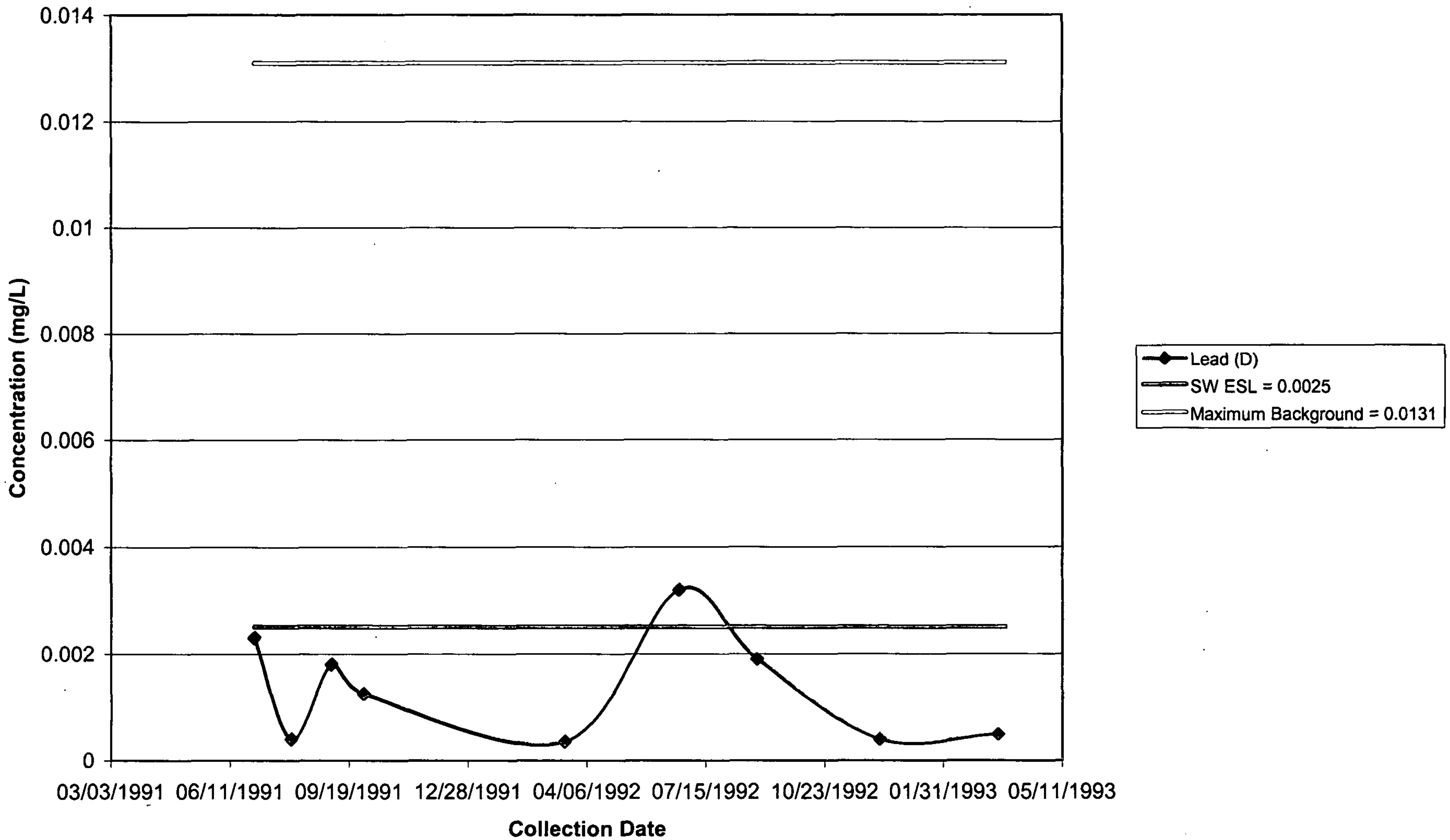

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Figure A3.4.RC AEU.14
Rock Creek Surface Water Sampling Location SW006 for Dissolved Lead

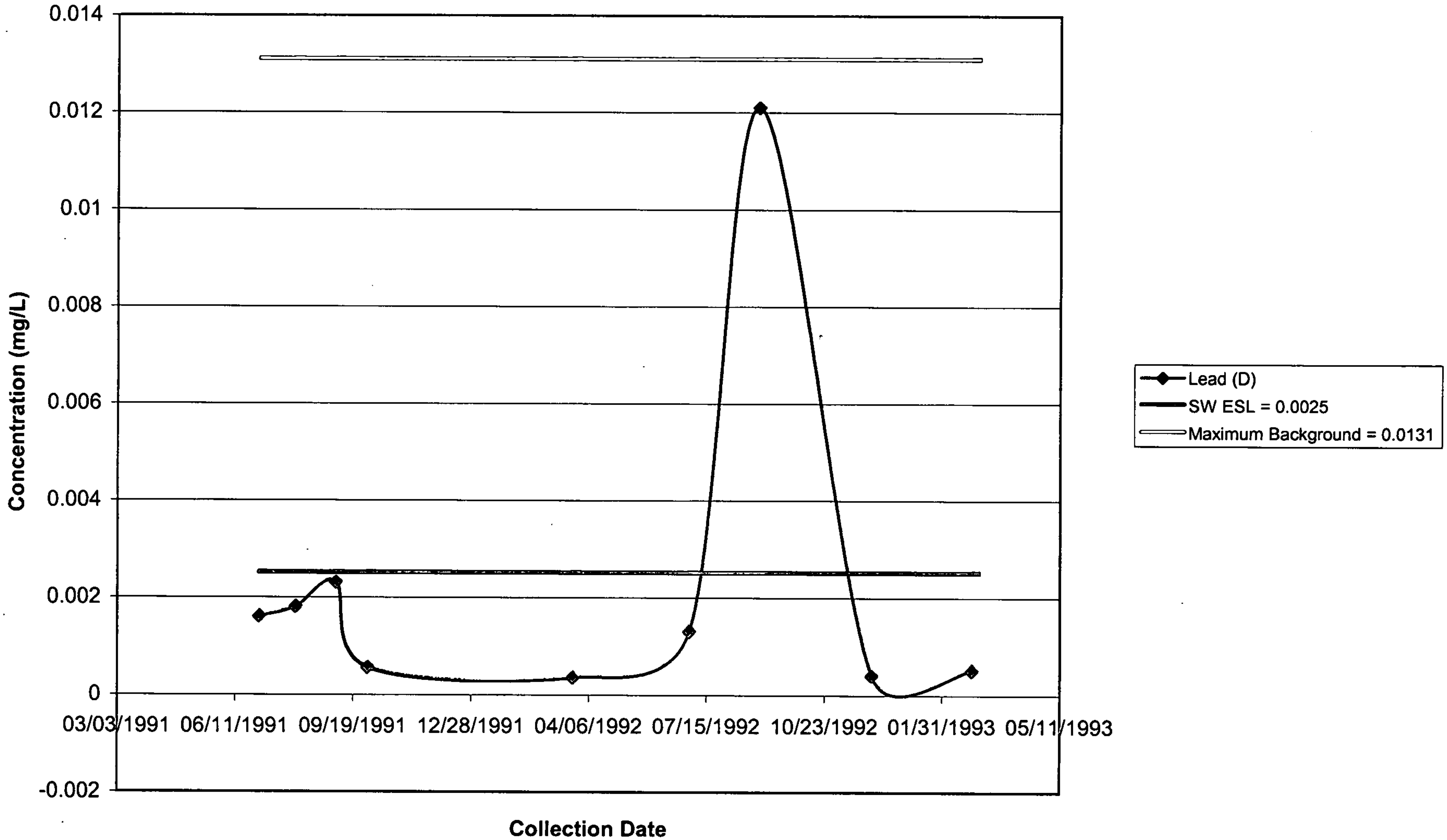

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Figure A3.4.RC AEU.15
Rock Creek Surface Water Sampling Location SW134 for Dissolved Lead

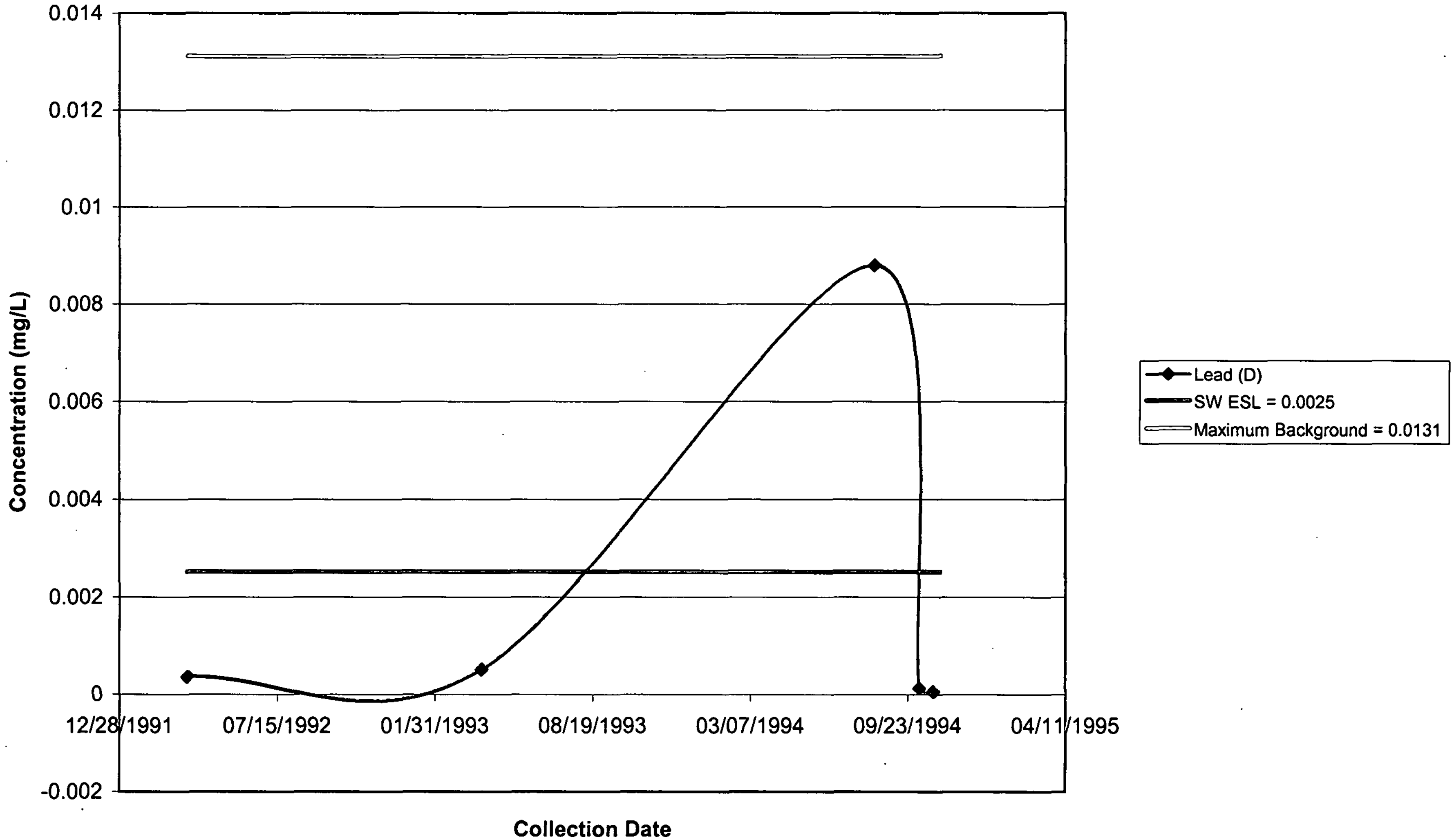

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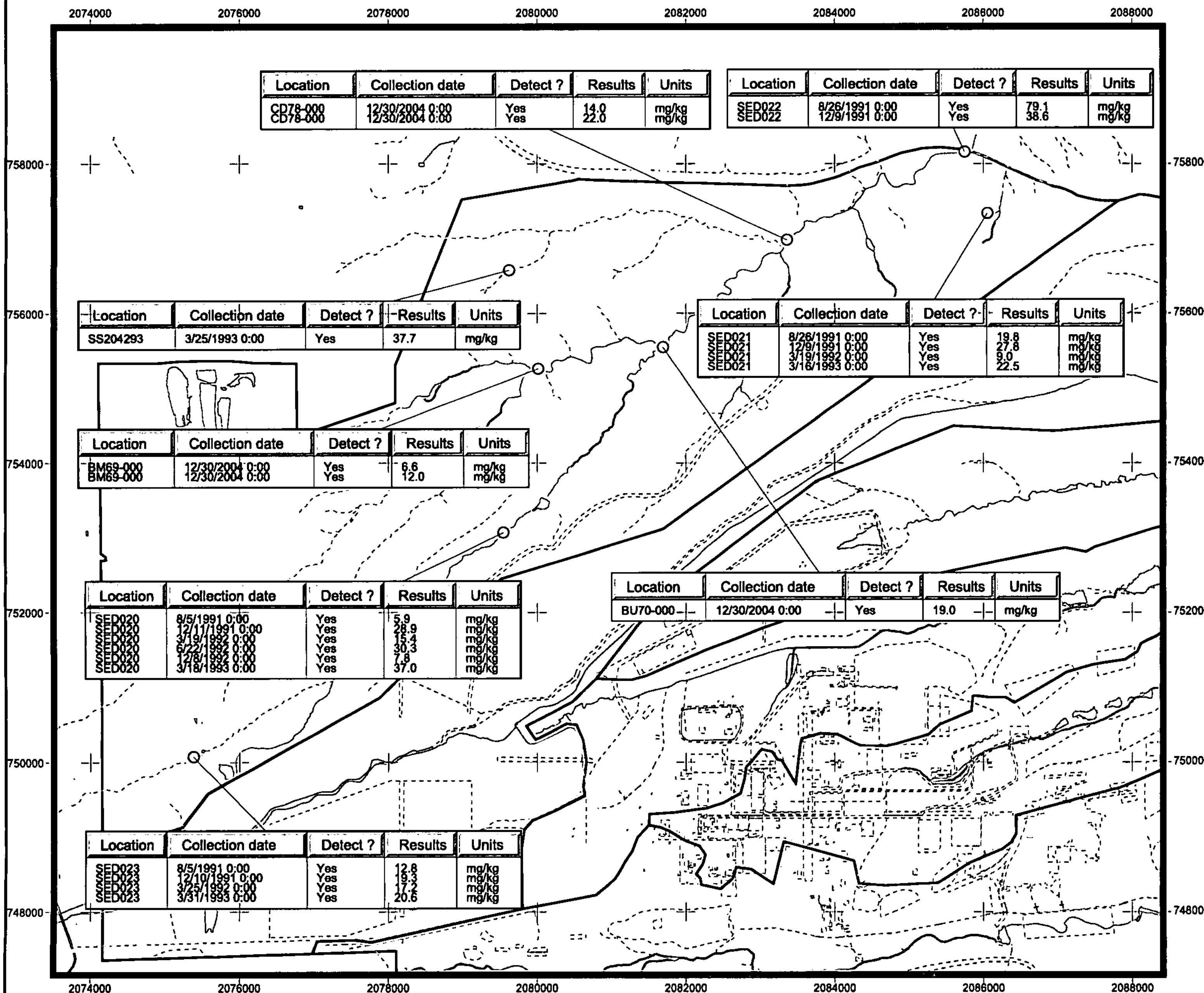
Figure A3.4.RC AEU.16
Rock Creek AEU
Sediment Sampling Locations for Lead



Location	Collection date	Detect ?	Results	Units
CD78-000	12/30/2004 0:00	Yes	14.0	mg/kg
CD78-000	12/30/2004 0:00	Yes	22.0	mg/kg

Location	Collection date	Detect ?	Results	Units
SED022	8/26/1991 0:00	Yes	79.1	mg/kg
SED022	12/9/1991 0:00	Yes	38.6	mg/kg

Location	Collection date	Detect ?	Results	Units
SS204293	3/25/1993 0:00	Yes	37.7	mg/kg

Location	Collection date	Detect ?	Results	Units
SED021	8/26/1991 0:00	Yes	19.8	mg/kg
SED021	12/9/1991 0:00	Yes	27.8	mg/kg
SED021	3/19/1992 0:00	Yes	9.0	mg/kg
SED021	3/16/1993 0:00	Yes	22.5	mg/kg

Location	Collection date	Detect ?	Results	Units
BM69-000	12/30/2004 0:00	Yes	6.6	mg/kg
BM69-000	12/30/2004 0:00	Yes	12.0	mg/kg

Location	Collection date	Detect ?	Results	Units
SED020	8/5/1991 0:00	Yes	5.9	mg/kg
SED020	12/11/1991 0:00	Yes	28.9	mg/kg
SED020	3/19/1992 0:00	Yes	15.4	mg/kg
SED020	6/22/1992 0:00	Yes	30.3	mg/kg
SED020	12/8/1992 0:00	Yes	7.8	mg/kg
SED020	3/18/1993 0:00	Yes	37.0	mg/kg

Location	Collection date	Detect ?	Results	Units
BU70-000	12/30/2004 0:00	Yes	19.0	mg/kg

Location	Collection date	Detect ?	Results	Units
SED023	8/5/1991 0:00	Yes	12.8	mg/kg
SED023	12/10/1991 0:00	Yes	19.3	mg/kg
SED023	3/25/1992 0:00	Yes	17.2	mg/kg
SED023	3/31/1993 0:00	Yes	20.6	mg/kg

KEY

Sampling location

- Detect >= ESL >= Maximum background
- Detect >=ESL < Maximum Background
- Detect < ESL < Maximum Background
- Nondetect

ESL = 35.8 mg/kg

Maximum background = 68.8 mg/kg

Standard Map Features

- Rock Creek AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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ArcView\AEU_PJ\rcaeu_pj_maps.apr

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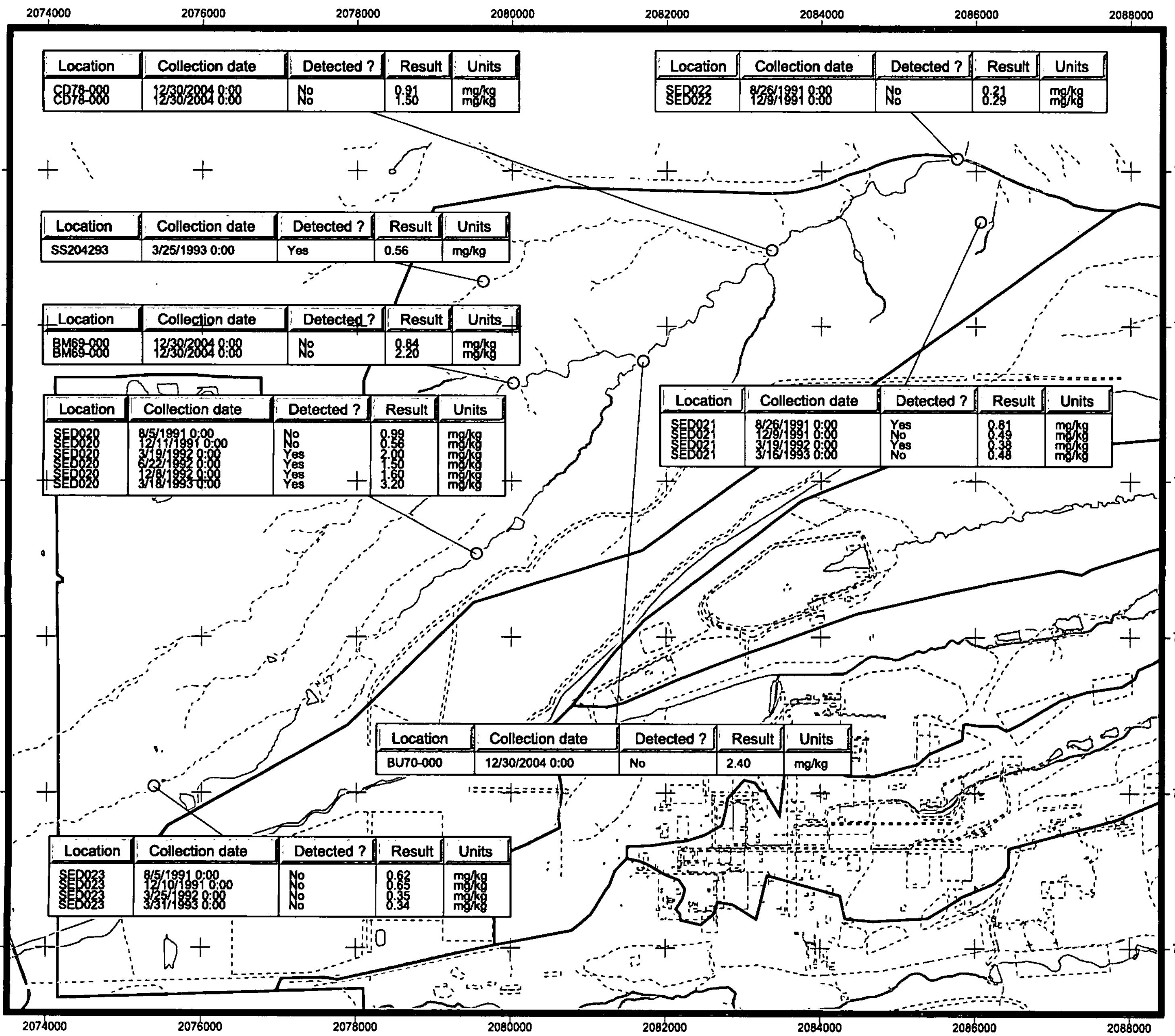
Figure A3.4.RC AEU.17
Rock Creek AEU
Sediment Sampling Locations for Selenium



Location	Collection date	Detected ?	Result	Units
CD78-000	12/30/2004 0:00	No	0.91	mg/kg
CD78-000	12/30/2004 0:00	No	1.50	mg/kg

Location	Collection date	Detected ?	Result	Units
SED022	8/26/1991 0:00	No	0.21	mg/kg
SED022	12/9/1991 0:00	No	0.29	mg/kg

Location	Collection date	Detected ?	Result	Units
SS204293	3/25/1993 0:00	Yes	0.56	mg/kg

Location	Collection date	Detected ?	Result	Units
BM69-000	12/30/2004 0:00	No	0.84	mg/kg
BM69-000	12/30/2004 0:00	No	2.20	mg/kg

Location	Collection date	Detected ?	Result	Units
SED020	8/5/1991 0:00	No	0.99	mg/kg
SED020	12/11/1991 0:00	No	0.56	mg/kg
SED020	3/19/1992 0:00	Yes	2.00	mg/kg
SED020	6/22/1992 0:00	Yes	1.50	mg/kg
SED020	12/8/1992 0:00	Yes	1.60	mg/kg
SED020	3/18/1993 0:00	Yes	3.20	mg/kg

Location	Collection date	Detected ?	Result	Units
SED021	8/26/1991 0:00	Yes	0.81	mg/kg
SED021	12/9/1991 0:00	No	0.49	mg/kg
SED021	3/19/1992 0:00	Yes	0.38	mg/kg
SED021	3/16/1993 0:00	No	0.48	mg/kg

Location	Collection date	Detected ?	Result	Units
BU70-000	12/30/2004 0:00	No	2.40	mg/kg

Location	Collection date	Detected ?	Result	Units
SED023	8/5/1991 0:00	No	0.62	mg/kg
SED023	12/10/1991 0:00	No	0.65	mg/kg
SED023	3/25/1992 0:00	No	0.35	mg/kg
SED023	3/31/1993 0:00	No	0.34	mg/kg

KEY

Sampling location

- Detect >= ESL >= Maximum background
- Detect >=ESL < Maximum Background
- Detect < ESL < Maximum Background
- Nondetect

ESL = 0.95 mg/kg

Maximum background = 3.2 mg/kg

Standard Map Features

- Rock Creek AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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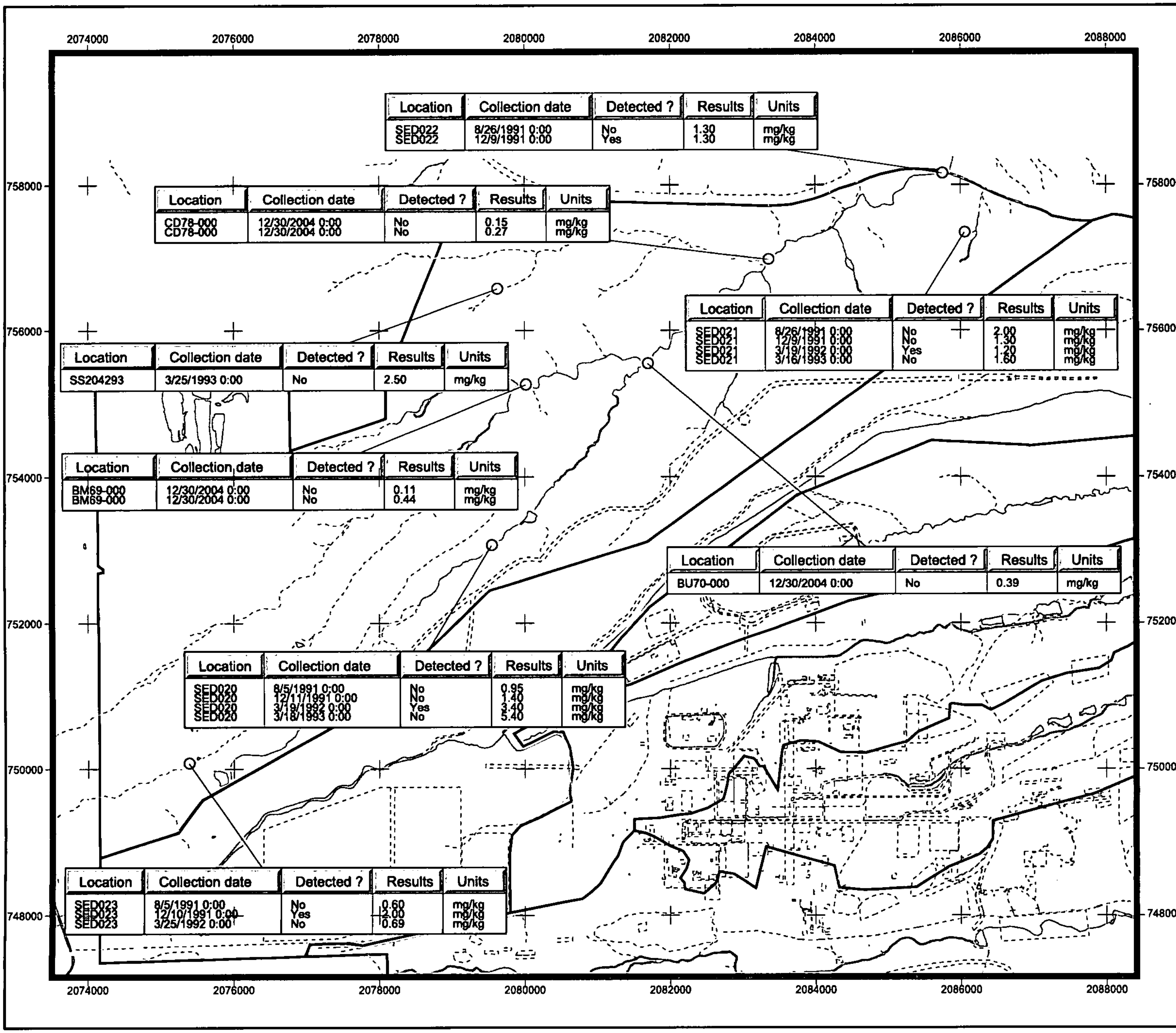

Location	Collection date	Detected ?	Results	Units
SED022	8/26/1991 0:00	No	1.30	mg/kg
SED022	12/9/1991 0:00	Yes	1.30	mg/kg

Location	Collection date	Detected ?	Results	Units
CD78-000	12/30/2004 0:00	No	0.15	mg/kg
CD78-000	12/30/2004 0:00	No	0.27	mg/kg

Location	Collection date	Detected ?	Results	Units
SED021	8/26/1991 0:00	No	2.00	mg/kg
SED021	12/9/1991 0:00	No	1.30	mg/kg
SED021	3/19/1992 0:00	Yes	1.20	mg/kg
SED021	3/16/1993 0:00	No	1.60	mg/kg

Location	Collection date	Detected ?	Results	Units
SS204293	3/25/1993 0:00	No	2.50	mg/kg

Location	Collection date	Detected ?	Results	Units
BM69-000	12/30/2004 0:00	No	0.11	mg/kg
BM69-000	12/30/2004 0:00	No	0.44	mg/kg

Location	Collection date	Detected ?	Results	Units
BU70-000	12/30/2004 0:00	No	0.39	mg/kg

Location	Collection date	Detected ?	Results	Units
SED020	8/5/1991 0:00	No	0.95	mg/kg
SED020	12/11/1991 0:00	No	1.40	mg/kg
SED020	3/19/1992 0:00	Yes	3.40	mg/kg
SED020	3/18/1993 0:00	No	5.40	mg/kg

Location	Collection date	Detected ?	Results	Units
SED023	8/5/1991 0:00	No	0.60	mg/kg
SED023	12/10/1991 0:00	Yes	2.00	mg/kg
SED023	3/25/1992 0:00	No	0.69	mg/kg

Figure A3.4.RC AEU.18 Rock Creek AEU Sediment Sampling Locations for Silver

KEY

Sampling location

- Detect >= ESL >= Maximum background
- Detect >=ESL < Maximum Background
- Detect < ESL < Maximum Background
- Nondetect

ESL = 1 mg/kg

Maximum background = 3.4 mg/kg

Standard Map Features

- Rock Creek AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N S E W

0 1000 2000 Feet

Scale 1:24000

State Plane Coordinate Projection
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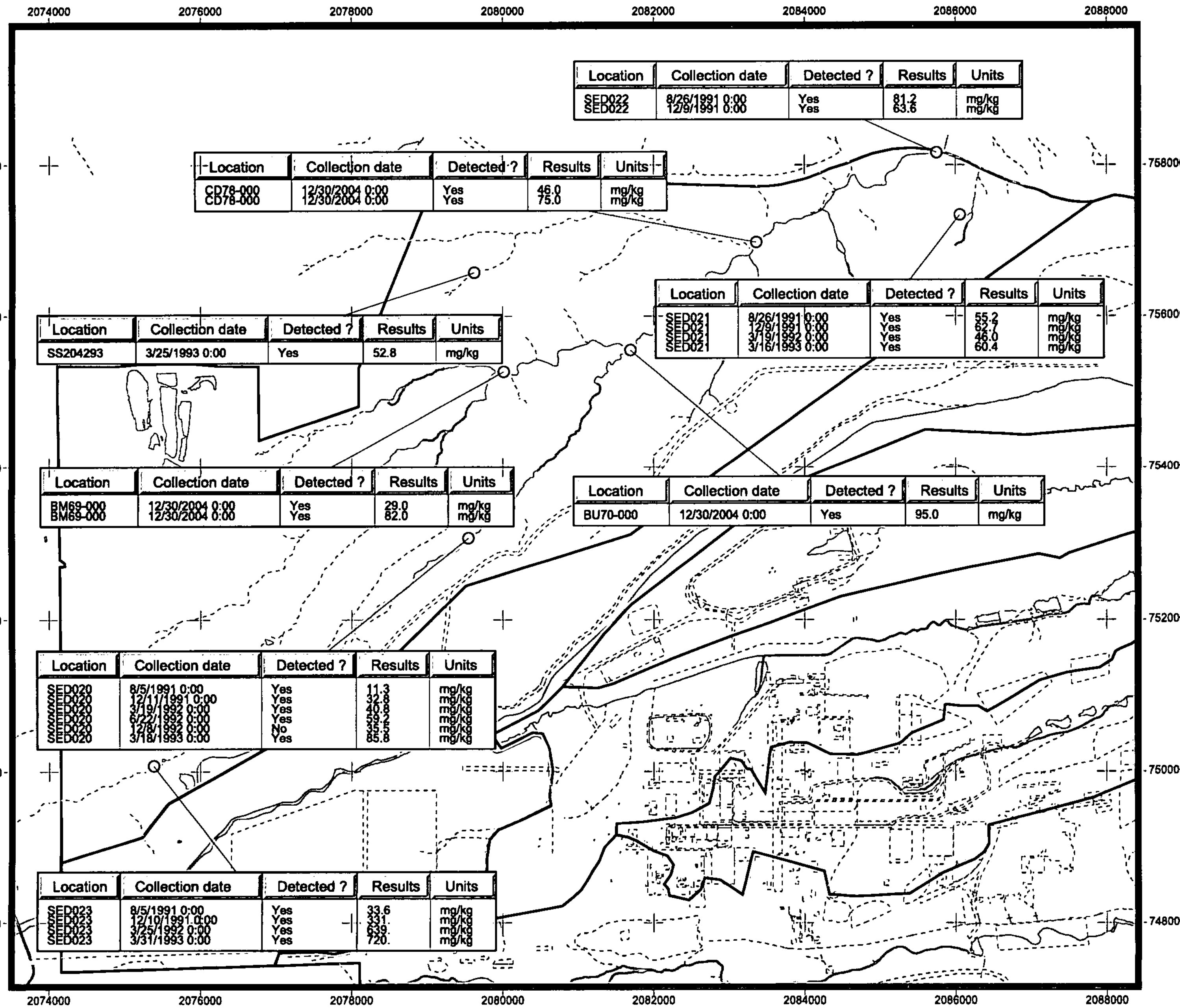
Figure A3.4.RC AEU.19
Rock Creek AEU
Sediment Sampling Locations for Zinc



Location	Collection date	Detected ?	Results	Units
SED022	8/26/1991 0:00	Yes	81.2	mg/kg
SED022	12/9/1991 0:00	Yes	63.6	mg/kg

Location	Collection date	Detected ?	Results	Units
CD78-000	12/30/2004 0:00	Yes	46.0	mg/kg
CD78-000	12/30/2004 0:00	Yes	75.0	mg/kg

Location	Collection date	Detected ?	Results	Units
SED021	8/26/1991 0:00	Yes	55.2	mg/kg
SED021	12/9/1991 0:00	Yes	62.7	mg/kg
SED021	3/19/1992 0:00	Yes	46.0	mg/kg
SED021	3/16/1993 0:00	Yes	60.4	mg/kg

Location	Collection date	Detected ?	Results	Units
SS204293	3/25/1993 0:00	Yes	52.8	mg/kg

Location	Collection date	Detected ?	Results	Units
BM69-000	12/30/2004 0:00	Yes	29.0	mg/kg
BM69-000	12/30/2004 0:00	Yes	82.0	mg/kg

Location	Collection date	Detected ?	Results	Units
BU70-000	12/30/2004 0:00	Yes	95.0	mg/kg

Location	Collection date	Detected ?	Results	Units
SED020	8/5/1991 0:00	Yes	11.3	mg/kg
SED020	12/11/1991 0:00	Yes	32.8	mg/kg
SED020	3/19/1992 0:00	Yes	40.8	mg/kg
SED020	6/22/1992 0:00	Yes	59.2	mg/kg
SED020	12/8/1992 0:00	No	35.5	mg/kg
SED020	3/18/1993 0:00	Yes	85.8	mg/kg

Location	Collection date	Detected ?	Results	Units
SED023	8/5/1991 0:00	Yes	33.6	mg/kg
SED023	12/10/1991 0:00	Yes	331.	mg/kg
SED023	3/25/1992 0:00	Yes	639.	mg/kg
SED023	3/31/1993 0:00	Yes	720.	mg/kg

KEY

Sampling location

- Detect >= ESL >= Maximum background
- Detect >=ESL < Maximum Background
- Detect < ESL < Maximum Background
- Nondetect

ESL = 121mg/kg

Maximum background = 720 mg/kg

Standard Map Features

- Rock Creek AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

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S

0 1000 2000 Feet

Scale 1:24000

State Plane Coordinate Projection
Colorado Central Zone
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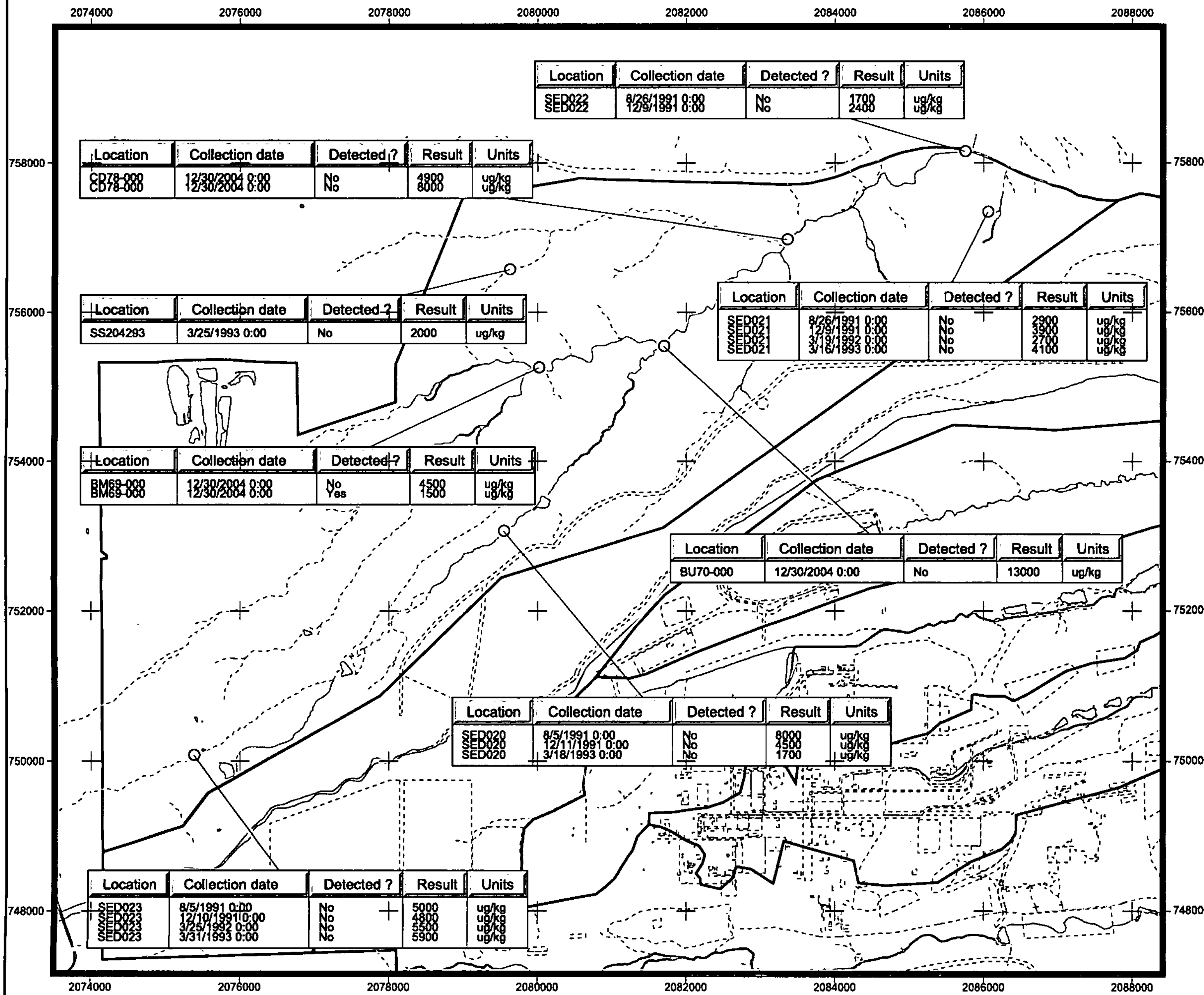
Figure A3.4.RC AEU.20
Rock Creek AEU
Sediment Sampling Locations for Pentachlorophenol



Location	Collection date	Detected ?	Result	Units
SED022	8/26/1991 0:00	No	1700	ug/kg
SED022	12/9/1991 0:00	No	2400	ug/kg

Location	Collection date	Detected ?	Result	Units
CD78-000	12/30/2004 0:00	No	4900	ug/kg
CD78-000	12/30/2004 0:00	No	8000	ug/kg

Location	Collection date	Detected ?	Result	Units
SS204293	3/25/1993 0:00	No	2000	ug/kg

Location	Collection date	Detected ?	Result	Units
SED021	8/26/1991 0:00	No	2900	ug/kg
SED021	12/9/1991 0:00	No	3900	ug/kg
SED021	3/19/1992 0:00	No	2700	ug/kg
SED021	3/16/1993 0:00	No	4100	ug/kg

Location	Collection date	Detected ?	Result	Units
BM69-000	12/30/2004 0:00	No	4500	ug/kg
BM69-000	12/30/2004 0:00	Yes	1500	ug/kg

Location	Collection date	Detected ?	Result	Units
BU70-000	12/30/2004 0:00	No	13000	ug/kg

Location	Collection date	Detected ?	Result	Units
SED020	8/5/1991 0:00	No	8000	ug/kg
SED020	12/11/1991 0:00	No	4500	ug/kg
SED020	3/18/1993 0:00	No	1700	ug/kg

Location	Collection date	Detected ?	Result	Units
SED023	8/5/1991 0:00	No	5000	ug/kg
SED023	12/10/1991 0:00	No	4800	ug/kg
SED023	3/25/1992 0:00	No	5500	ug/kg
SED023	3/31/1993 0:00	No	5900	ug/kg

KEY

Sampling location

- Detect >=ESL
- Detect < ESL
- Nondetect

ESL = 255 ug/kg

Standard Map Features

- Rock Creek AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:24000

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ArcView\AEU_P.J\rcaeu_pl_maps.apr

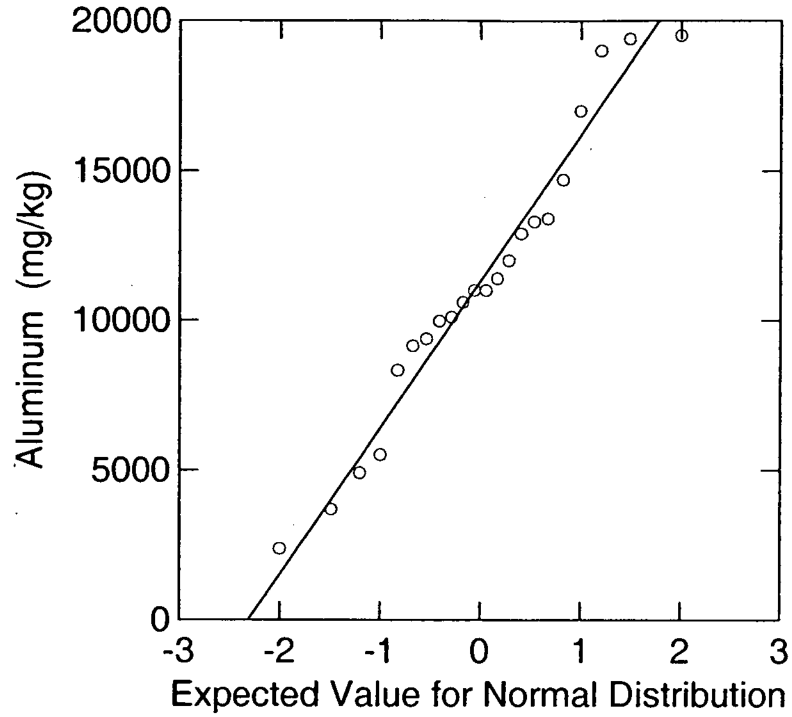

Figure A3.4.RC AEU.21 **Probability Plot of Aluminum Concentrations in Sediments from RC AEU.**

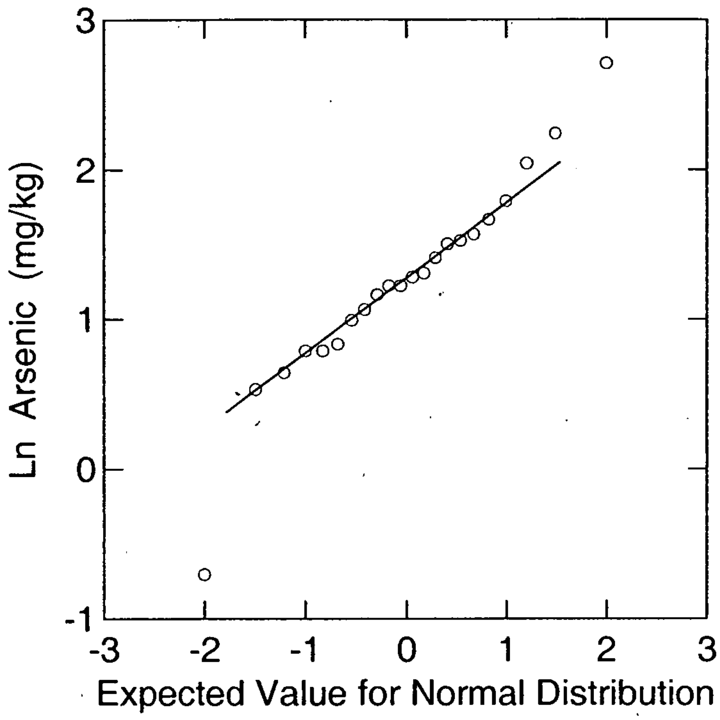

Figure A3.4.RC AEU.22 **Probability Plot of Arsenic Concentrations (Natural Logarithm) in Sediments from RC AEU.**

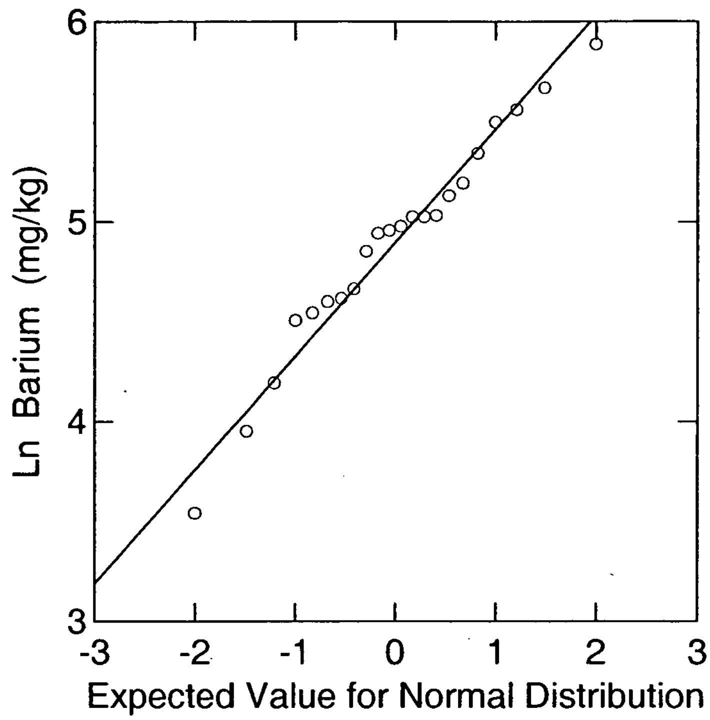

Figure A3.4.RC AEU.23 **Probability Plot of Barium Concentrations (Natural Logarithm) in Sediments from RC AEU.**

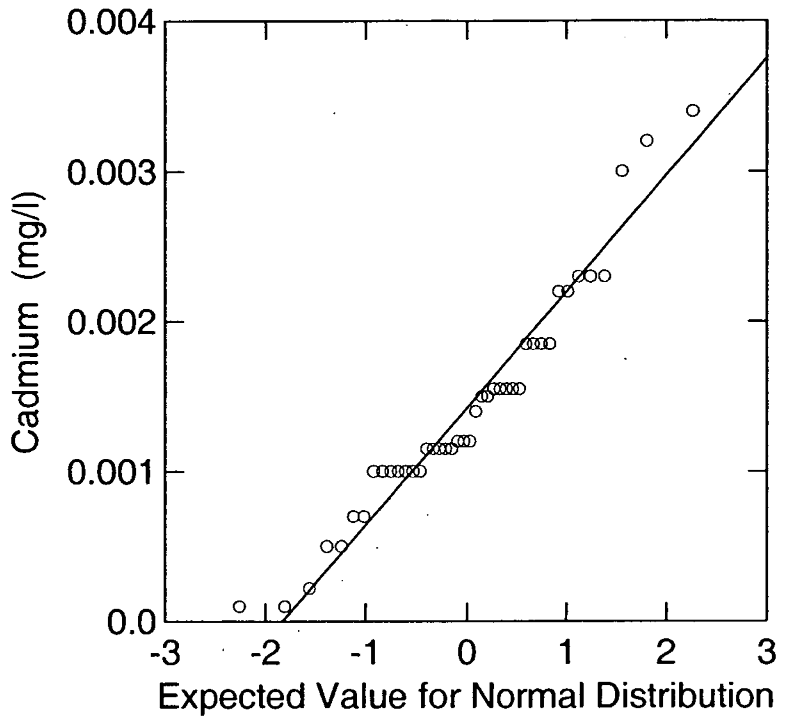

Figure A3.4.RC AEU.24 **Probability Plot of Cadmium Concentrations in Surface Water from RC AEU.**

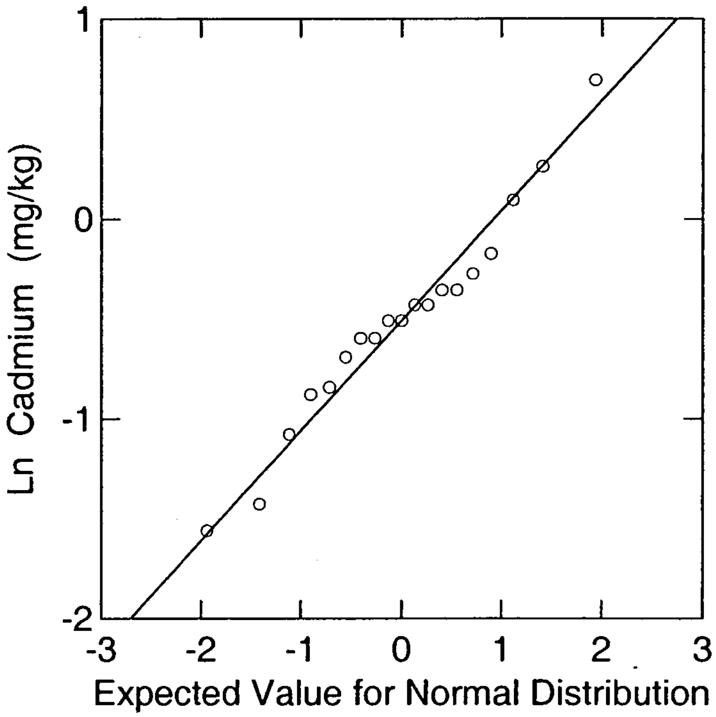

Figure A3.4.RC AEU.25 **Probability Plot of Cadmium Concentrations (Natural Logarithm) in Sediments from RC AEU.**

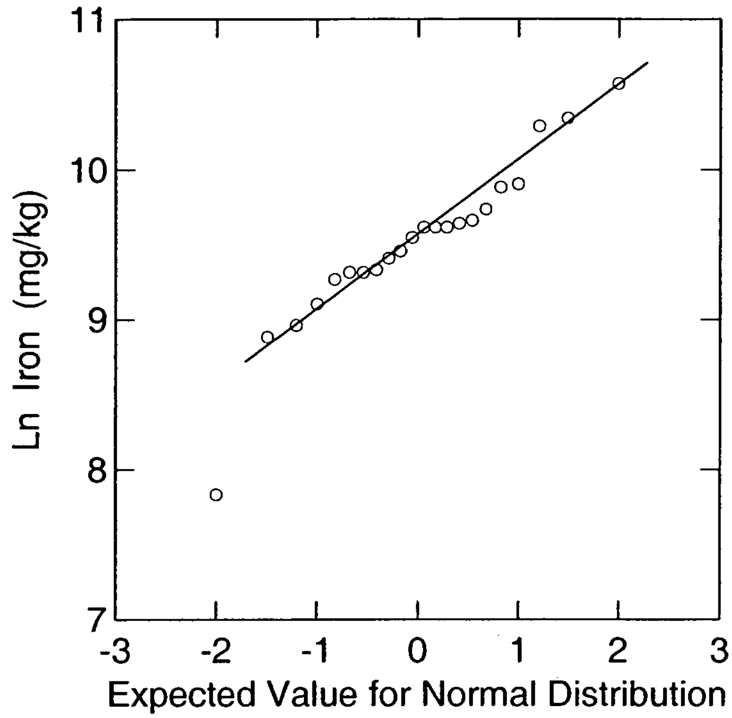

Figure A3.4.RC AEU.26 **Probability Plot of Iron Concentrations (Natural Logarithm) in Sediments from RC AEU.**

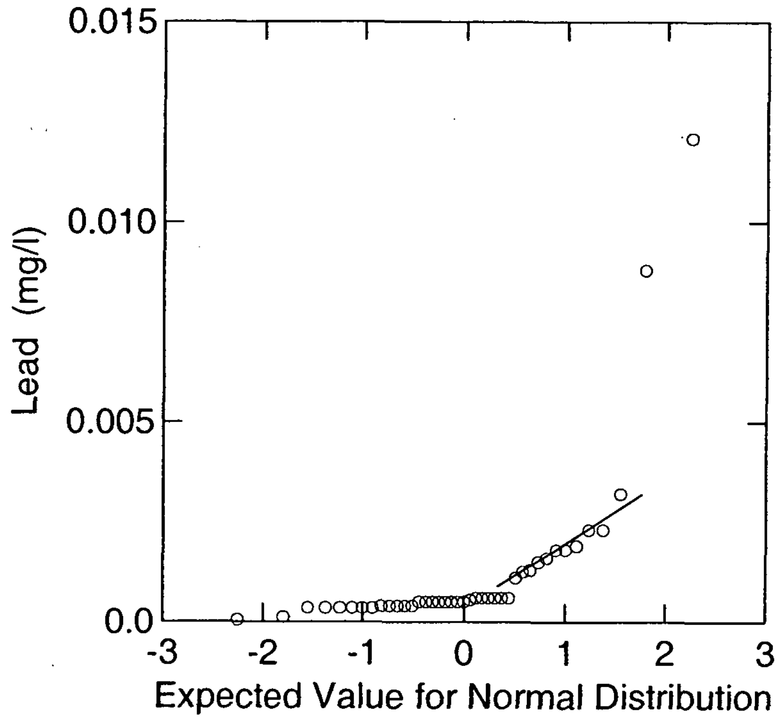

Figure A3.4.RC AEU.27 Probability Plot of Lead Concentrations in Surface Water from RC AEU.

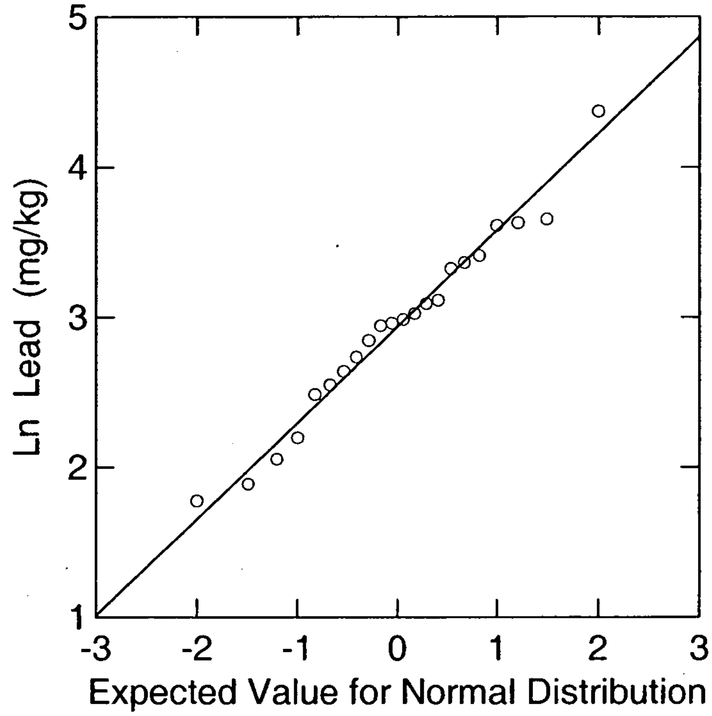

Figure A3.4.RC AEU.28 **Probability Plot of Lead Concentrations (Natural Logarithm) in Sediments from RC AEU.**

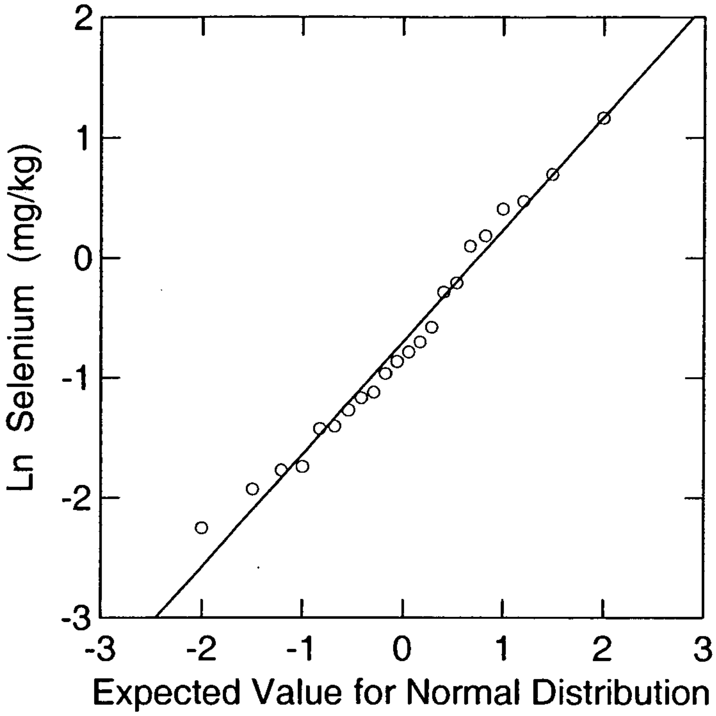

Figure A3.4.RC AEU.29 **Probability Plot of Selenium Concentrations (Natural Logarithm) in Sediments from RC AEU.**

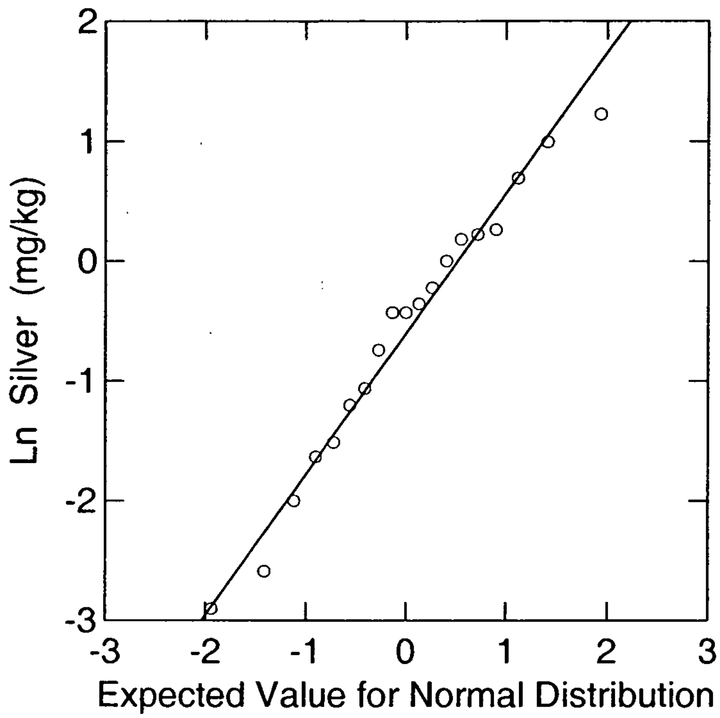

Figure A3.4.RC AEU.30 **Probability Plot of Silver Concentrations (Natural Logarithm) in Sediments from RC AEU.**

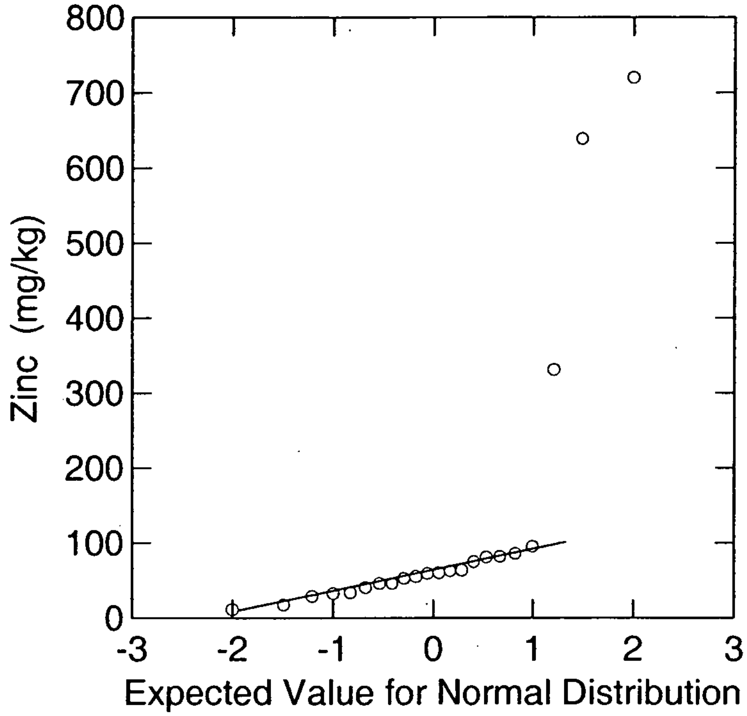

Figure A3.4.RC AEU.31 **Probability Plot of Zinc Concentrations in Sediments from RC AEU.**

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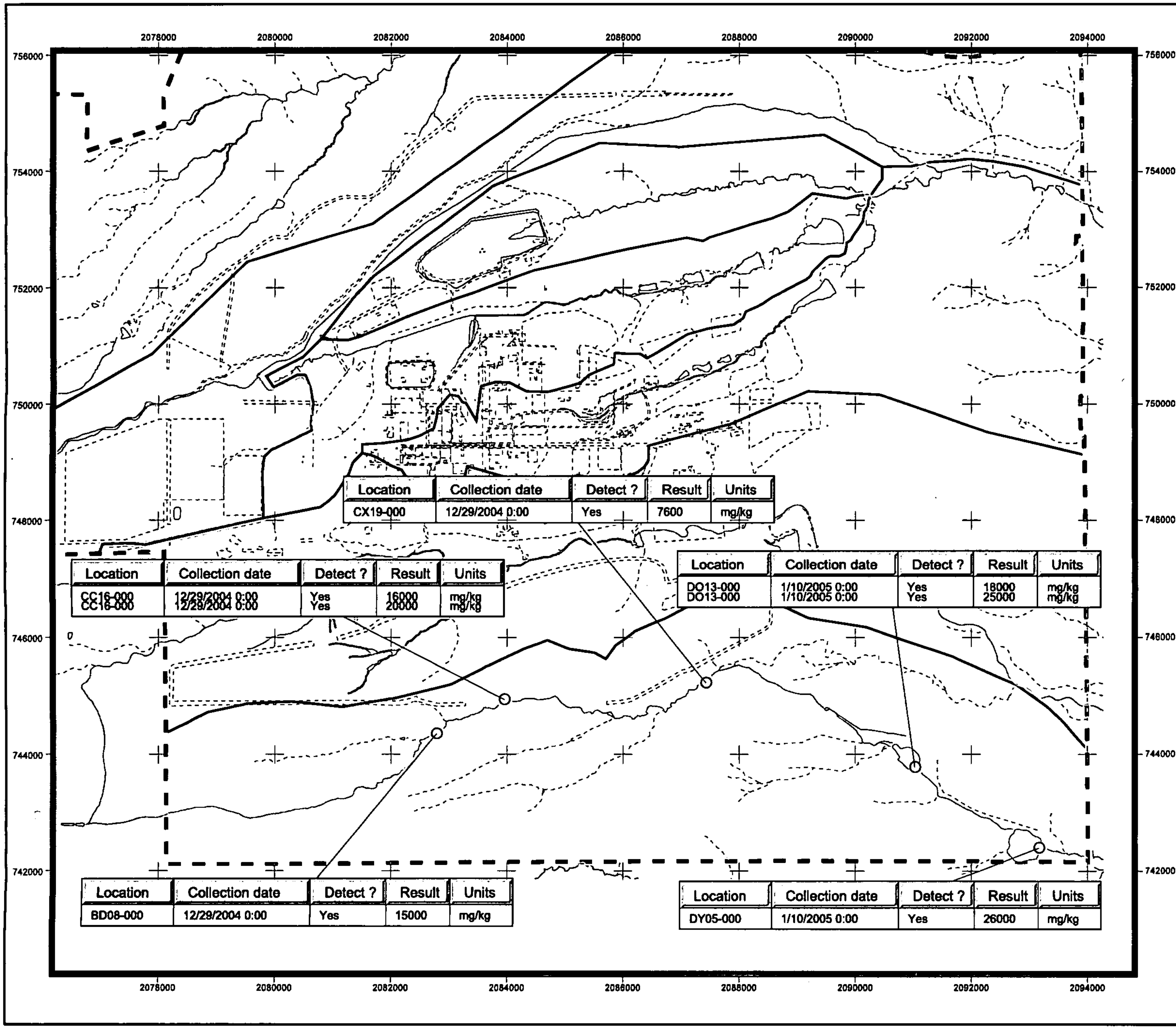

Location	Collection date	Detect ?	Result	Units
CX19-000	12/29/2004 0:00	Yes	7600	mg/kg

Location	Collection date	Detect ?	Result	Units
CC16-000	12/29/2004 0:00	Yes	16000	mg/kg
CC16-000	12/29/2004 0:00	Yes	20000	mg/kg

Location	Collection date	Detect ?	Result	Units
DO13-000	1/10/2005 0:00	Yes	18000	mg/kg
DO13-000	1/10/2005 0:00	Yes	25000	mg/kg

Location	Collection date	Detect ?	Result	Units
BD08-000	12/29/2004 0:00	Yes	15000	mg/kg

Location	Collection date	Detect ?	Result	Units
DY05-000	1/10/2005 0:00	Yes	26000	mg/kg

Figure A3.4.SE AEU.1
Southeast AEU
Sediment Sampling Locations for Aluminum

KEY

Sampling location

- ○ Detect >= ESL >= Maximum background
- ○ Detect >=ESL < Maximum Background
- ○ Detect < ESL < Maximum Background
- ○ Nondetect

ESL = 15900 mg/kg

Maximum background = 25200 mg/kg

Standard Map Features

- Southeast AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1250 2500 Feet

Scale 1:30000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

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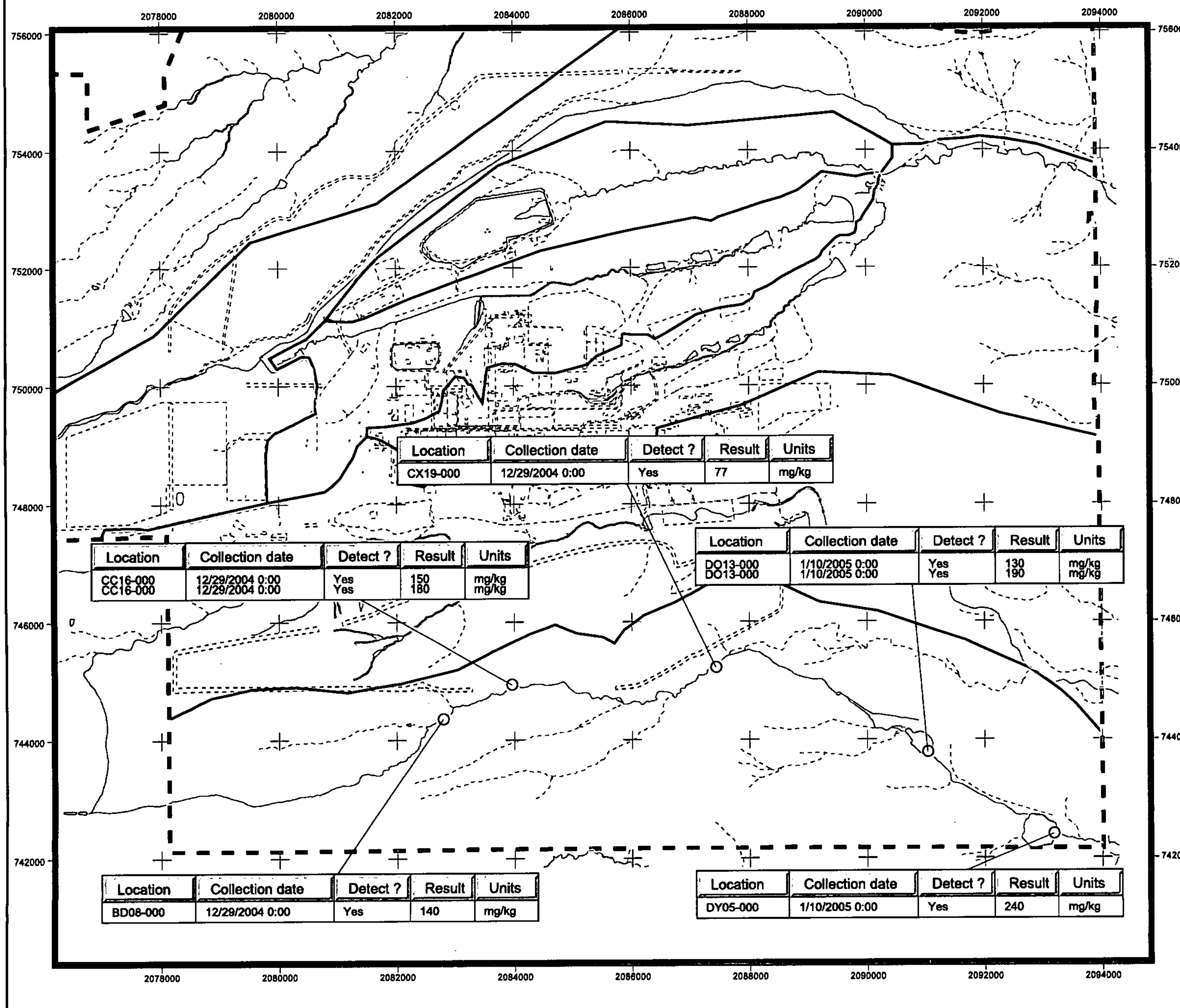

Location	Collection date	Detect ?	Result	Units
CX19-000	12/29/2004 0:00	Yes	77	mg/kg

Location	Collection date	Detect ?	Result	Units
CC16-000	12/29/2004 0:00	Yes	150	mg/kg
CC16-000	12/29/2004 0:00	Yes	180	mg/kg

Location	Collection date	Detect ?	Result	Units
DO13-000	1/10/2005 0:00	Yes	130	mg/kg
DO13-000	1/10/2005 0:00	Yes	190	mg/kg

Location	Collection date	Detect ?	Result	Units
BD08-000	12/29/2004 0:00	Yes	140	mg/kg

Location	Collection date	Detect ?	Result	Units
DY05-000	1/10/2005 0:00	Yes	240	mg/kg

Figure A3.4.SE AEU.2
Southeast AEU
Sediment Sampling Locations for Barium

KEY

Sampling location

- Detect >= ESL >= Maximum background
- Detect >=ESL < Maximum Background
- Detect < ESL < Maximum Background
- Nondetect

ESL = 189 mg/kg

Maximum background = 260 mg/kg

Standard Map Features

- Southeast AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N
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E
S

0 1250 2500 Feet

Scale 1:30000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

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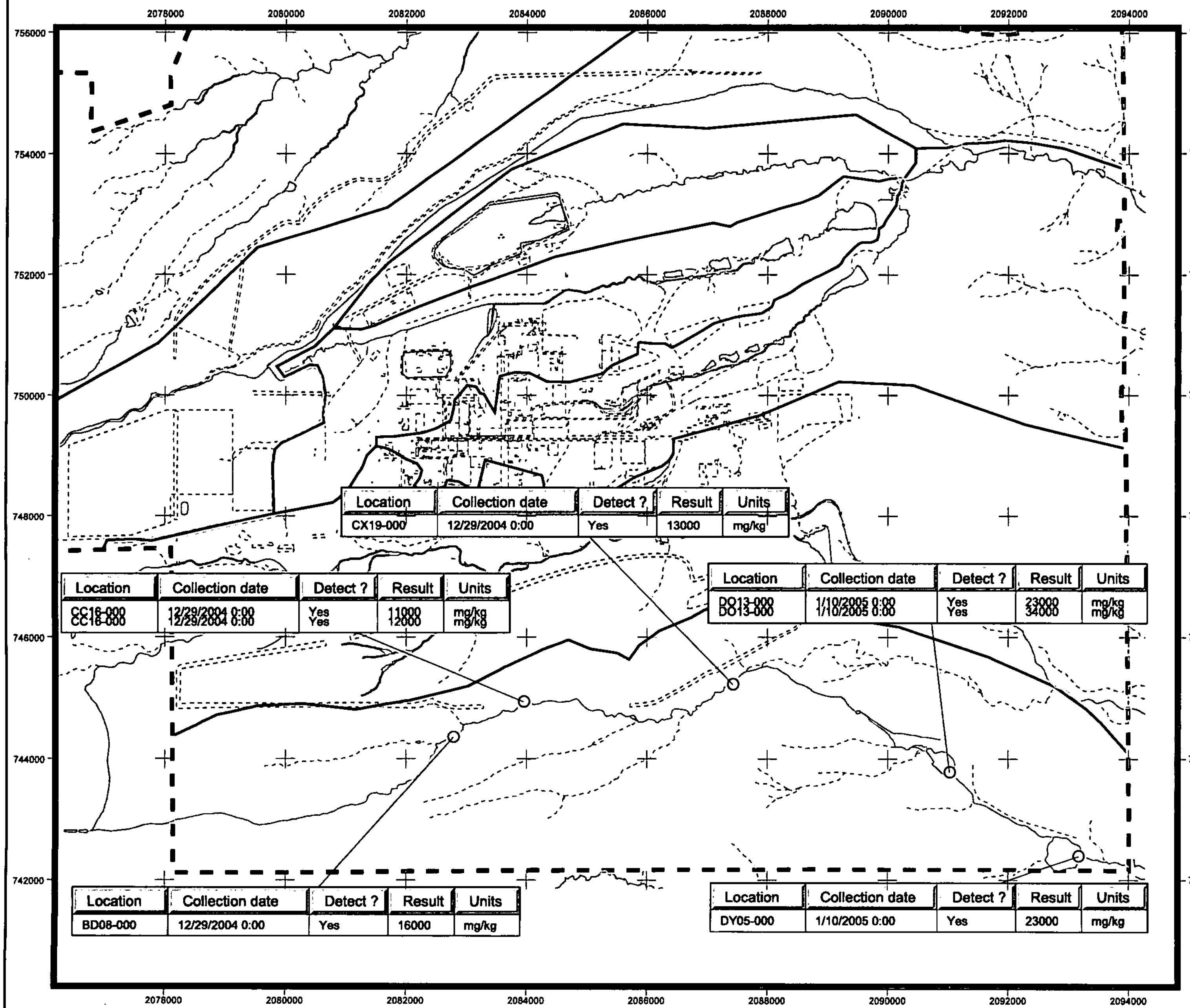
Figure A3.4.SE AEU.3
Southeast AEU
Sediment Sampling Locations for Iron



Location	Collection date	Detect ?	Result	Units
CX19-000	12/29/2004 0:00	Yes	13000	mg/kg

Location	Collection date	Detect ?	Result	Units
CC16-000	12/29/2004 0:00	Yes	11000	mg/kg
CC16-000	12/29/2004 0:00	Yes	12000	mg/kg

Location	Collection date	Detect ?	Result	Units
DO13-000	1/10/2005 0:00	Yes	23000	mg/kg
DO13-000	1/10/2005 0:00	Yes	34000	mg/kg

Location	Collection date	Detect ?	Result	Units
BD08-000	12/29/2004 0:00	Yes	16000	mg/kg

Location	Collection date	Detect ?	Result	Units
DY05-000	1/10/2005 0:00	Yes	23000	mg/kg

KEY

Sampling location

- Detect >= ESL >= Maximum background
- Detect >=ESL < Maximum Background
- Detect < ESL < Maximum Background
- Nondetect

ESL = 20000 mg/kg

Maximum background = 31400 mg/kg

Standard Map Features

- Southeast AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1250 2500 Feet

Scale 1:30000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

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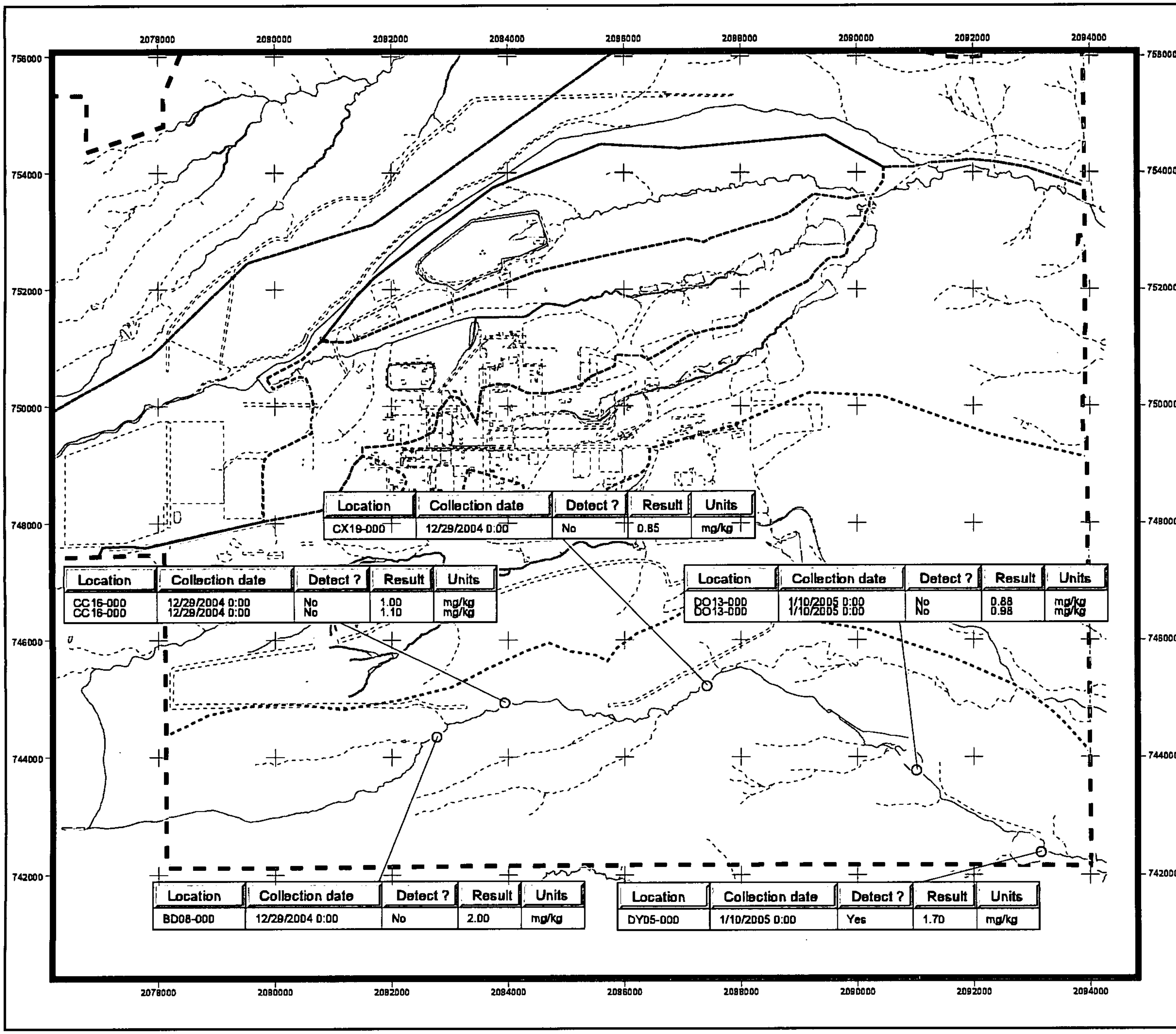
Figure A3.4.SE AEU.4
Southeast AEU
Sediment Sampling Locations for Selenium



Location	Collection date	Detect ?	Result	Units
CX19-000	12/29/2004 0:00	No	0.85	mg/kg

Location	Collection date	Detect ?	Result	Units
CC16-000	12/29/2004 0:00	No	1.00	mg/kg
CC16-000	12/29/2004 0:00	No	1.10	mg/kg

Location	Collection date	Detect ?	Result	Units
DO13-000	1/10/2005 0:00	No	0.88	mg/kg
DO13-000	1/10/2005 0:00	No	0.98	mg/kg

Location	Collection date	Detect ?	Result	Units
BD08-000	12/29/2004 0:00	No	2.00	mg/kg

Location	Collection date	Detect ?	Result	Units
DY05-000	1/10/2005 0:00	Yes	1.70	mg/kg

KEY

Sampling location

- Detect >= ESL >= Maximum background
- Detect >=ESL < Maximum Background
- Detect < ESL < Maximum Background
- Nondetect

ESL = .95 mg/kg

Maximum background = 3.2 mg/kg

Standard Map Features

- Southeast AEU
- Aquatic Exposure Unit boundary
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N
W
E
S

0 1250 2500 Feet

Scale 1:30000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

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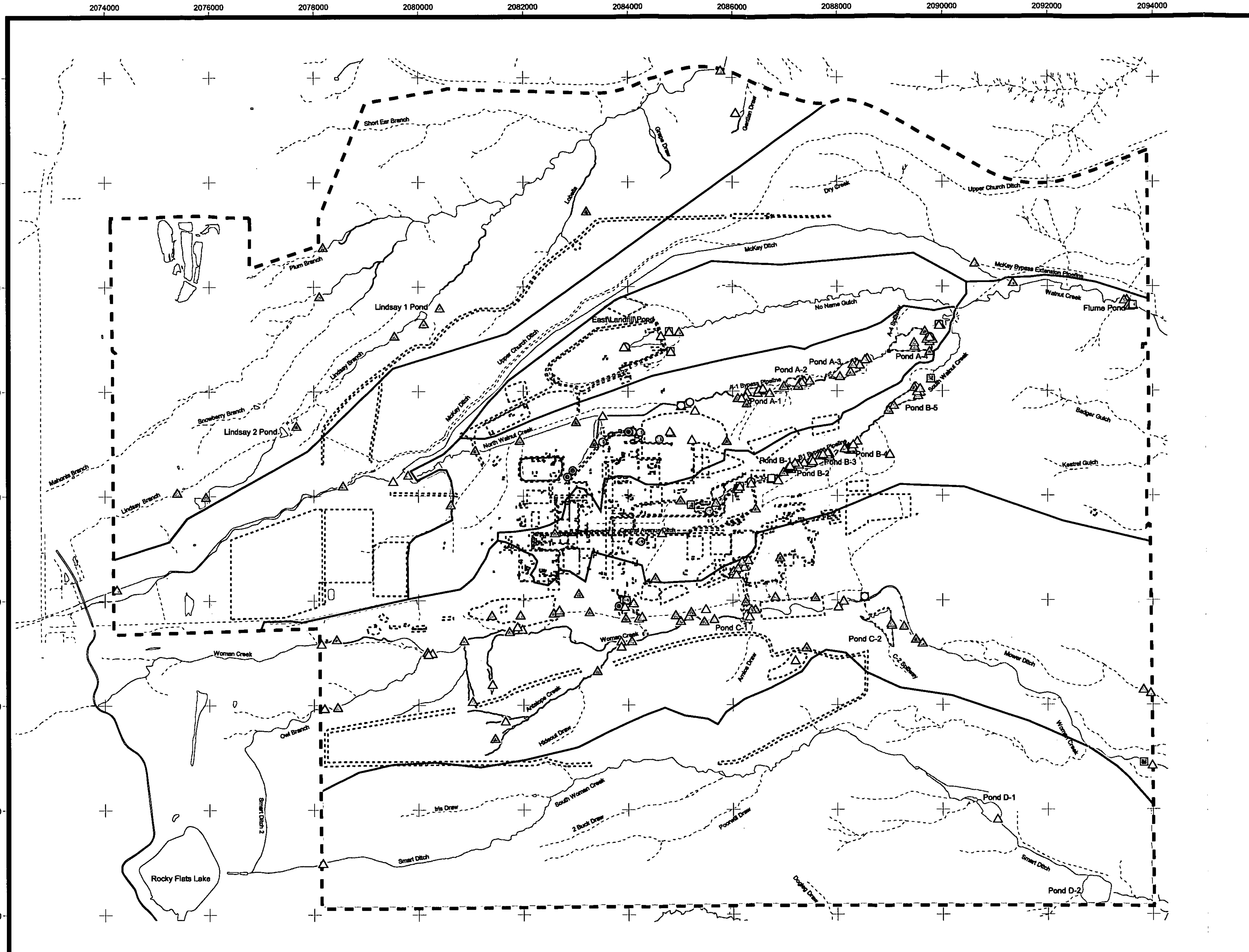

Figure A3.4.SE AEU.5

Silver Concentrations in Sitewide Surface Water

KEY

- ○ Sample Collected Since October 1, 2000
- □ Sample Collected Between October 1, 1996 and October 1, 2000
- △ Sample Collected Between June 1, 1991 and October 1, 1996

- ○ Concentration > Max Background MDC
- ○ Concentration > ESL and <= Max Background MDC
- ○ Concentration <= ESL
- ○ Nondetect (ND)

ESL = 0.00032 mg/L
Max Background MDC = 0.002 mg/L

Standard Map Features

- Southeast AEU
- Exposure Unit boundaries
- Former building where analyte was used or generated as waste
- Historical IHSS/PAC
- Pond
- Perennial stream
- Intermittent stream
- Ephemeral stream
- Site boundary

N W E S

0 1000 2000 Feet

Scale 1:24,000

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD 27

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

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Figure A3.4.SE AEU.6
Southeast Surface Water Sampling Location SW130 for Dissovled Silver

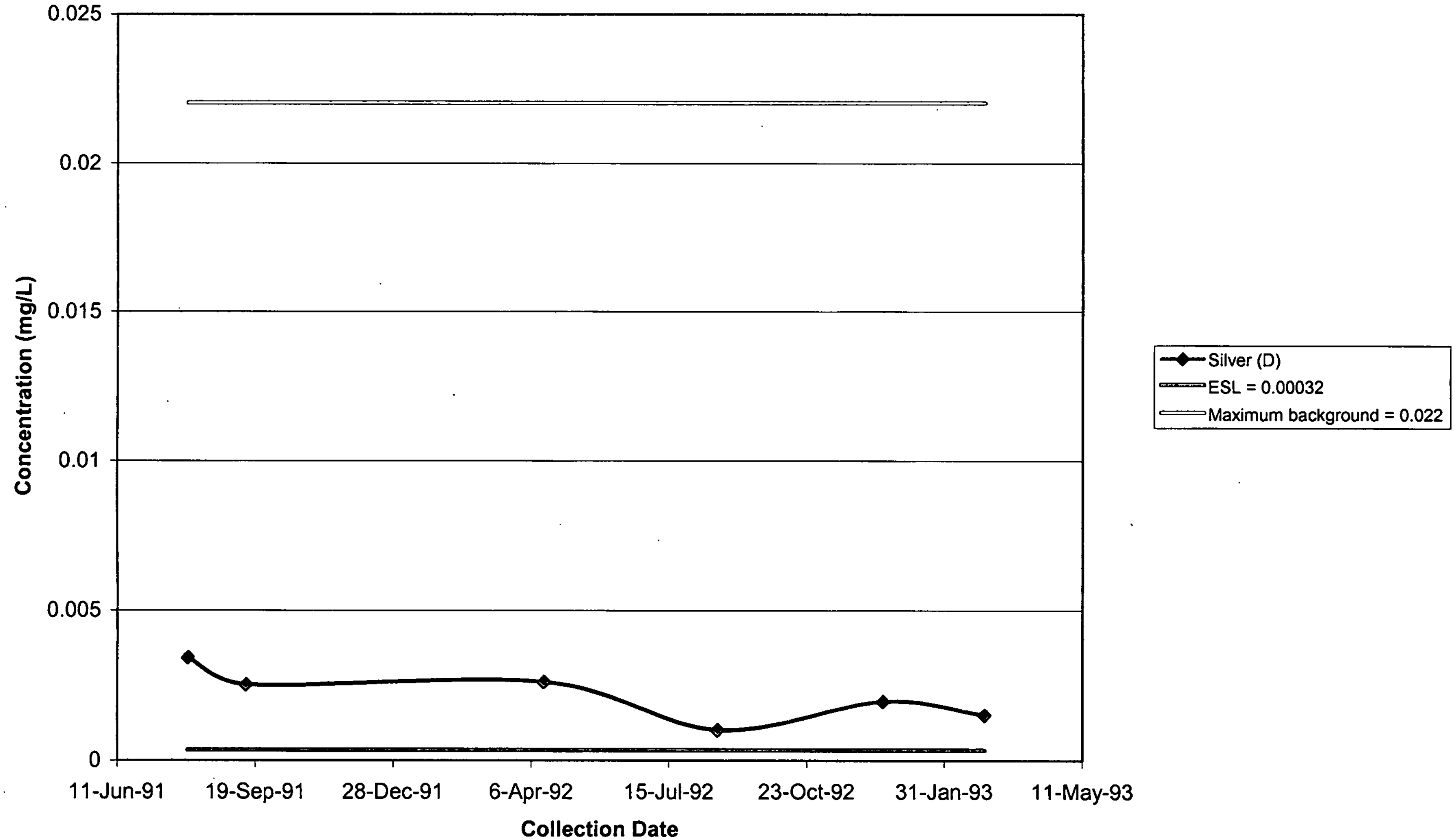

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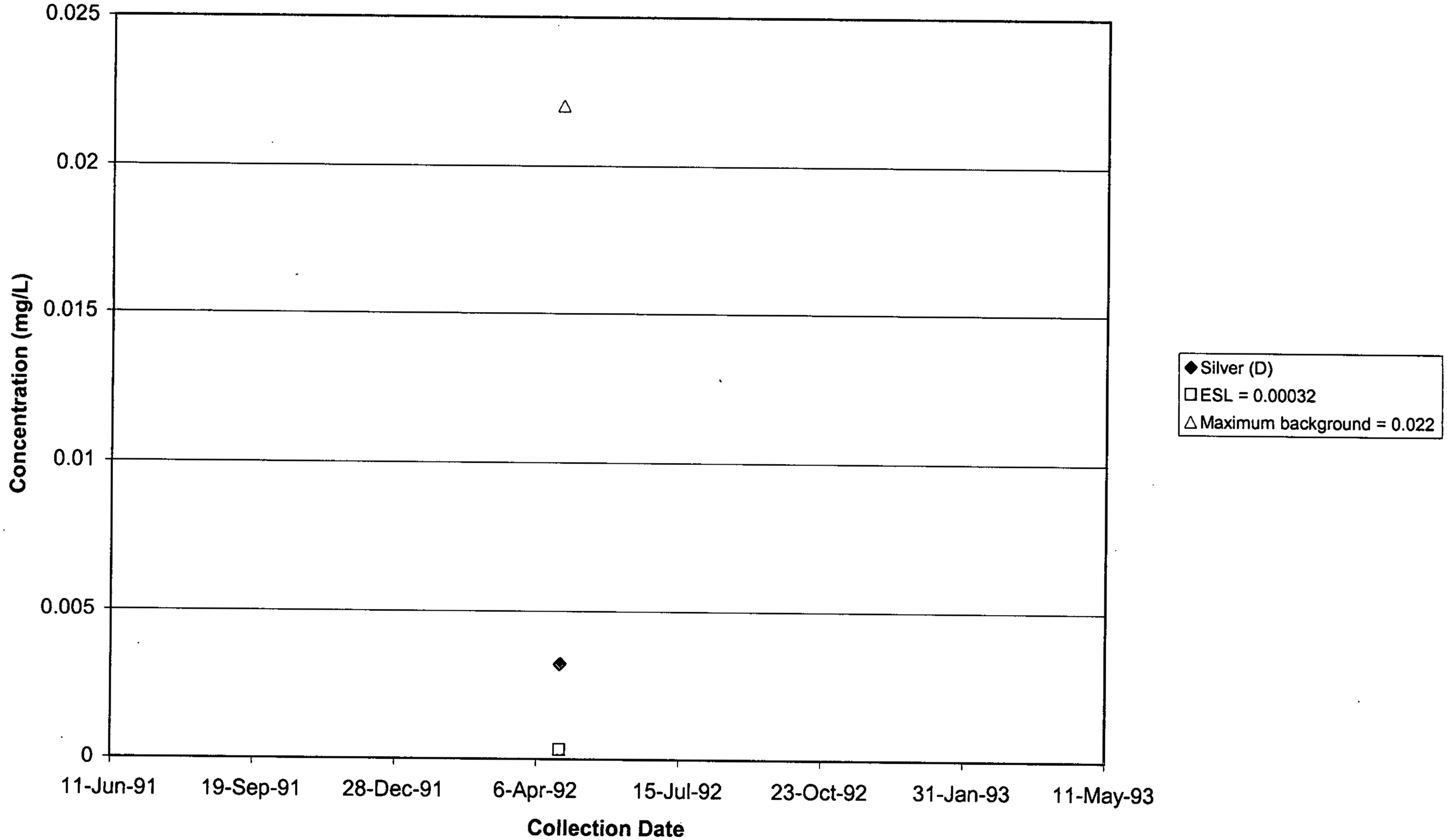
Figure A3.4.SE AEU.7
Southeast Surface Water Sampling Location D1 for Dissovled Silver



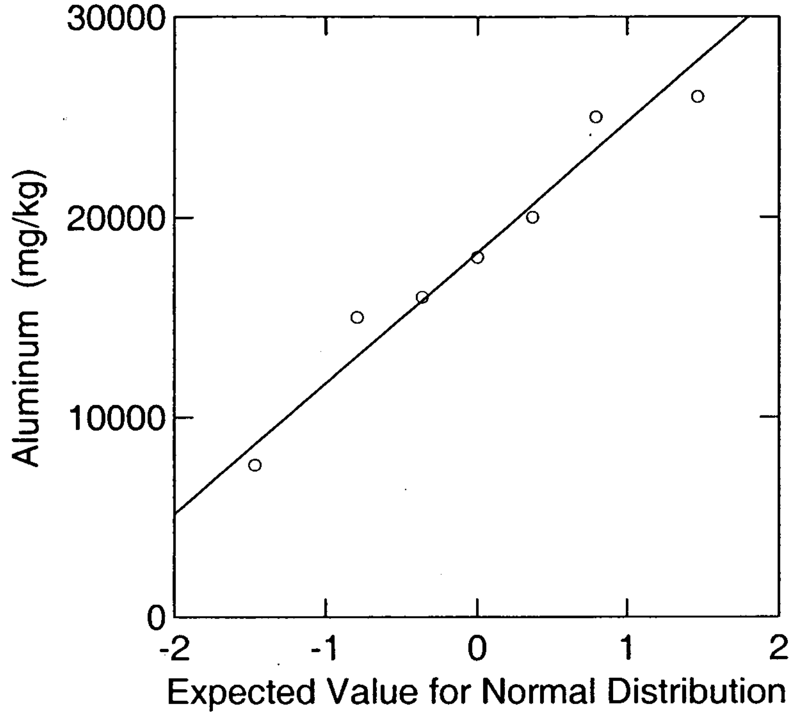


Figure A3.4.SE AEU.8 **Probability Plot of Aluminum Concentrations in Sediments from SE AEU.**

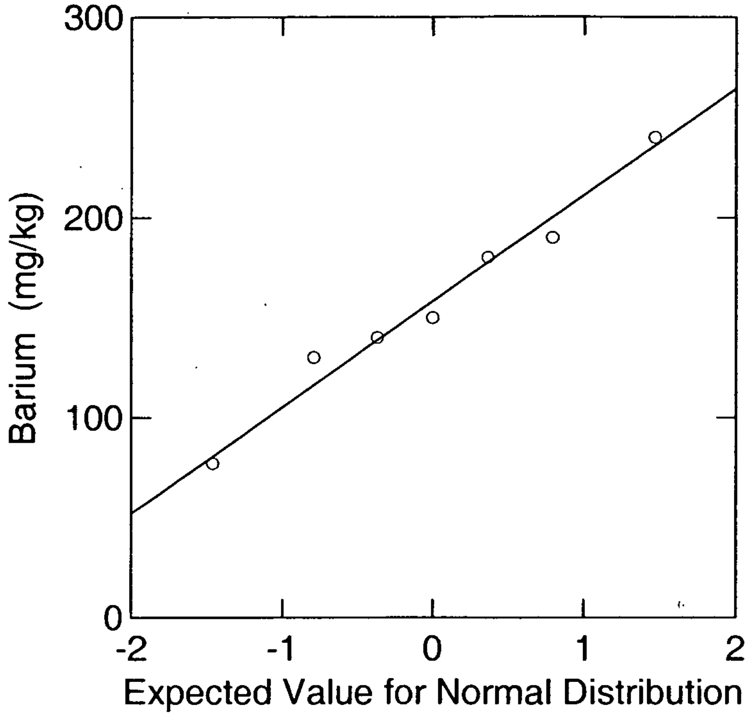


Figure A3.4.SE AEU.9 **Probability Plot of Barium Concentrations in Sediments from SE AEU.**

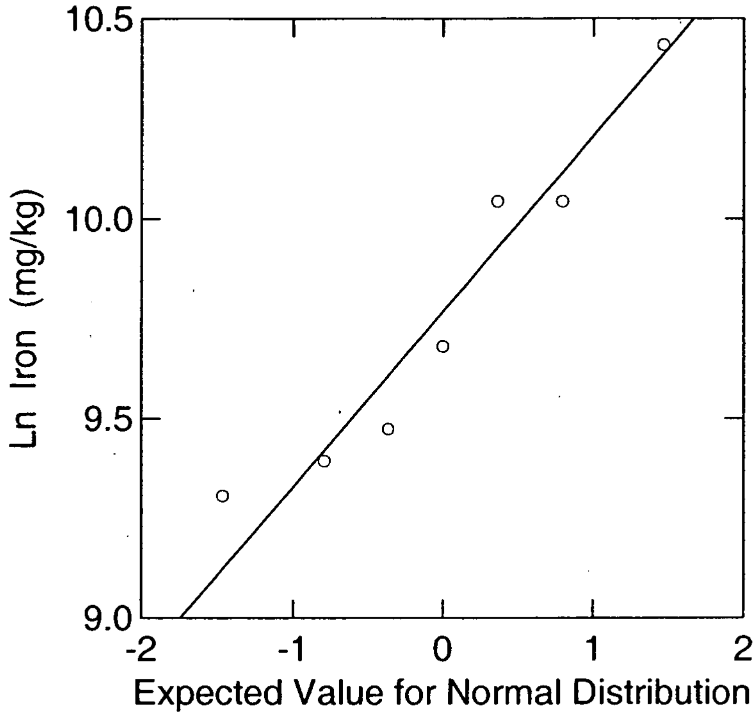


Figure A3.4.SE AEU.10 **Probability Plot of Iron Concentrations (Natural Logarithm) in Sediments from SE AEU.**

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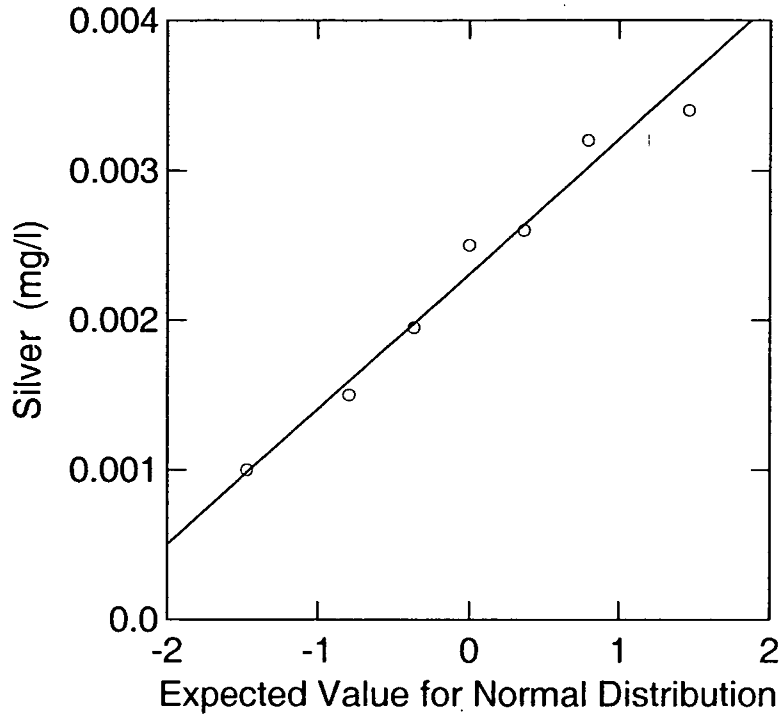

Figure A3.4.SE AEU.11 **Probability Plot of Silver Concentrations in the Surface Water from SE AEU.**

COMPREHENSIVE RISK ASSESSMENT

NO NAME GULCH AQUATIC EXPOSURE UNIT, ROCK CREEK AQUATIC EXPOSURE UNIT, MCKAY DITCH AQUATIC EXPOSURE UNIT, SOUTHEAST AQUATIC EXPOSURE UNIT

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CRA Data Set for the AEU

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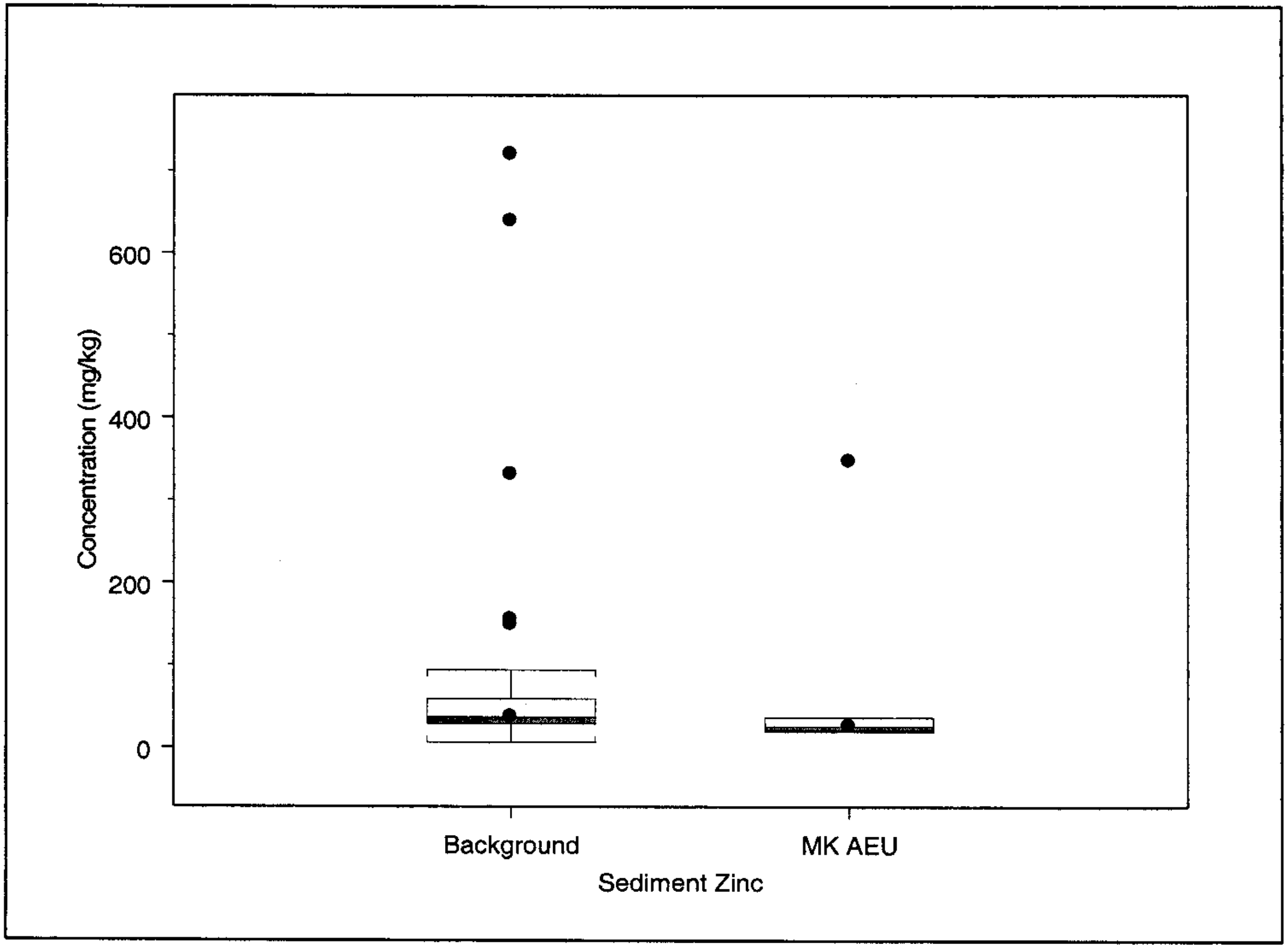
Figure A3.2...K AEU.16
MK AEU Sediment Box Plots for Zinc



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

COMPREHENSIVE RISK ASSESSMENT

NO NAME GULCH AQUATIC EXPOSURE UNIT, ROCK CREEK AQUATIC EXPOSURE UNIT, MCKAY DITCH AQUATIC EXPOSURE UNIT, SOUTHEAST AQUATIC EXPOSURE UNIT

VOLUME 15B1: ATTACHMENT 5

Alternative Toxicity Values and Site-Specific ESLs

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ACRONYMS AND ABBREVIATIONS

°C	degrees Celsius
μg	micrograms
μg/kg	micrograms per kilogram
μg/L	micrograms per liter
μm	micrometer
AEU	Aquatic Exposure Unit
AT	alternative toxicity
AWQC	Ambient Water Quality Criteria
BCG	biota concentration guideline
CB-PEC	consensus-based probable effects concentration
CB-TEC	consensus-based threshold effects concentration
CCC	criterion continuous concentration
CCME	Canadian Council of Ministers of the Environment
CDPHE	Colorado Department of Public Health and Environment
CMC	criterion maximum concentration
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
ECOI	ecological contaminant of interest
ECOPC	ecological contaminant of potential concern
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration

EqP	equilibrium partitioning
ERA	Ecological Risk Assessment
ERL	effect range low
ERM	effect range median
ESL	ecological screening level
HQ	hazard quotient
ISQG	interim sediment quality guideline
LEL	lowest effect level
LOAEL	lowest observed adverse effect level
MDC	maximum detected concentration
MENVIQ/EC	Ministere de l'Environnement du Quebec et Environnement Canada
mg	milligrams
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MIDEQ	Michigan Department of Environmental Quality
MK AEU	McKay Ditch Aquatic Exposure Unit
NIPHEP	National Institute of Public Health and Environmental Protection
NN AEU	No Name Gulch Aquatic Exposure Unit
NW AEU	North Walnut Creek Aquatic Exposure Unit
NYSDEC	New York State Department of Environmental Conservation
OMOE	Ontario Ministry of the Environment
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
pCi/L	picocuries per liter

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PEC	probable effect concentration
PEL	probable effect level
ppm	parts per million
RC AEU	Rock Creek Aquatic Exposure Unit
RESRAD	Residual Radioactivity
RFETS	Rocky Flats Environmental Technology Site
SE AEU	Southeast Aquatic Exposure Unit
SQG	sediment quality guideline
SW AEU	South Walnut Creek Aquatic Exposure Unit
TEC	threshold effect concentration
TEF	toxic equivalency factor
TEQ	toxic equivalency quotient
TET	toxic effect threshold
TMDL	total maximum daily load
TNRCC	Texas Natural Resource Conservation Commission
UCL	upper confidence limit
UTL	upper tolerance limit
WC AEU	Woman Creek Aquatic Exposure Unit
WHO	World Health Organization

1.0 INTRODUCTION

The initial ecological contaminant of potential concern (ECOPC) identification screening evaluation of ecological contaminants of interest (ECOIs) at the Rocky Flats Environmental Technology Site (RFETS) compared maximum detected concentrations (MDCs) of each chemical to conservative ecological screening levels (ESLs) to identify ECOPCs.[1] The second step of this two-tiered risk evaluation considered more realistic exposure and effects characterization by calculating site-specific refinements to the ESLs and identifying alternative toxicity (AT) benchmark values to support the risk characterization of ECOPCs in the Aquatic Exposure Units (AEUs). Concentrations of ECOPCs in sediment and water samples from each AEU were compared to these refined ESL and AT values to provide an upper and lower bound of the potential for adverse effects. While ESLs are typically concentrations at which adverse effects are rarely observed, ATs represent an upper-bound concentration above which adverse effects are possible or probable. Concentrations between the ESL and AT values are within the range of uncertain toxicity, where adverse effects are occasionally observed. The use of both the lower- and upper-bound toxicity values for each ECOPC bracketed the potential for risk from each ECOPC and allowed an evaluation of the likelihood of potential risk.

Surface water and sediment ECOPCs, for which site-specific alternative ESL and AT values were derived, are presented for each AEU in Tables ES.1 and ES.2, respectively, of the Executive Summary in Appendix A, Volume 15B1. For many of these ECOPCs, ESLs had been previously identified in the Final Comprehensive Risk Assessment Work Plan and Methodology (DOE 2004) (hereafter referred to as the CRA Methodology). For others, however, ESLs and ATs were developed following the steps described in the CRA Methodology. Tables A5.1 and A5.2 present site-specific ESLs and AT values for surface water and sediment, respectively, that are applicable to all AEUs and were used to evaluate surface water and sediment ECOPCs in the risk characterization process. Attachment 5 also includes AEU specific ESLs and AT values for the North Walnut Creek AEU (NW AEU), South Walnut Creek AEU (SW AEU), Woman Creek AEU (WC AEU), and No Name Gulch AEU (NN AEU) where there was sufficient data for developing AEU specific benchmarks. The attachment is the same for Volumes 15B1 and 15B2. Sources, endpoints, and toxicity information used for deriving surface water and sediment AT values and site-specific ESLs are described below.

[1] As a precautionary step, ESLs were developed for a number of ECOIs not previously identified within the CRA Methodology. The methods followed for the development of these ESLs prescribe to those contained within the Methodology. These ESL values were not relied upon in the AEUs evaluated to date but are retained in the event they may be required for future AEU evaluation (for the NW AEU, SW AEU, and WC AEU).

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2.0 SURFACE WATER ECOLOGICAL SCREENING LEVELS AND ALTERNATIVE TOXICITIES

Original surface water ESLs from the ECOPC identification process, developed in the CRA Methodology (DOE 2004), were used in the risk characterization phase of the AEU Ecological Risk Assessment (ERA) for most organic and some inorganic ECOPCs. Surface water ESLs were refined using site-specific water quality considerations (i.e., pH, hardness, and temperature) where water quality criteria affect ECOPC toxicity and equations were available for ESL recalculation. This pertained to ammonia, pentachlorophenol, and several divalent metals (barium, beryllium, cadmium, chromium, copper, lead, manganese, nickel, silver, and zinc). In these cases, sitewide and AEU-specific water quality parameters (Table A5.3) were used for recalculation of ESLs, referred to as refined ESLs. AT values, derived from acute water quality standards, were also calculated using these site-specific water quality parameters (Table A5.4).

Both ESLs and ATs for surface water ECOPCs were consistent with regard to the type of benchmark calculated. The majority of the surface water ESLs and ATs represent Ambient Water Quality Criteria (AWQC) from the Colorado Department of Public Health and Environment (CDPHE) (CDPHE 2005a and 2005b). Other state and federal resources from agencies including the U.S. Environmental Protection Agency (EPA) (EPA 2002), Michigan Department of Environmental Quality (MIDEQ) (MIDEQ 2003), New York State Department of Environmental Conservation (NYSDEC) (NYSDEC 1994), and the U.S. Department of Energy (DOE) (DOE 1996c) were used when Colorado-specific benchmarks were not available.

The endpoints associated with these standards are:

- Criterion continuous concentration (CCC); and
- Criterion maximum concentration (CMC).

The CCC is the chronic ambient water quality criterion protective from long-term exposures. It is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed indefinitely without resulting in an unacceptable effect. Chronic toxicity refers to effects through an extended time period and may be expressed in terms of an observation period equal to the lifetime of an organism or to the time span of more than one generation. Some chronic effects may be reversible; however, most are not. Chronic toxicity often is measured at sublethal endpoints associated with changes in physiological processes, reproductive impairment, reduced growth, or altered behavior. Chronic effects may be observed at the population level rather than in individuals. For example, if eggs fail to develop, reproductive fitness is reduced and the species population may be reduced or eliminated. Physiological stresses may also reduce individual health and result in a gradual population decline or absence from an area.

The CMC is recognized as being the acute ambient water quality criterion protective from short-duration exposures. It is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect. Acute standards are generally represented by higher concentrations (i.e., exposures) as compared to chronic standards. Generally, the concentrations that organisms can experience and survive is higher for short-term (i.e., acute) than for long-term (i.e., chronic) exposures. Acute toxicity refers to effects occurring in a short time period where death is often the endpoint. As such, acute toxicity measures typically focus on individual effects rather than on population or community effects. While acute toxicity is often measured at the individual level, it can have effects on overall populations if sufficient numbers of individuals are affected.

Water quality standards presented in Table A5.1 are protective of aquatic life and their uses assuming the 4-day average concentration of a chemical does not exceed the CCC more than once every 3 years on average, and assuming the 1-hour average concentration does not exceed the CMC more than once every 3 years on average. Both the CCC and CMC were developed to be protective of the vast majority of aquatic communities in the United States.

3.0 CHEMICAL-SPECIFIC REFINEMENTS TO SURFACE WATER SCREENING VALUES

3.1 ESL and AT Refinements for Inorganic ECOPCs

3.1.1 Ammonia

Concentrations of surface water ammonia from RFETS samples were reported as total aqueous ammonia and converted to the unionized fraction in order to compare appropriate fractions of ammonia in the site samples to ESLs in the ECOPC selection (EPA 1985). Conversion factors were based on site specific water quality conditions reported in Table A5.4, ranging from 1.56 % unionized ammonia (SW AEU) to 0.626 % (WC AEU). A default conversion factor of 0.396 %, based on the CRA methodology criteria for calculated ESLs (pH 7.0 and 20 degrees Celsius [°C]), was used in the absence of AEU specific water quality parameters.

The ESL used for ECOPC selection was a default screening benchmark for unionized ammonia (CDPHE 2005a). Ammonia toxicity is temperature- and pH-dependent. Although the chronic ESL was based on a default value and remained unchanged, refined calculations for determining unionized ammonia and the equation-based acute water quality criterion (AT value) included a pH and temperature component. A RFETS average pH of 7.5 was determined as a geometric mean of pH values from the entire site (n=666). Therefore, concentrations of unionized ammonia in site surface water were recalculated based on site-specific pH conditions (e.g., 1.24 percent at pH 7.5 and 20°C), as presented in Table A5.4. AEU-specific ESLs and ATs were calculated for AEUs

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where pH had been measured and that had an estimated water temperature of 20°C. A temperature of 20°C is a conservative value reflective of fall, winter, and spring stream flows when water is typically present in RFETS ephemeral streams. The resulting sitewide refined benchmark values for unionized ammonia are as follows:

- Chronic ambient water quality criterion: 0.02 milligrams per liter (mg/L) NO_2-N
- Sitewide acute ambient water quality criterion: 0.150 mg/L NO_2-N

Surface water quality summary statistics for the NW AEU, SW AEU, WC AEU, and NN AEU are presented in Table A5.4. The Rock Creek AEU (RC AEU), McKay Ditch AEU (MK AEU), and Southeast AEU (SE AEU) lacked available water quality information and, therefore, sitewide pH values were used for calculating refined ESLs and ATs (Table A5.4).

A sitewide alternative to the chronic (ESL) and acute (AT) ammonia standards also was calculated for total aqueous ammonia based on the site-specific pH values and an estimated water temperature of 20°C. As noted above, this temperature estimation is a conservative value reflective of fall, winter, and spring stream flows when water is typically present in RFETS ephemeral streams. This criterion also is dependant on whether salmonid species are present, because they represent one of the most sensitive groups of organisms affected by ammonia toxicity (EPA 2002). However, because salmonids are not known to occur within the RFETS drainages, the criterion was calculated assuming salmonids were absent. The resulting sitewide refined values are as follows:

- Chronic ambient water quality criterion: 3.06 milligrams (mg) N/L
- Acute ambient water quality criterion: 19.9 mg N/L

3.1.2 Aluminum

The current aluminum criterion (CDPHE 2002; EPA 2002) is based on older guidance (EPA 1988; EPA 440/5-86-008) that was reviewed for the purpose of identifying the appropriate metal fraction for screening. Specifically, the CDPHE (2002) criterion was based on the 304(a) aquatic life criterion derived using 1985 guidelines (*Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, PB85-227049, January 1985) issued in the federal AWQC for aluminum (EPA 1988). This criterion reviews the complex aquatic chemistry and nature of aluminum toxicity to aquatic organisms.

Aluminum toxicity in surface water is complex because it has higher solubility in both low- and high-pH surface water than when pH is neutral. Aluminum also forms various soluble and insoluble complexes under various water conditions. Toxicity of aluminum has been related to both total and dissolved fractions under different water chemistry conditions due to this complex chemical behavior.

To develop appropriate criterion for potentially different water conditions, it was determined that the acid-soluble dissolved fraction of aluminum in surface water (a mild acid digestion prior to 0.45 micrometer [μm] filtration) was the most appropriate measure on which to base the toxicity guidance (EPA 1988). The primary consideration in the decision was the use of this criterion in monitoring total maximum daily load (TMDL). Aluminum values for RFETS are reported in both dissolved and total fractions, which are not entirely appropriate for comparisons to the ESL. Total aluminum may include fractions that occur in nontoxic forms, while dissolved aluminum represents more of the bioavailable metal, including the most toxic hydroxylated forms, but potentially excluding precipitates that could become bioavailable if water quality characteristics change. The EPA and State of Colorado have recognized that total aluminum measurements often measure nontoxic clay fractions in surface water and that the true exposure point concentration (EPC) falls between the dissolved and total fraction concentrations. However, the total aluminum fraction was selected as a basis for comparison to the standards as a conservative measure.

Tests considered when deriving these standards were based on particulate-phase toxicity, whereas aluminum-rich clay mineralogy may dominate streams and render the comparisons to total aluminum fractions inappropriate. In Colorado, the 750 micrograms per liter (μg/L) acute criterion value should be used instead of the 87 μg/L chronic value when pH is greater than 6.9 and hardness is more than 50 parts per million (ppm) (Colorado Basic Standards Work Group 2004). Because these conditions occur at RFETS, the 750 μg/L is appropriate as a chronic exposure ESL at this site. In addition to these geochemical arguments, the calculated AWQC final chronic value (748 μg/L) was lowered to 87 μg/L to protect two sensitive species (brook trout and striped bass) despite the fact that "many high-quality waters in the U.S. contain more than 87 μg/L aluminum when either total recoverable or dissolved constituents are measured" (Colorado Basic Standards Work Group 2004). Sensitive trout, whose protection was the basis for lowering the criterion, are not present in the Dry Creek watershed at RFETS. The absence of fish in most AEUs and the fact that invertebrates are less sensitive than vertebrates to aluminum are further reasons to use 750 μg/L in a refined screening evaluation.

In summary, total aluminum concentrations in surface water were compared to the 750-μg/L ESL as a conservative measure of potential chronic toxicity to freshwater organisms at RFETS.

3.1.3 Hardness Dependant Metals

Laboratory test results indicate that toxicity for some metals is reduced by water hardness. Therefore, the revised ESLs and ATs for barium, beryllium, cadmium, chromium, copper, lead, manganese, nickel, silver, and zinc were derived from water

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hardness-based equations (MIDEQ 2003; CDPHE 2002). AEU-specific refinements for these metals were completed for the NW AEU, SW AEU, WC AEU, and NN AEU where data were available (Table A5.3). The site-specific hardness for RFETS (198 mg/L $CaCO_3$) was applied to these equations for the RC AEU, MK AEU, and SE AEU, as presented in Table A5.4.

3.2 ESL and AT Refinements for Organic ECOPCs

3.2.1 Pentachlorophenol

Pentachlorophenol toxicity is pH-dependent, and CDPHE (2002) guidance provided the following equations for determining site-specific acute and chronic criteria for this chemical:

- Acute = $e^{[1.005(pH) - 4.869]}$
- Chronic = $2 * e^{[1.005(pH) - 5.134]}$

AEU-specific refinements for pentachlorophenol were completed for the NW AEU, SW AEU, WC AEU, and NN AEU where pH data were available (Table A5.3). The site-specific pH from all RFETS water quality data (7.5) was applied to these equations for the RC AEU, MK AEU, and SE AEU because no AEU-specific pH measurements were available. The refined ESL and AT benchmarks for pentachlorophenol are presented in Table A5.1.

3.3 ESL and AT Refinements for Radionuclides

An AT value of 8.49 pCi/L for radium-228 was derived from DOE (2002) using RESRAD-BIOTA Version 1.1 (beta). This benchmark represents the Level 3 biota concentration guideline (BCG) for radium-228 equivalent to the chronic maximum no-effect exposure of 1 rad/day that will ensure protection of the population. The Level 3 BCG is based on this dose calculated for aquatic species, while the Level 1 BCG used to calculate the ESL is based on the more radiosensitive aquatic and riparian receptors.

4.0 SEDIMENT ECOLOGICAL SCREENING LEVELS AND ALTERNATIVE TOXICITIES

Sediment ESLs provide a low value of no effects to threshold effects, below which effects are unlikely to occur. Upper-bound estimates of concentrations for each ECOPC, above which effects are likely to occur, were identified in the published literature and are referred to as AT values. Concentrations that occur between these upper- and lower-bound values are of uncertain but potential toxicity.

The hierarchy for identification and selection of ATs was as follows:

1. MacDonald et al., 2000a (organics and metals) and MacDonald et al., 2000b (PCBs) – consensus-based probable effects concentrations (CB-PECs);

2. EPA, 1997;

3. Ingersoll et al., 1996; and

4. Other literature sources.

An AT was selected for each ECOPC. The original sediment ESLs from the ECOPC identification process in the CRA Methodology were used in this assessment, along with ATs representative of a lowest observed adverse effect level (LOAEL) where available or similar. The use of these two values for each ECOPC would then bracket the estimated risk using the hazard quotient (HQ) approach. A description of the values for each ECOPC by media is provided below, and a summary of the AT values for each ECOPC is provided in Table A5.2.

The endpoints for the sediment toxicity values vary. In general, the median observed toxicity value from available studies was selected as the AT (MacDonald et al., 1999). Compared to the ranges reported in Table A5.2, these values represent a central tendency measure and were greater than the ESL. A description of the endpoints, as identified by the investigative studies from which they were drawn, is provided below.

Bolton et al., 1985. The benchmark value for fluoride was derived from this study using an equilibrium partitioning approach. The AT benchmark represents the chronic equilibrium partition-derived threshold concentration when organic carbon in sediment equals 1 percent.

CCME, 2002. The Canadian federal government has compiled a list of regularly updated screening environmental quality guidelines for surface water and sediments in Canada. The ESL and AT benchmarks for total dioxins were identified in this document as:

- An interim sediment quality guideline (ISQG); and

- A probable effect level (PEL).

ISQGs were determined to provide a concentration below which effects are considered unlikely, whereas the PELs are concentrations above which adverse effects may occur. These benchmarks are generally good predictors of the likelihood of no effects or adverse effects. These benchmarks are reported in sediment dry weight derived using an effects-range approach.

The ESL (0.00085 microgram per kilogram [μg/kg]) and the AT (0.0215 μg/kg) for dioxins (polychlorinated dibenzo-p-dioxins and dibenzo furans) were based on the consensus toxic equivalency factors (TEFs) developed by the World Health Organization (WHO) (1998). Dioxins and furans are ECOPCs that pose a potential for additive risk to

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sediment-dwelling organisms. A cumulative effect is expected due to a similar mode of toxic action from different congeners. However, all halogenated and aromatic hydrocarbons with dioxin-like properties (dioxins and furan congeners) do not exert the same degree of toxicity. Therefore, TEFs were used to normalize congener concentrations to their dioxin equivalent (Table A5.5).

Only dioxin and furans detected in at least 5 percent of sediment samples in at least one AEU were evaluated as total dioxin equivalents. The concentration of each ECOPC was multiplied by its TEF to calculate the dioxin toxic equivalency quotient (TEQ). Congeners not detected in a specific sample were included in this calculation for the ECOPC selection, with half the reporting limit used as a proxy concentration. These nondetected congeners were excluded from the refined risk characterization evaluation. All TEQs within a sample were summed, and the summed TEQ was compared to the ESL and AT for total dioxins (CCME 2002) presented in Table A5.2. Tier 2 statistical calculations (e.g., 95 percent upper tolerance limit [UTL] and 95 percent upper confidence limit [UCL]) were calculated using these summed TEQ concentrations derived from each sample if the summed TEQ concentrations were greater than the ESL.

Cubbage, et al., 1997. These Washington state sediment quality guidelines represent a probable apparent effects threshold approach to sediment quality value derived using MICROTOX (for acenaphthylene and for carbazole) endpoints with dry-weight values.

Ginn and Pastorak, 1992. The state of Washington has developed sediment quality standards for some polar and ionic organic compounds. These standards provide an indication that the potential for adverse effects may require additional evaluation. AT benchmarks for 4-methylphenol and pentachlorophenol were selected from this reference.

Ingersoll et al., 1996. Sediment-effect concentrations were developed for a suite of chemicals based on laboratory data on the toxicity of contaminants associated with field-collected sediment to the amphipod *Hyalella azteca* and the midge *Chironomus riparius*. The sediment-effect concentrations are defined as the concentrations of individual contaminants in sediment below which toxicity is rarely observed and above which toxicity is frequently observed. Two types of sediment-effect concentrations were calculated from the data:

- Effect range low (ERL); and
- Effect range median (ERM).

The ERL is the lower 10th-percentile concentration associated with observations of biological effects. According to this method, concentrations below the ERL should rarely be associated with adverse effects (EPA 1996). The ERL for total polynuclear aromatic hydrocarbons (PAHs) was used as a surrogate for the dibenzo(a,h)anthracene AT benchmark, for which no other AT value was available. The ERM represents the chemical concentration above which adverse effects would frequently occur. For the purposes of this evaluation, the reported ERL was selected as the AT benchmark for aluminum, iron, manganese, benzo(g,h,i)perylene, and indeno(1,2,3-cd)pyrene.

Jones et al., 1997. This reference provides a compilation of available sediment ATs and various approaches for their development. The AT benchmark for 2-butanone represents a secondary chronic value for sediment derived using the EqP approach. The guidance recommends these values be used cautiously given that they are site-specific and calculated using a 1-percent organic carbon fraction.

MacDonald et al., 1999. Numeric standards for freshwater and marine, surface water, and sediment were gathered as part of a regional study contributing to the Georgia Basin Ecosystem Initiative, a federal-provincial partnership that provides a broad framework for action toward long-term sustainability in the Georgia Basin, British Columbia. Part of this effort was to determine applicable comparison standards for screening processes. Water quality, sediment quality, and tissue residue guidelines were reviewed for consideration as basic tools in evaluating environmental conditions for the development of water management strategies. This document provides a summary of all obtained, validated standards available in the literature at the time. Appendices are devoted to the summary of toxicity values by chemical and by media. The information for sediment ECOPCs was reviewed, and the range of reported ATs is summarized for each chemical in Table A5.2. Consistent types of toxicity values were relied upon to represent median-level effects thresholds as compared to the range of values reported. These AT values are as follows:

- The AT value for selenium represents a criterion in dry weight from Nagpal, et al. (1995). This was the only value available for total selenium in sediment.
- The AT value for acenaphthene represents a PEL from Nagpal, et al. (1995).
- The AT benchmark values for barium and silver were derived from this guidance and represent the Texas sediment quality guideline: 85th percentile level in reservoirs, dry weight (TNRCC 1996). The barium AT concentration represents the average of the observed toxicity values reviewed for this evaluation (reported range of 20 to 500 milligrams per kilogram [mg/kg]). These screening levels are based on percentile concentration from statewide historical data and are not health or toxicity based. While the guidelines are not enforceable, they provide a basis for evaluating contaminant concentrations in media at the site to which receptors are potentially exposed.

MacDonald et al., 2000a. Numeric sediment quality guidelines (SQGs) were compiled and evaluated for metals and organic compounds. Two SQGs were identified for each chemical:

- A consensus-based threshold effect concentration (TEC); and

- A consensus-based probable effect concentration (PEC).

The TECs were determined to provide a concentration below which effects are considered unlikely, whereas the PECs are concentrations above which adverse effects are likely. These benchmarks are generally good predictors of the likelihood of no effects or adverse effects. Consensus-based TECs for sediment correctly predicated toxicity from 34.3 percent of samples for mercury (n=79) to 88.9 percent of samples for total polychlorinated biphenyls (PCBs) (n = 120), while PECs for sediment correctly predicted samples to be toxic in 77 percent of samples for arsenic (n=150) to 100 percent of samples for mercury (n = 100) for metals, PAHs, and PCBs. Thus, there is confidence that these guidelines accurately predict the potential for adverse effects except for the low SEV for mercury, where there is greater uncertainty.

MacDonald et al., 2000b. Numeric SQGs were compiled and evaluated for PCBs, and a set of comparable SQGs were identified for certain inorganic and organic chemicals. The following SQGs were identified for each congener and for total PCBs:

- A consensus-based TEC;
- A lowest effect level (LEL) concentration; and
- A toxic effect threshold (TET) concentration.

The TEC for total PCBs was determined to provide a concentration below which effects are considered unlikely. The LEL, an alternative SQG selected due to the lack of TECs for individual PCB congeners, is a numerical threshold concentration protective of 85 to 90 percent of sediment-dwelling organisms. The TET, an alternative SQG selected due to the lack of PECs for individual PCB congeners, represents concentrations above which adverse effects are likely. TETs were reported to represent concentrations above which adverse effects are expected on 90 percent of sediment-dwelling organisms. These benchmarks were designed for sediments with 1-percent organic carbon; higher proportions would be protective of receptors and increase these toxicity value concentrations.

PCBs are ECOPCs that pose a potential for additive risk to sediment-dwelling organisms. A cumulative effect from PCBs is expected due to a similar mode of toxic action from different congeners. Only PCB congeners that were detected in at least 5 percent of sediment samples in at least one AEU were evaluated both as individual PCBs and jointly as total PCBs. These concentrations were evaluated against their respective ESL and AT benchmarks (MacDonald, et al. 2000a and 2000b). Aroclor 1254 and Aroclor 1260 were the only PCB congeners detected in at least 5 percent of the sediment samples. Concentrations of these PCBs in each sample were added to determine the total PCB concentration in the sample. Congeners not detected in a specific sample were included in this calculation with half the reporting limit used as a proxy concentration. Tier 1 and

Tier 2 statistical calculations (e.g., 95 percent UTL and 95 percent UCL) were calculated using these total PCB concentrations derived from each sample.

An ESL for total PAHs was not provided in the CRA methodology. The consensus-based TEC (CB-TEC) and PEC (CB-PEC) were identified from MacDonald et al. (2000a) for use as the total PAH ESL and AT values, respectively, for comparison against summed PAH concentrations. The CB-TEC (1,610 ug/kg) and CB-PEC (22,850 ug/kg) were reported to predict the absence of toxicity or the presence of toxicity in 81.5 and 100 percent of samples (n=167), respectively.

MENVIQ/EC, 1992. The value for benzo(k)fluoranthene was derived from this study and represents the sediment quality TET using a screening-level concentration approach; i.e., TET when organic carbon in sediment equals 1 percent.

NYSDEC, 1994. The value for antimony was derived from this study using a screening-level concentration approach and represents the LEL in dry weight.

EPA, 1997. These values represent a guideline or sediment quality advisory level at 1 percent organic carbon using an equilibrium partitioning (EqP) approach. Equilibrium partitioning calculations were used to calculate AT benchmark concentrations (atrazine and bromomethane) in addition to ESLs for detected ECOIs where no previous ESL had been identified (1,2,4-trimethylbenzene, 1,3-dichlorocenzene, 1,3,5-trimethylbenzene, 2-butanone, 2,4,6-trichlorophenol, atrazine, benzyl alcohol, trans-1,2-dichloroethene). Chronic surface water AWQCs were used as the basis for calculating sediment ESLs, while acute AWQCs were used as the basis for calculating sediment AT benchmarks (Table A5.6), where:

$$EqP_{ESL} = ESL_{water} * Koc * foc$$

EqP = Equilibrium partitioning-based sediment ESL
ESL_{water} = Surface water ESL (chronic)
Koc = Organic carbon portioning coefficient
foc = Fraction organic carbon (assumed 1%)

$$EqP_{TT} = AT_{water} * Koc * foc$$

EqP = Equilibrium partitioning-based sediment AT
AT_{water} = Surface water AT (acute)
Koc = Organic carbon portioning coefficient
foc = Fraction organic carbon (assumed 1%)

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TABLES

Table A5.1
Alternative Toxicity Values for Surface Water ECOPCs

ECOPC	Units	Site-Wide[1] ESL	Site-Wide[1] AT	Woman Creek ESL	Woman Creek AT	No Name ESL	No Name AT	North Walnut ESL	North Walnut AT	South Walnut ESL	South Walnut AT	Reference
Inorganic												
Aluminum (T)	µg/L	750	N/A	Same as site-wide								CDPHE 2005a
Ammonia (unionized)	µg/L	20	150	20	104	20	104	20	150	20	165	CDPHE 2005a
Ammonia (T)	µg/L	3,060	19,900	3,870	30,900	3,810	29,900	3,060	19,900	2,740	16,900	USEPA 1999
Antimony (T)	µg/L	240	2,300	Same as site-wide								MIDEQ 2003
Barium (T)	µg/L	908	5,181	731	4,172	856	4,887	1,115	6,363	934	5,330	MIDEQ 2003
Beryllium (T)	µg/L	13.56	244	8.1	146	11.8	212	22.1	398	14.5	261	MIDEQ 2003
Cadmium (D)	µg/L	3.71	8.97	3.2	7.2	3.6	8.4	4.3	11.1	3.8	9.2	CDPHE 2005a
Chromium (D)	µg/L	130	999	110	846	124	956	152	1,171	133	1022	CDPHE 2005a
Cobalt (T)	µg/L	100	740	Same as site-wide								MIDEQ 2003
Copper (D)	µg/L	16.1	25.7	14	21	15	24	19	31	16	26	CDPHE 2005a
Cyanide (T)	µg/L	0.5	5	Same as site-wide								CDPHE 2005a
Fluoride (T)	µg/L	2,120	10,200	Same as site-wide								NY State 1998
Iron (D)	µg/L	1,000	N/A	Same as site-wide								USEPA 2002
Lead (D)	µg/L	5.3	135	4.2	109	5.0	127	6.5	166	5.4	139	CDPHE 2005a
Lithium (T)	µg/L	96	1,700	Same as site-wide								MIDEQ 2003
Manganese (T)	µg/L	1,650	2,990	1,937	3,506	2,036	3,684	2,211	4,002	2,092	3,786	CDPHE 2005a
Mercury (D)	µg/L	0.77	1.4	Same as site-wide								CDPHE 2005a
Nickel (D)	µg/L	93	837	78	704	89	799	109	985	95	856	CDPHE 2005a
Nitrite (T)	µg/L	4,470	8,950	Same as site-wide								CDPHE 2005a
Selenium (T)	µg/L	4.6	18.4	Same as site-wide								CDPHE 2005a
Silver (D)	µg/L	1.04	6.61	0.7	4.7	0.9	6.0	1.5	9.2	1.1	6.9	CDPHE 2005a
Strontium (T)	µg/L	8,300	150,000	Same as site-wide								MIDEQ 2003
Tin (T)	µg/L	73	2,700	Same as site-wide								DOE 1996c
Vanadium (T)	µg/L	12	220	Same as site-wide								MIDEQ 2003
Zinc (D)	µg/L	211	210	178	176	202	200	249	247	216	214	CDPHE 2005a
Organic												
4,4'-DDT	µg/L	0.001	0.55	Same as site-wide								CDPHE 2005a
bis(2-ethylhexyl)phthalate	µg/L	28.5	285	Same as site-wide								MIDEQ 2003
Di-n-butylphthalate	µg/L	9.7	75	Same as site-wide								MIDEQ 2003
PCB-1254	µg/L	0.014	2	Same as site-wide								CDPHE 2005a
Pentachlorophenol	µg/L	6.69	28.8	7.86	20.5	8.10	21.1	11.06	28.8	12.48	32.5	CDPHE 2005a
Phenanthrene	µg/L	2.4	43	Same as site-wide								MIDEQ 2003
Phenol	µg/L	2,560	10,200	Same as site-wide								CDPHE 2005a
Radionuclides												
Americium-241	pCi/L	43.8	N/A	Same as site-wide								USDOE 2002[a]
Plutonium-239/240	pCi/L	18.7	N/A	Same as site-wide								USDOE 2002[a]
Radium-226	pCi/L	1.02	N/A	Same as site-wide								USDOE 2002[a]
Radium-228	pCi/L	0.849	8.49	Same as site-wide								USDOE 2002[a]
Uranium-233/234	pCi/L	20.1	N/A	Same as site-wide								USDOE 2002[a]
Uranium-235	pCi/L	21.7	N/A	Same as site-wide								USDOE 2002[a]
Uranium-238	pCi/L	22.3	N/A	Same as site-wide								USDOE 2002[a]

[1] Sitewide ESLs and AT values include Rock Creek, McKay Ditch, and Southeast AEUs.

[a] RESRAD-BIOTA version 1.1 (beta) used to derive AT for radionuclides

For conservative screening purposes the total and dissolved chronic and acute NAWQC criteria are represented by the chronic value.

Hardness dependant criteria were calculated based on site specific hardness values.

Site Wide hardness = 199; pH = 7.5 .

Woman Creek hardness = 162; pH = 7.16.

No Name Gulch hardness = 188; pH = 7.19.

North Walnut Creek hardness = 241; pH = 7.5.

South Walnut Creek hardness = 204; pH = 7.62.

Ammonium NAWQC were calculated based on site specific pH and temperature = 20°C.

PCB Value is for total PCBs.

Pentachlorophenol chronic criteria determined as exp(1.005*(pH)-5.134).

Pentachlorophenol acute criteria determined as (exp(1.005*(pH)-4.869))*2.

N/A = Not applicable or not available.

(T) = Total

(D) = Dissolved

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Table A5.2
Alternative Toxicity Values for Sediment ECOPCs

ECOPC[1]	Units	Reported Range of Benchmarks[2]	(n)	ESL Value[3]	Reference	Type of Value	Alternative Toxicity Value	Reference	Type of Value
Inorganics									
Aluminum	mg/kg	15,900 – 58,000	(3)	15,900	MacDonald et al., 1999	SQG	58,000	Ingersoll et al., 1996	ERM
Antimony (total)	mg/kg	2 – 500	(9)	2	MacDonald et al., 1999	SQG	3.2	NYSDEC, 1994	SLCA
Arsenic	mg/kg	3 – 150	(39)	9.79	MacDonald et al., 2000a	CB-TEC	33	MacDonald et al., 2000a	CB-PEC
Barium (total)	mg/kg	20 – 500	(6)	189	MacDonald et al., 1999	SQG	287	MacDonald et al., 1999	SQG
Cadmium	mg/kg	0.2 – 30	(34)	0.99	MacDonald et al., 2000a	CB-TEC	4.98	MacDonald et al., 2000a	CB-PEC
Chromium	mg/kg	6.25 – 600	(34)	43.4	MacDonald et al., 2000a	CB-TEC	111	MacDonald et al., 2000a	CB-PEC
Copper	mg/kg	8.4 – 840	(36)	31.6	MacDonald et al., 2000a	CB-TEC	149	MacDonald et al., 2000a	CB-PEC
Fluoride	mg/kg	0.01 – 96	(21)	0.01	MacDonald et al., 1999	ERL	7	Bolton et al., 1985	TET
Iron	mg/kg	20,000 – 290,000	(17)	20,000	MacDonald et al., 1999	LEL	280,000	Ingersoll et al., 1996	ERM
Lead	mg/kg	23 – 720	(42)	35.8	MacDonald et al., 2000a	CB-TEC	128	MacDonald et al., 2000a	CB-PEC
Manganese	mg/kg	300 – 1,800	(16)	630	MacDonald et al., 1999	TEL	1,700	Ingersoll et al., 1996	ERM
Mercury	mg/kg	0.1 – 15	(27)	0.18	MacDonald et al., 2000a	CB-TEC	1.06	MacDonald et al., 2000a	CB-PEC
Nickel	mg/kg	5 – 100	(31)	22.7	MacDonald et al., 2000a	CB-TEC	48.6	MacDonald et al., 2000a	CB-PEC
Selenium	mg/kg	0.95 – 5	(3)	0.95	MacDonald et al., 1999	SQG	1.73	MacDonald et al., 1999	SQG
Silver	mg/kg	0.5 - 4.5	(9)	1	Long et al., 1995	ERL	1.6	MacDonald et al., 1999	SQG
Zinc	mg/kg	50 – 3200	(42)	121	MacDonald et al., 2000a	CB-TEC	459	MacDonald et al., 2000a	CB-PEC
Organics									
1,2,4-Trimethylbenzene	µg/kg	-	-	122	EPA 1997b	EqP based	N/A	-	-
1,3,5-Trimethylbenzene	µg/kg	-	-	316	EPA 1997b	EqP based	N/A	-	-
1,3-Dichlorobenzene	µg/kg	-	-	122	EPA 1997b	EqP based	N/A	-	-
2,4,6-Trichlorophenol	µg/kg	-	-	59.3	EPA 1997b	EqP based	N/A	-	-
2-Butanone	µg/kg	270	(2)	84.2	EPA 1997b	EqP based	270	Jones et al., 1997	EqP based SCV
2-Methylnaphthalene	µg/kg	20 – 201	(8)	20.2	CCME 2002	ISQG	201	CCME 2002	PEL
4-Bromophenyl-phenylether	µg/kg	-	-	166	EPA 1997b	EqP based	N/A	-	-
4-Methylphenol	µg/kg	12.3 - 670	(2)	12.3	EPA,1997b	EqP based	670	Ginn and Pastorak, 1992	WS-SQS
Acenaphthene	µg/kg	6.71 – 100,000	(17)	6.71	CCME 2002	ISQG	89	MacDonald et al., 1999	PEL
Acenaphthylene	µg/kg	5.87 – 6,000	(13)	5.87	CCME 2002	ISQG	1,900	Cubbage et al., 1997	WS-SQS
Anthracene	µg/kg	6.8 – 41,000	(21)	57.2	MacDonald et al., 2000a	CB-TEC	845	MacDonald et al., 2000a	CB-PEC
Aroclor 1254	µg/kg	7.3 – 604	(16)	60	MacDonald et al., 2000b	LEL	300	MacDonald et al., 2000b	TET
Aroclor 1260	µg/kg	5 – 240	(6)	5	MacDonald et al., 2000b	LEL	200	MacDonald et al., 2000b	TET
Atrazine	µg/kg	0.3 - 230.4	(3)	16.8	EPA 1997b	EqP based	230.4	EPA 1997b	EqP based
Benzo(a)anthracene	µg/kg	108-1050	(2)	108	MacDonald et al., 2000a	CB-TEC	1,050	MacDonald et al., 2000a	CB-PEC
Benzo(a)pyrene	µg/kg	9.6 – 450,000	(27)	150	MacDonald et al., 2000a	CB-TEC	1,450	MacDonald et al., 2000a	CB-PEC
Benzo(g,h,i)perylene	µg/kg	10.4 – 21,000	(19)	13	MacDonald et al., 1999	ERL	280	Ingersoll et al., 1996	ERM
Benzo(k)fluoranthene	µg/kg	2.6 – 1,250,000	(9)	240	MacDonald et al., 1999	LEL	750	MENVIQ/EC 1992	TET
Benzyl Alcohol	µg/kg	-	-	1.35	EPA 1997b	EqP based	N/A	-	-
Bromomethane	µg/kg	3.43	(1)	3.43	EPA 1997b	EqP based	62.72	EPA 1997b	EqP based
Carbazole	µg/kg	140 -1,800	(4)	25.2	EPA 1997b	EqP based	1,600	Cubbage et al., 1997	WS-SQS
Chrysene	µg/kg	8.6 – 11,500	(25)	166	MacDonald et al., 2000a	CB-TEC	1,290	MacDonald et al., 2000a	CB-PEC
DDT	µg/kg	4.16 – 11,000	(5)	4.16	MacDonald et al., 2000a	CB-TEC	62.9	MacDonald et al., 2000a	CB-PEC
Dibenz(a,h)anthracene	µg/kg	5 – 3,500	(17)	33	MacDonald et al., 2000a	CB-TEC	240	Ingersoll et al., 1996	Total PAH ERL (surrogate)
Dichlorofluoromethane	µg/kg	-	-	52.6	EPA 1997b	EqP based	N/A	-	-
Fluoranthene	µg/kg	20 – 130,000	(28)	423	MacDonald et al., 2000a	CB-TEC	2,230	MacDonald et al., 2000a	CB-PEC
Fluorene	µg/kg	77.4 - 536	(21)	77.4	MacDonald et al., 2000a	CB-TEC	536	MacDonald et al., 2000a	CB-PEC
Heptachlor epoxide[3]	µg/kg		()	2.47	MacDonald et al., 2000a	CB-TEC	16.00	MacDonald et al., 2000a	CB-PEC
Heptachlor	µg/kg	0.132 - 50	(11)	0.132	EPA,1997b	EqP based	16	MacDonald et al., 2000a	CB-PEC
Indeno(1,2,3-cd)pyrene	µg/kg	10.4 – 6,000,000	(20)	17	MacDonald et al., 1999	TEL	250	Ingersoll et al., 1996	ERM
Lindane[3]	µg/kg		()	2.37	MacDonald et al., 2000a	CB-TEC	4.99	MacDonald et al., 2000a	CB-PEC
Methylene chloride[3]	µg/kg	500 - 500	()				500	Bolton et al., 1985	
Naphthalene	µg/kg	10 – 140,000	(21)	176	MacDonald et al., 2000a	CB-TEC	561	MacDonald et al., 2000a	CB-PEC

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Table A5.2
Alternative Toxicity Values for Sediment ECOPCs

ECOPC[1]	Units	Reported Range of Benchmarks[2]	(n)	ESL Value[3]	Reference	Type of Value	Alternative Toxicity Value	Reference	Type of Value
Pentachlorophenol	µg/kg	255 - 360	(2)	255	EPA 1997b	EqP based	360	Cubbage et al., 1997	WS-SQS
Phenanthrene	µg/kg	6.8 – 210,000	(27)	204	MacDonald et al., 2000a	CB-TEC	1,170	MacDonald et al., 2000a	CB-PEC
Pyrene	µg/kg	7.6 – 85,000	(25)	195	MacDonald et al., 2000a	CB-TEC	1,520	MacDonald et al., 2000a	CB-PEC
trans-1,2-Dichloroethene	µg/kg	-	-	657	EPA 1997b	EqP based	N/A	-	-
Total DDTs	µg/kg	1.19 - 4,450	(24)	5.28	MacDonald et al., 2000a	CB-TEC	572	MacDonald et al., 2000a	CB-PEC
Total PAHs	µg/kg	200 – 700,000	(17)	1610	MacDonald et al., 2000a	CB-TEC	22800	MacDonald et al., 2000a	CB-PEC
Total PCBs	µg/kg	2.9 – 40,000	(24)	40.0	MacDonald et al., 2000b	CB-TEC	676	MacDonald et al., 2000a	CB-PEC
TEQ - Dioxins	µg/kg	0.001 - 100	(8)	0.00085	CCME 2002	ISQG	0.0215	CCME 2002	PEL

[1] Metals as dissolved unless otherwise stated.

[2] Range of benchmarks is derrived from McDonald et al. 1999 and presented values.

[3] ESL values derrived from Table B-4 of CRA Methodology; or, from cited reference if not listed in Table B-4.

The hierarch of use of the alternative ESLs was as follows: MacDonald et al., 2000a,b as a preference: others (EPA, 1997b; Ingersoll et al., 1996 etc) have no preference as compared to each other. The best available, most appropriate value is reported as the Toxicity Threshold value.

CB-PEC = concensus-based probable effect concentration.

CB-TEC = concensus-based threshold effect concentration.

EqP = SW ESL * Koc * foc ; foc estimated at 1%.

ERL = Effects Range Low.

ERM = Effects Range Moderate.

ISQG = Interim Sediment Quality Guideline.

LEL = Lowest Effect Level.

MENVIQ/EC = Ministere de l'Environnement du Quebec / Environment Canada.

PEL = Probable Effect Level.

SCV = secondary chronic value.

SLCA = Screening Level Concentration Approach (minimum effect criteria).

SQAL = Sediment Quality Advisory Level (based on 1% foc).

SQG = Sediment Quality Guideline.

TEL = Threshold Effects Level.

TET = Toxic Effect Threshold at 1% OC.

WS-SQS = Washington State Sediment Quality Standard.

N/A = Not applicable.

- = Not available.

Table A5.3
Refined Water ESLs and Alternative Toxicity Values

Analyte	Units	SW ESL (µg/L) ESL (Chronic)	TT (Acute)	Woman Creek ESL (Chronic)	TT (Acute)	NoName ESL (Chronic)	TT (Acute)	North Walnut ESL (Chronic)	TT (Acute)	South Walnut ESL (Chronic)	TT (Acute)	CF_c	M_a	B_a	M_c	B_c	Source
Unionized Ammonia	mg/L	0.02	0.15	0.02	0.104	0.02	0.104	0.02	0.15	0.02	0.165						CDPHE 2005a
Total Aqueous Ammonia (early life stages present)	mg/L	3.06	-	3.87	-	3.81	-	3.06	-	2.74	-	-	-	-	-	-	EPA 1999
Total Aqueous Ammonia (salmonids absent)	mg/L	-	19.9	-	30.9	-	29.9	-	19.9	-	16.5	-	-	-	-	-	EPA 1999
Barium, Total	µg/L	907.84	5,181	731.07	4,172	856.38	4,887	1,115	6,363	934.05	5,330	-	1.0629	1.1869	1.0629	2.9285	MIDEQ 2002
Beryllium, Total	µg/L	13.56	244	8.10	146	11.80	212	22.11	398	14.51	261	-	2.5279	-10.7689	2.5279	-7.8785	MIDEQ 2002
Cadmium, Dissolved	µg/L	3.71	8.97	3.20	7.19	3.57	8.45	4.28	11.05	3.79	9.23	0.9142	1.128	-3.6867	0.7852	-2.715	CDPHE 2005a
Chromium III, Dissolved	µg/L	130	999	110	846	124	956	152	1,171	133	1022	0.86	0.819	2.5736	0.819	0.534	CDPHE 2005a
Copper, Dissolved	µg/L	16.1	25.7	13.5	21.2	15.4	24.4	19.0	30.8	16.5	26.3	0.96	0.9422	-1.7408	0.8545	-1.7428	CDPHE 2005a
Lead, Dissolved	µg/L	5.3	135	4.2	109	5.0	127	6.5	166	5.4	139	0.6871	1.273	-1.46	1.273	-4.705	CDPHE 2005a
Manganese, Total	µg/L	2,073	3,752	1,937	3,506	2,036	3,684	2,211	4,002	2,092	3,786	-	0.3331	6.4676	0.3331	5.8743	CDPHE 2005a
Nickel, Dissolved	µg/L	93	837	78	704	89	799	109	985	95	856	0.997	0.846	2.253	0.846	0.0554	CDPHE 2005a
Silver, Dissolved	µg/L	1.04	6.61	0.73	4.65	0.95	6.01	1.45	9.21	1.09	6.92	-	1.72	-6.52	1.72	-9.06	CDPHE 2005a
Zinc, Dissolved	µg/L	211	210	178	176	202	200	249	247	216	214	0.986	0.8473	0.8618	0.8473	0.8699	CDPHE 2005a

Site specific hardness of 198.61, pH 7.5, and water temperature of 20°C were used in site-wide calculations.
Site specific hardness of 162, pH 7.16, and water temperature of 20°C were used in calculations for Woman Creek AEU.
Site specific hardness of 188, pH 7.19, and water temperature of 20°C were used in calculations for No Name AEU.
Site specific hardness of 241, pH 7.5, and water temperature of 20°C were used in calculations for North Walnut AEU.
Site specific hardness of 204, pH 7.62, and water temperature of 20°C were used in calculations for South Walnut AEU.
Ammonia criteria based on one hr (acute ESL) and 30 day average (chronic ESL) concentrations in mg/L not exceeded more than once every 3 yrs on average. In addition, the highest 4 day average within the 30day period should not exceed
Hardness adjusted metal ESLs determined using 198.61 mg/L $CaCO_3$.
Ammonia ESLs determined using a pH of 7.5 and 20°C.
Acute ESL (dissolved) = exp(Ma[ln(hardness)]+Ba)*(CF).
Chronic ESL (dissolved) = exp(Mc[ln(hardness)]+Bc)*(CF).
Acute ESL (total) = exp(Ma[ln(hardness)]+Ba).
Chronic ESL (total) = exp(Mc[ln(hardness)]+Bc).
Where CF = metal specific total to dissolved conversion factor provided in EPA 2002.
- = Not available.

Table A5.4
Water Quality Parameters for Rocky Flats AEUs

AEU/Analyte	n	Minimum Value	Maximum Value	Mean Value	Standard Deviation
Site-Wide					
pH	666	1.7	11.7	**7.5**	6.5
Fraction of unionized ammonia in total aqueous ammonia (%)	-	-	-	**1.24**	-
Hardness (mg/L)	886	8.8	770	**199**	82
Woman Creek AEU					
pH	394	5	8.8	**7.2**	-
Fraction of unionized ammonia in total aqueous ammonia (%)	-	-	-	**0.626**	-
Total Organic Carbon (mg/L)	251	1	44	7.4	5.4
Hardness (mg/L)	152	46.3	470	**162**	62
No Name Gulch AEU					
pH	56	6.4	8.9	**7.2**	-
Fraction of unionized ammonia in total aqueous ammonia (%)	-	-	-	**0.626**	-
Total Organic Carbon (mg/L)	31	1.8	51	18.2	12.1
Hardness (mg/L)	1	188	188	**188**	N/A
North Walnut Creek AEU					
pH	118	1.7	11.7	**7.5**	
Fraction of unionized ammonia in total aqueous ammonia (%)	-	-	-	**1.24**	-
Total Organic Carbon (mg/L)	114	2	26	7.7	5.2
Hardness (mg/L)	378	20	770	**241**	125
South Walnut Creek AEU					
pH	98	6.6	9.8	**7.6**	
Fraction of unionized ammonia in total aqueous ammonia (%)	-	-	-	**1.56**	-
Total Organic Carbon (mg/L)	87	1.4	22	8.0	4.1
Hardness (mg/L)	355	8.8	570	**204**	106

Fraction of unionized ammonia calculated using the equation from USEPA 1985.
- = Not available.

Table A5.5
Unique Dioxins and Furans that are CRA Ready in the 4/27/05 Database
(may include NLR data)

Dioxin Congener	Aquatic TEF[b]
1,2,3,4,6,7,8-Heptachlorodibenzofuran	0.01
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	0.001
1,2,3,4,7,8,9-Heptachlorodibenzofuran	0.01
Heptachlorodibenzofuran[a]	0.01
Heptachlorodibenzo-p-dioxin [a]	0.001
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	0.5
1,2,3,6,7,8-Hexachlorodibenzofuran	0.1
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	0.01
1,2,3,7,8,9-Hexachlorodibenzofuran	0.1
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	0.01
1,2,3,4,7,8-Hexachlorodibenzofuran	0.1
2,3,4,6,7,8-Hexachlorodibenzofuran	0.1
Hexachlorodibenzofuran [a]	0.1
Hexachlorodibenzo-p-dioxin [a]	0.5
1,2,3,7,8-Pentachlorodibenzofuran	0.05
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	1
2,3,4,7,8-Pentachlorodibenzofuran	0.5
Pentachlorodibenzofuran [a]	0.5
Pentachlorodibenzo-p-dioxin [a]	1
2,3,7,8-Tetrachlorodibenzodioxin	1
2,3,7,8-Tetrachlorodibenzofuran	0.05
Tetrachlorodibenzo-p-dioxin [a]	1
Octachlorodibenzofuran	0.0001
Octachlorodibenzo-p-dioxin	0.0001

Note that no dioxins were analyzed in NN AEU, MK AEU, RC AEU, or SE AEU

[a] The highest TEF within the series was assigned for results listed as generic dioxin/furan.

Sources: WHO 1997; Van den Berg et al. (1998).

Table A5.6

Equilibrium Partitioning Calculations for Deriving Sediment ESL and AT Benchmarks

Chemical	SW AT (µg/L)	SW ESL (µg/L)	Koc	foc	EqP based Sediment Benchmark	Type
1,2,4-Trimethylbenzene	310	17.0	717.60	0.01	122	ESL
2,4,6-Trichlorophenol	79	5.0	1,186.00	0.01	59	ESL
Atrazine	-	7.30	230.40	0.01	17	ESL
Atrazine	100	100	230.40	0.01	230	AT
1,3,5-Trimethylbenzene	810	45.0	703.00	0.01	316	ESL
1,3-Dichlorobenzene	200	28.0	434.00	0.01	122	ESL
Benzyl Alcohol	150	8.60	15.66	0.01	1.35	ESL
trans-1,2-Dichloroethene	28,000	1,500.00	43.79	0.01	657	ESL
2-butanone	-	2,200	3.827	0.01	84	ESL
Bromomethane	640	640.00	9.80	0.01	63	AT

EqP = ESL_{water} * Koc * foc.

- = Not available.

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COMPREHENSIVE RISK ASSESSMENT

NO NAME GULCH AQUATIC EXPOSURE UNIT, ROCK CREEK AQUATIC EXPOSURE UNIT, MCKAY DITCH AQUATIC EXPOSURE UNIT, SOUTHEAST AQUATIC EXPOSURE UNIT

VOLUME 15B1: ATTACHMENT 6

Chemical Risk Characterization Lines of Evidence in Support of the Risk Characterization

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ACRONYMS AND ABBREVIATIONS

AEU	Aquatic Exposure Unit
bgs	below ground surface
CRA	Comprehensive Risk Assessment
ECOPC	ecological contaminant of potential concern
EPC	exposure point concentration
ESL	ecological screening level
MK AEU	McKay Ditch Aquatic Exposure Unit
NN AEU	No Name Gulch Aquatic Exposure Unit
PAH	Polycyclic aromatic hydrocarbon

1.0 CHEMICAL RISK CHARACTERIZATION LINE OF EVIDENCE METHODS

The identified surface water and sediment ecological contaminants of potential concern (ECOPCs) were carried into the risk characterization process, and several data sets were generated in order to better understand current exposure conditions. Surface water data sets were queried to develop "post-1999" data summaries, and sediment samples were summarized as a surface sediment (0 to 6 inches deep) data set. An additional data interpretation involved the evaluation of adjacent surface soils as potential, future erosional contributions to aquatic habitats.

1.1 Surface Water

The Aquatic Exposure Unit (AEU) surface water ECOPC selection process relied upon the comprehensive data sets gathered from all samples collected from June 28, 1991 to August 2005. Given that water quality and chemical loading conditions are dynamic and affected by variables of site releases, accelerated action efforts, flow, environmental buffering capacity, etc., it was determined that a data set reflective of more current conditions could provide more realistic evaluation of surface water ECOPC chemistry. Therefore, summary statistics were generated for surface water data limited to samples collected post-1999.

The post-1999 surface water data sets were statistically compared to background concentrations. Summary statistics and results of the background screen are provided for the No Name Gulch AEU (NN AEU) in Tables A6.1 through A6.3 and the McKay Ditch AEU (MK AEU) in Tables A6.4 and A6.5.

1.2 Sediment

The AEU sediment ECOPC selection process relied upon the comprehensive data sets that included sediment samples collected from all depth fractions. Certain samples were collected from depths of over 9 feet below ground surface (bgs), which is not a relevant exposure media for aquatic life receptors. In contrast, data limited to surface sediments is more representative of the exposure media for aquatic species. As an additional line of evidence reflective of sediment with the potential for a complete exposure pathway to sediment receptors, all samples gathered from "surface" sediment (the top 6 inches) were evaluated. Surface sediment concentrations of ECOPCs identified in the Comprehensive Risk Assessment (CRA) were compared to ecological screening levels (ESLs). These data more accurately describe the realistic exposure conditions within an AEU. The results of the surface sediment data set were statistically summarized, and results are presented in Table 6.6 for the NN AEU and Table 6.7 for the MK AEU.

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1.3 Adjacent Surface Soils

Surface soils do not provide a direct exposure pathway to aquatic receptors. However, surface soils can potentially erode into adjacent waterways via overland transport (runoff), in which case they may contribute to the future chemical makeup of the AEUs. In the interest of being conservative, adjacent surface soils (defined as any surface soil sample collected within 20 feet of the wetted edge of an AEU aquatic feature) were evaluated by comparing sediment ECOPC concentrations to surface soil concentrations. If, for example, cadmium was identified as a sediment ECOPC, then cadmium in adjacent surface soils was evaluated to determine if the concentrations were greater than the sediment ESL. If the soil result was greater, then a potential for future contribution from soil to sediment was considered to exist. Conversely, if the soil concentration was less than the ESL, then potential future sediment chemical concentrations may be diluted through natural drainage erosion. The data for adjacent surface soils were summarized for the NN AEU and MK AEU (Tables A6.8 and A6.9, respectively).

1.4 Total PAHs

Polycyclic aromatic hydrocarbons (PAHs) exert toxicity in an additive manner because of a similar mode of toxic action (narcosis). Additional data evaluation in risk characterization included an evaluation of these organic contaminants to account for this interaction. The total PAH concentrations were calculated for samples from an AEU if any individual PAHs were retained as ECOPCs for risk characterization.

1. All PAH compounds detected in greater than 5 percent of the samples were included in the total calculations.
2. The sum of PAHs was determined for each sample, using half the detection limit for nondetected chemicals.
3. The maximum total PAH value was compared to the "total PAH" ESL.
4. The total detected PAHs for each sample was calculated for surface sediment and compared to the ESL.

This conservative measure of assessment was conducted for NN AEU, where seven individual PAHs were identified as ECOPCs. Their potential for risk to benthic organisms was further evaluated in risk characterization (Section 5). Calculations for these total PAHs are presented in Tables A6.10 and A6.11.

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Table A6.1
Summary of Post-1999 Surface Water ECOI Data in the NN AEU

Analyte	Range of Reported Detection Limits	Number of Samples	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Inorganics (mg/L) (Total)							
Aluminum	0.00240 - 0.0356	26	96.2	0.0169	55.4	6.42	13.0
Ammonia	0.0150 - 0.0150	1	100	1.50	1.50	1.50	N/A
Antimony	5.50E-04 - 0.00260	26	30.8	5.90E-04	0.00190	7.56E-04	4.84E-04
Arsenic	6.50E-04 - 0.00260	26	46.2	0.00110	0.0147	0.00223	0.00342
Barium	2.00E-05 - 8.00E-04	26	100	0.0844	0.820	0.222	0.196
Beryllium	2.00E-05 - 3.20E-04	26	46.2	3.00E-05	0.00250	3.13E-04	6.06E-04
Cadmium	8.00E-05 - 2.00E-04	26	11.5	9.00E-05	5.20E-04	8.17E-05	1.00E-04
Calcium	0.00160 - 0.0480	26	100	19.7	150	61.0	30.0
Chromium	1.00E-04 - 9.00E-04	26	80.8	1.70E-04	0.0442	0.00557	0.0105
Cobalt	1.50E-04 - 0.00230	26	57.7	1.60E-04	0.0123	0.00152	0.00290
Copper	1.20E-04 - 0.00150	26	92.3	4.50E-04	0.0444	0.00661	0.00961
Iron	0.00210 - 0.0120	26	100	0.0459	76	9.33	18.6
Lead	4.80E-04 - 0.00120	26	53.8	5.40E-04	0.0344	0.00403	0.00806
Lithium	2.00E-05 - 0.00310	26	100	0.00620	0.0456	0.0155	0.0106
Magnesium	9.80E-04 - 0.0636	26	100	4.54	39.9	12.4	8.80
Manganese	2.00E-05 - 3.90E-04	26	100	0.00160	1.20	0.186	0.387
Mercury	1.40E-05 - 1.00E-04	23	4.35	1.10E-04	1.10E-04	4.79E-05	1.86E-05
Molybdenum	4.00E-04 - 0.00100	26	84.6	6.10E-04	0.00410	0.00132	8.26E-04
Nickel	2.50E-04 - 0.00480	26	88.5	0.00100	0.0363	0.00598	0.00820
Potassium	0.00210 - 0.817	26	96.2	1.67	19	4.28	3.61
Selenium	8.50E-04 - 0.00230	26	26.9	0.00110	0.00210	9.02E-04	5.52E-04
Silver	1.20E-04 - 3.00E-04	25	8	3.20E-04	5.30E-04	1.32E-04	9.59E-05
Sodium	3.80E-04 - 2.60	26	100	4.77	87	31.1	21.8
Strontium	2.00E-05 - 2.80E-04	26	100	0.106	1	0.376	0.251
Thallium	9.00E-04 - 0.00240	26	11.5	0.00370	0.00710	0.00122	0.00154
Tin	7.00E-04 - 0.00260	26	3.85	0.00320	0.00320	7.29E-04	5.66E-04
Uranium	0.00200 - 0.0390	26	3.85	0.00270	0.00270	0.00345	0.00475
Vanadium	2.00E-05 - 0.00180	26	88.5	5.40E-04	0.0951	0.0123	0.0226
Zinc	1.00E-04 - 0.00190	26	57.7	0.00440	0.125	0.0292	0.0359
Inorganics (mg/L) (Dissolved)							
Aluminum	0.0150 - 0.0150	1	100	0.0240	0.0240	0.0240	N/A
Barium	2.10E-04 - 2.10E-04	1	100	0.640	0.640	0.640	N/A
Calcium	0.0150 - 0.0150	1	100	140	140	140	N/A
Cobalt	9.50E-04 - 9.50E-04	1	100	0.00130	0.00130	0.00130	N/A
Iron	0.00340 - 0.00340	1	100	46	46	46	N/A
Lithium	0.00180 - 0.00180	1	100	0.0290	0.0290	0.0290	N/A
Magnesium	0.0150 - 0.0150	1	100	32	32	32	N/A
Manganese	1.90E-04 - 1.90E-04	1	100	1.20	1.20	1.20	N/A
Nickel	8.00E-04 - 8.00E-04	1	100	0.00600	0.00600	0.00600	N/A
Potassium	0.400 - 0.400	1	100	5	5	5	N/A
Sodium	1.10 - 1.10	1	100	60	60	60	N/A
Strontium	4.50E-05 - 4.50E-05	1	100	0.970	0.970	0.970	N/A
Zinc	0.00190 - 0.00190	1	100	0.0140	0.0140	0.0140	N/A
Organics (ug/L)							
1,1-Dichloroethane	0.170 - 1	33	75.8	0.390	3	1.39	0.681
1,1-Dichloroethene	0.200 - 1	33	3.03	0.520	0.520	0.501	0.00348
1,2,3-Trichlorobenzene	0.160 - 1	33	6.06	0.100	0.200	0.479	0.0857
1,2,3-Trichloropropane	0.260 - 1	33	3.03	0.700	0.700	0.506	0.0348
1,2,4-Trichlorobenzene	0.200 - 10	36	11.1	0.200	0.200	0.842	1.28
1,2,4-Trimethylbenzene	0.150 - 1	33	48.5	0.190	1.30	0.591	0.272
1,2-Dichlorobenzene	0.150 - 10	36	61.1	0.240	0.400	0.774	1.29
1,3,5-Trimethylbenzene	0.160 - 1	33	33.3	0.100	0.390	0.415	0.129
1,3-Dichlorobenzene	0.130 - 10	36	19.4	0.100	0.280	0.809	1.29
1,4-Dichlorobenzene	0.160 - 10	36	61.1	0.290	0.530	0.835	1.28
2-Butanone	0.420 - 10	31	12.9	2	9.20	3.32	1.61
2-Methylnaphthalene	1.50 - 10.6	4	25	6.20	6.20	5.38	0.568
4-Chlorotoluene	0.210 - 1	33	3.03	0.300	0.300	0.494	0.0348
4-Isopropyltoluene	0.200 - 1	32	25	0.100	0.400	0.444	0.107
4-Methylphenol	2.10 - 10	3	33.3	1	1	3.67	2.31
Acenaphthene	1 - 10.6	4	75	1	2.70	2.75	1.84
Acetone	1.90 - 10	32	71.9	3	24	7.03	4.16
Benzene	0.150 - 1	33	72.7	0.310	2.50	1.19	0.576
Benzoic Acid	12 - 53.2	4	50	0.600	8	15.1	12.8
bis(2-ethylhexyl)phthalate	3.10 - 10.6	4	50	2	2	3.58	1.82
Bromoform	0.230 - 1	33	3.03	0.700	0.700	0.506	0.0348
Butylbenzylphthalate	1.60 - 10.6	4	50	0.700	2	3.25	2.26

Table A6.1
Summary of Post-1999 Surface Water ECOI Data in the NN AEU

Analyte	Range of Reported Detection Limits			Number of Samples	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Chlorobenzene	0.130	-	1	33	63.6	0.240	0.950	0.433	0.139
Chloroethane	0.180	-	1	33	75.8	2.60	24	10.7	6.98
Chloromethane	0.250	-	1	33	12.1	0.100	2.80	0.648	0.551
cis-1,2-Dichloroethene	0.140	-	1	33	18.2	0.100	0.200	0.439	0.132
Dibenzofuran	5	-	10.6	4	50	0.600	1	2.98	2.52
Dichlorodifluoromethane	0.220	-	1	32	21.9	0.500	1	0.554	0.140
Diethylphthalate	1.10	-	10.6	4	50	0.700	0.800	2.95	2.54
Di-n-butylphthalate	1.10	-	10.6	4	25	1	1	4.08	2.05
Ethylbenzene	0.120	-	1	33	33.3	0.100	1	0.488	0.173
Fluorene	1.30	-	10.6	4	75	1	2.60	2.73	1.84
Hexachlorobutadiene	0.180	-	10	36	8.33	0.100	0.690	0.874	1.26
Isopropylbenzene	0.170	-	1	33	69.7	0.340	1	0.685	0.196
Methylene Chloride	0.210	-	1	33	39.4	0.200	0.890	0.475	0.146
Naphthalene	0.150	-	10	36	69.4	0.800	27	6.00	6.94
n-Butylbenzene	0.210	-	1	33	6.06	0.100	0.280	0.481	0.0784
n-Propylbenzene	0.170	-	1	33	60.6	0.180	0.700	0.414	0.111
Phenanthrene	1.30	-	10.6	4	50	3	3.50	4.20	1.12
Phenol	1.40	-	10.6	4	50	0.600	3.50	3.60	2.15
sec-Butylbenzene	0.230	-	1	33	12.1	0.100	0.200	0.461	0.109
Styrene	0.140	-	1	33	3.03	3	3	0.576	0.435
Toluene	0.150	-	1	33	72.7	0.180	2.30	0.476	0.355
Trichloroethene	0.160	-	1	33	21.2	0.100	0.610	0.454	0.117
Trichlorofluoromethane	0.240	-	1	33	3.03	0.500	0.500	0.500	0
Vinyl Chloride	0.190	-	1	33	54.5	0.330	2	0.694	0.380
Xylene	0.410	-	3	33	57.6	0.590	4.10	1.62	1.25
Radionuclides (pCi/L)									
Americium-241	0.0180	-	0.185	23	100	-0.00600	0.0240	0.00363	0.00797
Plutonium-239/240	0.0170	-	0.0820	23	100	-0.00200	0.0560	0.00726	0.0158
Uranium-233/234	0.0200	-	0.328	23	100	0.327	3.79	1.57	0.861
Uranium-235	0.0150	-	0.253	23	100	0.0150	0.338	0.0677	0.0658
Uranium-238	0.0200	-	0.252	23	100	0.266	2.98	1.28	0.704

N/A = Not applicable.

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Table A6.2

Statistical Distribution and Comparison to Background for Surface Water, Dissolved Analyses (excluding background samples) - 2000 - 2005 Data NN AEU

Analyte	Units	Statistical Distribution Testing Results						Background Comparison Test		
		Background			NN AEU (excluding background samples)			Test	1 - p	>Bkg
		Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)			
Aluminum	mg/L	138	NONPARAMETRIC	46	1	N/A	100	WRS	N/A	N/A
Antimony	mg/L	137	NONPARAMETRIC	15	1	N/A	0	N/A	N/A	N/A
Arsenic	mg/L	129	NONPARAMETRIC	5	1	N/A	0	N/A	N/A	N/A
Barium	mg/L	140	NONPARAMETRIC	68	1	N/A	100	WRS	N/A	N/A
Beryllium	mg/L	134	NONPARAMETRIC	3	1	N/A	0	N/A	N/A	N/A
Cadmium	mg/L	136	NONPARAMETRIC	7	1	N/A	0	N/A	N/A	N/A
Calcium	mg/L	141	NONPARAMETRIC	100	1	N/A	100	WRS	N/A	N/A
Chromium	mg/L	136	NONPARAMETRIC	5	1	N/A	0	N/A	N/A	N/A
Cobalt	mg/L	139	NONPARAMETRIC	4	1	N/A	100	N/A	N/A	N/A
Copper	mg/L	138	NONPARAMETRIC	33	1	N/A	0	N/A	N/A	N/A
Iron	mg/L	137	LOGNORMAL	80	1	N/A	100	WRS	N/A	N/A
Lead	mg/L	133	NONPARAMETRIC	24	1	N/A	0	N/A	N/A	N/A
Lithium	mg/L	134	NONPARAMETRIC	34	1	N/A	100	WRS	N/A	N/A
Magnesium	mg/L	141	NONPARAMETRIC	82	1	N/A	100	WRS	N/A	N/A
Manganese	mg/L	139	LOGNORMAL	81	1	N/A	100	WRS	N/A	N/A
Mercury	mg/L	135	NONPARAMETRIC	7	1	N/A	0	N/A	N/A	N/A
Molybdenum	mg/L	139	NONPARAMETRIC	14	1	N/A	0	N/A	N/A	N/A
Nickel	mg/L	134	NONPARAMETRIC	7	1	N/A	100	N/A	N/A	N/A
Potassium	mg/L	134	NONPARAMETRIC	66	1	N/A	100	WRS	N/A	N/A
Selenium	mg/L	133	NONPARAMETRIC	8	1	N/A	0	N/A	N/A	N/A
Silver	mg/L	141	NONPARAMETRIC	6	1	N/A	0	N/A	N/A	N/A
Sodium	mg/L	141	NONPARAMETRIC	99	1	N/A	100	WRS	N/A	N/A
Strontium	mg/L	139	NONPARAMETRIC	76	1	N/A	100	WRS	N/A	N/A
Thallium	mg/L	134	NONPARAMETRIC	3	1	N/A	0	N/A	N/A	N/A
Tin	mg/L	133	NONPARAMETRIC	8	1	N/A	0	N/A	N/A	N/A
Uranium	mg/L	N/A	N/A	N/A	1	N/A	0	N/A	N/A	N/A
Vanadium	mg/L	139	NONPARAMETRIC	9	1	N/A	0	N/A	N/A	N/A
Zinc	mg/L	138	NONPARAMETRIC	57	1	N/A	100	WRS	N/A	N/A

Test: WRS = Wilcoxon Rank Sum, t-Test_N = Student's t-test using normal data, t-Test-LN = Student's t-test using log-transformed data, N/A = not applicable; site and/or background detection frequency less than 20%.
CRA Dataset ID: 062305_A1.

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Table A6.3

Statistical Distribution and Comparison to Background for Surface Water, Total Analyses (excluding background samples) - 2000 - 2005 Data NN AEU

Analyte	Units	Statistical Distribution Testing Results						Background Comparison Test		
		Background			NN AEU (excluding background samples)			Test	1-p	>Bkg
		Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)			
Benzo(a)pyrene	ug/L	N/A	N/A	N/A	4	NONPARAMETRIC	0	N/A	N/A	N/A
bis(2-ethylhexyl)phthalate	ug/L	3	N/A	17	4	NORMAL	50	N/A	N/A	N/A
Di-n-butylphthalate	ug/L	1	N/A	6	4	NONPARAMETRIC	25	N/A	N/A	N/A
Pentachlorophenol	ug/L	N/A	N/A	N/A	4	NORMAL	0	N/A	N/A	N/A
Phenanthrene	ug/L	N/A	N/A	N/A	4	NORMAL	50	N/A	N/A	N/A
Phenol	ug/L	N/A	N/A	N/A	4	NORMAL	50	N/A	N/A	N/A
Pyrene	ug/L	N/A	N/A	N/A	4	NONPARAMETRIC	0	N/A	N/A	N/A
Aluminum	mg/L	166	NONPARAMETRIC	82	25	GAMMA	96	WRS	0.063	Yes
Ammonia	mg/L	1	N/A	0	1	N/A	100	N/A	N/A	N/A
Antimony	mg/L	169	NONPARAMETRIC	10	25	NONPARAMETRIC	28	N/A	N/A	N/A
Arsenic	mg/L	161	NONPARAMETRIC	23	25	NONPARAMETRIC	48	WRS	0.448	No
Barium	mg/L	172	NONPARAMETRIC	78	25	NONPARAMETRIC	100	WRS	0.000	Yes
Beryllium	mg/L	167	NONPARAMETRIC	13	25	LOGNORMAL	44	N/A	N/A	N/A
Cadmium	mg/L	165	NONPARAMETRIC	5	25	NONPARAMETRIC	12	N/A	N/A	N/A
Calcium	mg/L	172	NONPARAMETRIC	100	25	GAMMA	100	WRS	0.000	Yes
Chromium	mg/L	167	NONPARAMETRIC	29	25	LOGNORMAL	80	WRS	0.999	No
Cobalt	mg/L	171	NONPARAMETRIC	17	25	GAMMA	56	N/A	N/A	N/A
Copper	mg/L	164	NONPARAMETRIC	46	25	LOGNORMAL	92	WRS	1	No
Iron	mg/L	172	NONPARAMETRIC	97	25	LOGNORMAL	100	WRS	0.112	No
Lead	mg/L	166	NONPARAMETRIC	45	25	NONPARAMETRIC	56	WRS	0.957	No
Lithium	mg/L	166	NONPARAMETRIC	49	25	NONPARAMETRIC	100	WRS	0.00	Yes
Magnesium	mg/L	172	NONPARAMETRIC	86	25	GAMMA	100	WRS	0.000	Yes
Manganese	mg/L	171	LOGNORMAL	91	25	NONPARAMETRIC	100	WRS	8.77E-01	No
Mercury	mg/L	162	NONPARAMETRIC	11	22	NONPARAMETRIC	5	N/A	N/A	N/A
Molybdenum	mg/L	167	NONPARAMETRIC	22	25	GAMMA	84	WRS	1.000	No
Nickel	mg/L	167	NONPARAMETRIC	26	25	GAMMA	92	WRS	0.993	No
Potassium	mg/L	167	NONPARAMETRIC	74	25	NONPARAMETRIC	96	WRS	0	Yes
Selenium	mg/L	162	NONPARAMETRIC	14	25	NONPARAMETRIC	28	N/A	N/A	N/A
Silver	mg/L	170	NONPARAMETRIC	6	24	NONPARAMETRIC	8	N/A	N/A	N/A
Sodium	mg/L	172	NONPARAMETRIC	99	25	LOGNORMAL	100	WRS	0.006	Yes
Strontium	mg/L	168	NONPARAMETRIC	80	25	GAMMA	100	WRS	0.000	Yes
Thallium	mg/L	166	NONPARAMETRIC	6	25	NONPARAMETRIC	12	N/A	N/A	N/A
Tin	mg/L	161	NONPARAMETRIC	12	25	NONPARAMETRIC	4	N/A	N/A	N/A
Uranium	mg/L	9	GAMMA	22	25	NONPARAMETRIC	4	N/A	N/A	N/A
Vanadium	mg/L	171	NONPARAMETRIC	34	25	LOGNORMAL	88	WRS	7.67E-01	No
Zinc	mg/L	N/A	N/A	74	25	GAMMA	60	WRS	6.28E-01	No
Americium-241	pCi/L	101	NONPARAMETRIC	100	21	NONPARAMETRIC	100	WRS	0.931	No
Plutonium-239/240	pCi/L	107	NONPARAMETRIC	100	21	NONPARAMETRIC	100	WRS	0.374	No
Uranium-233/234	pCi/L	77	NONPARAMETRIC	100	21	NORMAL	100	WRS	3.33E-09	Yes
Uranium-235	pCi/L	74	NONPARAMETRIC	100	21	GAMMA	100	WRS	0.009	Yes
Uranium-238	pCi/L	77	NONPARAMETRIC	100	21	NORMAL	100	WRS	5.28E-09	Yes

Test: WRS = Wilcoxon Rank Sum, t-Test_N = Student's t-test using normal data, t-Test-LN = Student's t-test using log-transformed data, N/A = not applicable; site and/or background detection frequency less than 20%.

CRA Dataset ID: 062305_A1.

Table A6.4
Summary of Post-1999 Surface Water ECOI Data in the MK AEU

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Inorganics (mg/L)							
Aluminum	0.055 - 0.055	2.00	100	0.088	1.70	0.894	1.14
Barium	0.0021 - 0.0021	2.00	100	0.290	0.300	0.295	0.007
Boron	0.013 - 0.013	2.00	100	0.019	0.020	0.020	7.07E-04
Calcium	0.096 - 0.096	2.00	100	72.0	110	91.0	26.9
Chromium	0.0012 - 0.0012	2.00	50.0	0.002	0.002	0.001	0.001
Cobalt	0.00091 - 0.00091	2.00	50.0	0.002	0.002	0.001	0.001
Iron	0.028 - 0.028	2.00	100	0.087	2.80	1.44	1.92
Lithium	0.0048 - 0.0048	2.00	100	0.005	0.008	0.007	0.002
Magnesium	0.017 - 0.017	2.00	100	13.0	23.0	18.0	7.07
Manganese	0.0019 - 0.0019	2.00	100	0.023	0.260	0.142	0.168
Nickel	0.002 - 0.002	2.00	100	0.002	0.004	0.003	0.001
Potassium	0.25 - 0.25	2.00	100	2.50	4.10	3.30	1.13
Sodium	1.4 - 1.4	2.00	100	90.0	490	290	283
Strontium	0.0013 - 0.0013	2.00	100	0.440	0.590	0.515	0.106
Titanium	0.0026 - 0.0026	2.00	100	0.003	0.035	0.019	0.023
Uranium	0.0078 - 0.0078	2.00	50.0	0.035	0.035	0.022	0.018
Vanadium	0.0024 - 0.0024	2.00	50.0	0.004	0.004	0.002	0.002
Zinc	0.0049 - 0.0049	2.00	50.0	0.320	0.320	0.161	0.225
Radionuclides (pCi/L)							
Americium-241	0.0345 - 0.109	2.00	100	0.010	0.023	0.016	0.009
Plutonium-239/240	0.084 - 0.101	2.00	100	-0.009	0.217	0.104	0.160
Uranium-233/234	0.487 - 0.587	2.00	100	0.369	5.93	3.15	3.93
Uranium-235	0.35 - 0.529	2.00	100	-0.027	0.117	0.045	0.102
Uranium-238	0.291 - 0.35	2.00	100	0.194	3.39	1.79	2.26
Silica	0.023 - 0.023	2.00	100	13.0	17.0	15.0	2.83

Table A6.5

Statistical Distribution and Comparison to Background for Surface Water, Total Analyses (excluding background samples) - 2000 - 2005 Data (MK AEU)

Analyte	Units	Statistical Distribution Testing Results						Background Comparison Test		
		Background			MK AEU (excluding background samples)					
		Total Samples	Distribution Recommended by ProUCL	Detects (%)	Total Samples	Distribution Recommended by ProUCL	Detects (%)	Test	1 - p	>Bkg
Inorganics (mg/L)										
Aluminum	mg/L	166	NONPARAMETRIC	82	2	N/A	100	WRS	0.482	No
Antimony	mg/L	169	NONPARAMETRIC	10	2	N/A	0	N/A	N/A	N/A
Arsenic	mg/L	161	NONPARAMETRIC	23	2	N/A	0	N/A	N/A	N/A
Barium	mg/L	172	NONPARAMETRIC	78	2	N/A	100	WRS	0.011	No
Beryllium	mg/L	167	NONPARAMETRIC	13	2	N/A	0	N/A	N/A	N/A
Boron	mg/L	N/A	N/A	N/A	2	N/A	100	N/A	N/A	N/A
Cadmium	mg/L	165	NONPARAMETRIC	5	2	N/A	0	N/A	N/A	N/A
Calcium	mg/L	172	NONPARAMETRIC	100	2	N/A	100	WRS	0.008	No
Chromium	mg/L	167	NONPARAMETRIC	29	2	N/A	50	WRS	0.933	No
Cobalt	mg/L	171	NONPARAMETRIC	17	2	N/A	50	N/A	N/A	N/A
Copper	mg/L	164	NONPARAMETRIC	46	2	N/A	0	N/A	N/A	N/A
Iron	mg/L	172	NONPARAMETRIC	97	2	N/A	100	WRS	0.562	No
Lead	mg/L	166	NONPARAMETRIC	45	2	N/A	0	N/A	N/A	N/A
Lithium	mg/L	166	NONPARAMETRIC	49	2	N/A	100	WRS	0.271	No
Magnesium	mg/L	172	NONPARAMETRIC	86	2	N/A	100	WRS	0.008	No
Manganese	mg/L	171	LOGNORMAL	91	2	N/A	100	WRS	0.171	No
Mercury	mg/L	162	NONPARAMETRIC	11	2	N/A	0	N/A	N/A	N/A
Molybdenum	mg/L	167	NONPARAMETRIC	22	2	N/A	0	N/A	N/A	N/A
Nickel	mg/L	167	NONPARAMETRIC	26	2	N/A	100	WRS	0.892	No
Potassium	mg/L	167	NONPARAMETRIC	74	2	N/A	100	WRS	0.053	No
Selenium	mg/L	162	NONPARAMETRIC	14	2	N/A	0	N/A	N/A	N/A
Silica	mg/L	90	NONPARAMETRIC	98	2	N/A	100	WRS	0.018	No
Silver	mg/L	170	NONPARAMETRIC	6	2	N/A	0	N/A	N/A	N/A
Sodium	mg/L	172	NONPARAMETRIC	99	2	N/A	100	WRS	0.008	No
Strontium	mg/L	168	NONPARAMETRIC	80	2	N/A	100	WRS	0.024	No
Thallium	mg/L	166	NONPARAMETRIC	6	2	N/A	0	N/A	N/A	N/A
Tin	mg/L	161	NONPARAMETRIC	12	2	N/A	0	N/A	N/A	N/A
Titanium	mg/L	N/A	N/A	N/A	2	N/A	100	N/A	N/A	N/A
Uranium	mg/L	9	GAMMA	22	2	N/A	50	WRS	0.029	No
Vanadium	mg/L	171	NONPARAMETRIC	34	2	N/A	50	WRS	0.840	No
Zinc	mg/L	170	LOGNORMAL	74	2	N/A	50	WRS	0.452	No
Radionuclides (pCi/L)										
Americium-241	pCi/L	101	NONPARAMETRIC	100	2	N/A	100	WRS	0.027	No
Plutonium-239/240	pCi/L	107	NONPARAMETRIC	100	2	N/A	100	WRS	0.491	No
Uranium-233/234	pCi/L	77	NONPARAMETRIC	100	2	N/A	100	WRS	0.063	No
Uranium-235	pCi/L	74	NONPARAMETRIC	100	2	N/A	100	WRS	0.606	No
Uranium-238	pCi/L	77	NONPARAMETRIC	100	2	N/A	100	WRS	0.130	No

Test: WRS = Wilcoxon Rank Sum, t-Test_N = Student's t-test using normal data, t-Test-LN = Student's t-test using log-transformed data, N/A = not applicable; site and/or background detection frequency less than 20%.
CRA Dataset ID: 042705_D5.

Table A6.6
Summary of Surface Sediment ECOI Data in the NN AEU

Analyte	Range of Reported Detection Limits			Number of Samples	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Inorganic (mg/kg)									
Aluminum	4.40	-	40	17	100	6,000	24,000	15,639	4,940
Arsenic	0.140	-	2	17	100	3.80	7.10	5.48	1.07
Barium	0.150	-	40	17	100	92.6	390	200	83.6
Beryllium	0.0250	-	1	17	100	0.600	1.20	0.951	0.158
Boron	1.50	-	2	10	100	4.80	10	7.06	1.79
Cadmium	0.0560	-	1.20	17	11.8	0.110	0.160	0.224	0.223
Calcium	2.70	-	1,000	17	100	2,280	74,000	12,234	16,469
Cesium	95.2	-	200	5	20	3.90	3.90	42.6	22.1
Chromium	0.0600	-	2	17	94.1	3.70	25	14.5	6.31
Cobalt	0.120	-	10	17	100	4.30	11.8	7.57	1.69
Copper	0.0740	-	5	17	100	5.70	19.1	15.7	3.15
Iron	1.20	-	20	17	100	10,100	21,500	15,718	2,929
Lead	0.360	-	1.30	17	100	12	29.3	19.8	4.71
Lithium	0.290	-	20	15	100	4.30	15	9.83	2.83
Magnesium	5.80	-	1,000	17	100	1,200	4,200	3,034	810
Manganese	0.150	-	3	17	100	78	1,100	269	242
Mercury	0.00540	-	0.130	17	58.8	0.0170	0.0650	0.0495	0.0122
Molybdenum	0.200	-	40	15	73.3	0.260	5.20	0.939	1.20
Nickel	0.200	-	8	17	100	7	17	13.0	2.15
Nitrate / Nitrite	0.200	-	1.10	7	85.7	0.638	3.20	1.67	0.973
Potassium	36	-	1,000	17	100	989	2,810	1,729	569
Selenium	0.220	-	1	17	29.4	0.410	0.880	0.455	0.208
Silica	1.50	-	2	10	100	1,400	2,000	1,720	230
Silicon	0	-	4.40	5	100	153	417	263	107
Silver	0.0720	-	2	17	5.88	0.340	0.340	0.291	0.301
Sodium	8.60	-	1,000	17	88.2	38.1	600	158	135
Strontium	0.0920	-	40	15	100	33.4	320	73.8	70.8
Thallium	0.290	-	2	17	52.9	0.310	2.30	0.481	0.530
Tin	0.560	-	40	15	26.7	7.70	10.7	4.98	6.53
Titanium	0.220	-	0.290	10	100	59	150	93.8	27.6
Vanadium	0.350	-	10	17	100	19.7	59	37.5	11.6
Zinc	0.490	-	4	17	100	29.1	110	64.2	18.6
Organic (ug/kg)									
1,2,4-Trimethylbenzene	1.10	-	1.50	10	60	1.40	4.60	2.87	0.994
2-Butanone	5.40	-	12	15	6.67	13	13	10.6	3.51
Acetone	5.30	-	12	15	66.7	6.10	99	23.1	24.0
Anthracene	26	-	400	15	13.3	37	51	185	62.0
Benzo(a)anthracene	28	-	400	15	40	42	150	220	151
Benzo(a)pyrene	45	-	400	15	13.3	98	160	322	133
Benzo(b)fluoranthene	32	-	400	15	26.7	56	190	282	150
Benzo(g,h,i)perylene	30	-	400	15	13.3	71	89	316	143
Benzo(k)fluoranthene	36	-	400	15	6.67	110	110	340	125
bis(2-ethylhexyl)phthalate	81	-	400	15	33.3	36	220	284	150
Chrysene	31	-	400	15	26.7	44	190	277	155
Di-n-butylphthalate	23	-	400	15	6.67	34	34	337	134
Fluoranthene	25	-	400	15	40	79	340	250	137
Indeno(1,2,3-cd)pyrene	25	-	400	15	13.3	57	86	315	145
Methylene Chloride	0.920	-	6.10	15	66.7	2.60	3.30	5.71	6.72
Naphthalene	0.990	-	400	15	20	1.70	2.50	66.9	95.4
Phenanthrene	39	-	400	15	40	57	280	238	143
Pyrene	150	-	400	15	13.3	210	320	340	113
Toluene	0.900	-	6	15	13.3	8	190	15.9	48.2
Radionuclide (pCi/g)									
Americium-241	0	-	0.196	19	100	-0.0370	0.130	0.0287	0.0352
Cesium-134	0.0800	-	0.0900	3	100	0.0604	0.167	0.103	0.0569
Cesium-137	0.0300	-	0.100	7	100	0.0640	1.21	0.327	0.403
Gross Alpha	2.41	-	56	7	100	4.82	37	19.8	11.3
Gross Beta	2.23	-	21	7	100	6.45	32	22.4	10.2
Plutonium-239/240	0	-	0.170	21	100	-0.0140	0.447	0.0443	0.0964
Radium-226	0.140	-	0.160	4	100	0.910	1.53	1.25	0.259
Radium-228	0.0600	-	0.360	5	100	1.12	1.62	1.33	0.182
Strontium-89/90	0.0400	-	1.02	7	100	0.0539	1.04	0.308	0.341

Table A6.6
Summary of Surface Sediment ECOI Data in the NN AEU

Analyte	Range of Reported Detection Limits			Number of Samples	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Uranium-233/234	0.0220	-	0.385	19	100	0.480	1.51	0.952	0.226
Uranium-235	0	-	0.385	19	100	0	0.143	0.0642	0.0357
Uranium-238	0	-	0.281	19	100	0.500	1.58	0.968	0.234

Table A6.7
Summary of Surface Sediment ECOI Data in the MK AEU

Analyte	Range of Reported Detection Limits	Total Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration	Arithmetic Mean Concentration	Standard Deviation
Inorganics (mg/kg)							
Aluminum	4 - 40	10.0	100	2,390	30,300	10,709	8,789
Antimony	0.54 - 12	10.0	10.0	12.4	12.4	3.59	3.91
Arsenic	0.14 - 2	10.0	100	1.40	8.40	3.37	2.32
Barium	0.14 - 40	10.0	100	18.0	145	73.6	48.0
Beryllium	0.023 - 1	10.0	80.0	0.260	1.50	0.541	0.416
Boron	1.4 - 1.6	2.00	100	1.40	4.20	2.80	1.98
Cadmium	0.052 - 1.46	10.0	30.0	0.067	0.410	0.361	0.201
Calcium	3.6 - 2,000	10.0	100	470	30,000	5,138	8,873
Cesium	10.7 - 200	8.00	12.5	4.90	4.90	17.3	21.2
Chromium	0.055 - 2	10.0	100	2.10	44.3	12.3	13.1
Chromium VI	0.005 - 0.005	1.00	100	0.013	0.013	0.013	N/A
Cobalt	0.11 - 10	10.0	90.0	1.90	9.30	4.89	2.24
Copper	0.068 - 5	10.0	90.0	3.10	33.2	12.7	10.7
Fluoride	2.5 - 2.5	1.00	100	8.47	8.47	8.47	N/A
Iron	1.2 - 20	10.0	100	4,200	27,500	12,303	7,906
Lead	0.33 - 1.1	10.0	100	2.00	73.6	16.7	21.5
Lithium	0.26 - 20	10.0	100	2.30	19.2	8.14	5.99
Magnesium	5.3 - 2,000	10.0	100	570	4,580	2,250	1,509
Manganese	0.14 - 3	10.0	100	67.0	326	181	86.6
Mercury	0.005 - 0.243	10.0	20.0	0.022	0.150	0.065	0.041
Molybdenum	0.18 - 40	10.0	50.0	0.320	2.40	1.43	1.07
Nickel	0.18 - 8	10.0	90.0	3.10	28.3	10.8	8.15
Nitrate / Nitrite	0.02 - 1.3	7.00	57.1	0.300	64.0	9.73	23.9
Potassium	33 - 2,000	10.0	100	423	2,940	1,387	924
Selenium	0.24 - 1.46	10.0	10.0	2.70	2.70	0.474	0.790
Silica	1.4 - 1.6	2.00	100	500	800	650	212
Silicon	4.1 - 5	3.00	100	252	854	463	339
Sodium	8.8 - 2,000	10.0	100	65.1	2,090	419	608
Strontium	0.085 - 400	10.0	100	4.10	44.0	22.3	14.4
Thallium	0.29 - 2	10.0	10.0	0.400	0.400	0.262	0.190
Tin	0.52 - 40	10.0	30.0	3.60	9.30	5.89	6.68
Titanium	0.2 - 0.23	2.00	100	66.0	110	88.0	31.1
Uranium	0.96 - 1.1	2.00	50.0	1.10	1.10	0.790	0.438
Vanadium	0.32 - 10	10.0	100	7.40	67.7	26.5	19.5
Zinc	0.45 - 4	10.0	100	19.0	347	91.6	103
Organics (µg/kg)							
2-Butanone	10 - 27	8.00	12.5	3.00	3.00	7.06	3.05
4-Methylphenol	330 - 890	8.00	12.5	95.0	95.0	303	173
Benzoic Acid	1600 - 2,200	7.00	14.3	480	480	1,369	814
bis(2-ethylhexyl)phthalate	330 - 890	8.00	37.5	52.0	120	315	232
Chrysene	330 - 890	8.00	12.5	150	150	310	164
Di-n-butylphthalate	330 - 890	8.00	37.5	38.0	280	289	197
Fluoranthene	330 - 890	8.00	25.0	88.0	170	291	180
Phenanthrene	330 - 890	8.00	12.5	96.0	96.0	303	172
Pyrene	330 - 890	8.00	25.0	61.0	170	288	184
Toluene	5 - 27	8.00	25.0	2.00	6.00	5.00	3.63
Radionuclides (pCi/g)							
Americium-241	0 - 0.166	10.0	100	-0.024	0.087	0.017	0.029
Cesium-134	0.087 - 0.2	3.00	100	0.087	0.200	0.132	0.060
Cesium-137	0.04 - 0.104	7.00	100	0.002	0.391	0.154	0.133
Gross Alpha	1.8 - 27.17	9.00	100	-2.40	79.0	35.3	27.5
Gross Beta	2.4 - 6	9.00	100	8.45	69.0	44.1	16.9
Plutonium-239/240	0 - 0.132	10.0	100	0.002	0.054	0.023	0.018
Radium-226	0.18 - 0.71	5.00	100	0.390	1.90	0.918	0.597
Radium-228	0.07 - 0.64	3.00	100	0.930	1.70	1.19	0.442
Strontium-89/90	0.04 - 0.4	7.00	100	0.030	0.316	0.178	0.113
Uranium-233/234	0.014 - 0.293	10.0	100	0.380	15.0	2.59	4.45
Uranium-235	0 - 0.305	10.0	100	0.016	0.460	0.100	0.134
Uranium-238	0.01 - 0.287	10.0	100	0.310	13.0	2.30	3.86

N/A = Not applicable.

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Table A6.8
Summary of Adjacent Surface Soil Data in the NN AEU

Analyte	Number of Results	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration (MDC)	Arithmetic Mean Concentration	Standard Deviation	ESL	MDC > ESL
Inorganics (mg/kg)								
Aluminum	**17**	**100%**	**6,420**	**18,000**	**10,467**	**3,156**	**15,900**	**Yes**
Barium	**17**	**100%**	**72.0**	**263**	**151**	**58.3**	**189**	**Yes**
Iron	17	100%	7,860	18,400	12,002	2,455	20,000	No
Lead	**17**	**100%**	**10.2**	**42.5**	**26.0**	**7.43**	**35.8**	**Yes**
Organics (µg/kg)								
Benzo(a)anthrancene	1	100%	84	84	84	N/A	108	No
Benzo(a)pyrene	1	100%	70	70	70	N/A	150	No
Benzo(g,h,i)perylene	1	0%	0	0	175	N/A	13	No
Chrysene	1	100%	81	81	81	N/A	166	No
Indeno(1,2,3-cd)pyrene	1	0%	0	0	175	N/A	17	No
Phenanthrene	1	100%	120	120	120	N/A	204	No
Pyrene	1	100%	160	160	160	N/A	195	No

Note: Includes soil data for all years.

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Table A6.9
Summary of Adjacent Surface Soil Data in the MK AEU

Analyte	Number of Results	Detected	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration (MDC)	Arithmetic Mean Concentration	Standard Deviation	ESL	MDC > ESL
Inorganics (mg/kg)									
Aluminum	1	1	100%	9630	9,630	9,630	NA	15,900	No
Chromium	1	1	100%	11.1	11.1	11.1	NA	43.4	No
Fluoride	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nickel	1	1	100%	7.9	7.90	7.90	NA	22.7	No
Selenium	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Note: Includes soil data for all years.

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Table A6.9
Summary of Adjacent Surface Soil Data in the MK AEU

Analyte	Number of Results	Detected	Detection Frequency (%)	Minimum Detected Concentration	Maximum Detected Concentration (MDC)	Arithmetic Mean Concentration	Standard Deviation	ESL	MDC > ESL
Inorganics (mg/kg)									
Aluminum	1	1	100%	9630	9,630	9,630	NA	15,900	No
Chromium	1	1	100%	11.1	11.1	11.1	NA	43.4	No
Fluoride	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nickel	1	1	100%	7.9	7.90	7.90	NA	22.7	No
Selenium	0	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Notes:
Includes soil data for all years.

TableA6.10

Sum Total PAH Values by Sample for NN AEU Sediment

Channel or Pond	Location	Sample Number	Total PAH	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Fluoranthene	Fluorene	Indeno (1,2,3-cd) pyrene	Naphthalene	Phenanthrene	Pyrene
Channel	SED006	SD00239WC	2625	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175
Channel	SED006	SD00259WC	2550	170	170	170	170	170	170	170	170	170	170	170	170	170	170	170
Channel	SED006	SD00290WC	2752	200	200	37	150	160	190	89	110	190	340	200	86	200	280	320
Channel	SED006	SD00314WC	3750	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250
Channel	SED036	SD00260WC	2700	180	180	180	180	180	180	180	180	180	180	180	180	180	180	180
Channel	SED68992	SD60089WC	3300	220	220	220	220	220	220	220	220	220	220	220	220	220	220	220
EastLandfillPond	CG57-000	05F0391-001	4018	220	220	220	61	440	440	440	440	49	90	440	440	2	76	440
EastLandfillPond	CH57-000	05F0391-002	4973	255	255	255	54	500	500	500	500	500	87	500	500	1	66	500
EastLandfillPond	CI57-000	05F0391-003	5001	200	200	200	400	400	400	400	400	400	400	400	400	1	400	400
EastLandfillPond	CI57-001	05F0391-004	4877	195	195	195	390	390	390	390	390	390	390	390	390	2	390	390
EastLandfillPond	CI58-000	05F0391-005	5058	200	200	200	405	405	405	405	405	405	405	405	405	3	405	405
EastLandfillPond	CI58-001	05F0391-006	5448	220	220	220	435	435	435	435	435	435	435	435	435	3	435	435
EastLandfillPond	CI58-002	05F0391-007	3148	190	190	190	42	380	64	380	380	44	85	380	380	2	61	380
EastLandfillPond	CI58-003	05F0391-008	5253	210	210	210	420	420	420	420	420	420	420	420	420	3	420	420
EastLandfillPond	CJ58-000	05F0391-009	2570	210	210	51	120	98	160	71	415	110	240	415	57	3	200	210
EastLandfillPond	CJ58-001	05F0391-010	3896	215	215	215	46	430	56	430	430	430	79	430	430	3	57	430
Maximum Total PAH (ug/kg)			**5448**															

Nondetected concentrations reported at 1/2 detection limits and included in the total PAH concentration.

Note: Treatment on nondetects.

Table A6.11
Total Maximum Detected PAH Values for NN AEU Sediment

Channel or Pond	Location	Sample Number	Total PAH	7,12-Dimethylbenz(a)anthracene	Acenaphthene	Acenaphthylene	Anthracene	Benzo(a) anthracene	Benzo(a) pyrene	Benzo(b) fluoranthene	Benzo(g,h,i) perylene	Benzo(k) fluoranthene	Chrysene	Dibenz(a,h) anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-cd) pyrene	Naphthalene	Phenanthrene	Pyrene
Channel	SED006	SD00239WC	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Channel	SED006	SD00259WC	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Channel	SED006	SD00290WC	1762	ND	ND	ND	37	150	160	190	89	110	ND	ND	340	ND	86	ND	280	320
Channel	SED006	SD00314WC	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Channel	SED036	SD00260WC	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Channel	SED68992	SD60089WC	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EastLandfillPond	CG57-000	05F0391-001	229	ND	ND	ND	ND	61	ND	ND	ND	ND	ND	ND	90	ND	ND	2	76	ND
EastLandfillPond	CH57-000	05F0391-002	208	ND	ND	ND	ND	54	ND	ND	ND	ND	ND	ND	87	ND	ND	1	66	ND
EastLandfillPond	CI57-000	05F0391-003	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	1	ND	ND
EastLandfillPond	CI57-001	05F0391-004	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EastLandfillPond	CI58-000	05F0391-005	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EastLandfillPond	CI58-001	05F0391-006	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EastLandfillPond	CI58-002	05F0391-007	252	ND	ND	ND	ND	42	ND	64	ND	ND	ND	ND	85	ND	ND	ND	61	ND
EastLandfillPond	CI58-003	05F0391-008	0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
EastLandfillPond	CJ58-000	05F0391-009	1207	ND	ND	ND	51	120	98	160	71	ND	ND	ND	240	ND	57	ND	200	210
EastLandfillPond	CJ58-001	05F0391-010	238	ND	ND	ND	ND	46	ND	56	ND	ND	ND	ND	79	ND	ND	ND	57	ND
Maximum Total PAH (ug/kg)			1762																	

Nondetected concentrations and individual PAHs detected in fewer than 5 percent of samples in the AEU were excluded from the total-PAH calculation.

Note: Totals based on not including nondetects. Sum of only detected chemicals.

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COMPREHENSIVE RISK ASSESSMENT

NO NAME GULCH AQUATIC EXPOSURE UNIT, ROCK CREEK AQUATIC EXPOSURE UNIT, MCKAY DITCH AQUATIC EXPOSURE UNIT, SOUTHEAST AQUATIC EXPOSURE UNIT

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Other/Drainage LOEs in Support of the Risk Characterization

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ACRONYMS AND ABBREVIATIONS

AEU	Aquatic Exposure Unit
BSF	biota to sediment factor
COC	contaminant of concern
CRA	Comprehensive Risk Assessment
DOE	U.S. Department of Energy
ECOC	ecological chemical of concern
ECOI	ecological contaminant of interest
ECOPC	ecological contaminant of potential concern
EE	Environmental Evaluation
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ERA	Ecological Risk Assessment
EU	Exposure Unit
HI	hazard index
HQ	hazard quotient
IA	Industrial Area
IBI	index of biotic integrity
IMP	Integrated Monitoring Plan
LOE	Line of Evidence
mg/kg	milligrams per kilogram
N/A	not applicable
NPDES	National Pollutant Discharge Elimination System

OU	Operable Unit
PCB	polychlorinated biphenyl
PCOC	potential contaminant of concern
PMJM	Preble's meadow jumping mouse
ppb	part per billion
RBP	Rapid Bioassessment Protocol
RFETS	Rocky Flats Environmental Technology Site
RFI/RI	Remedial Feasibility Investigation/Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
TSS	total suspended solids
WOE	Weight of Evidence

1.0 INTRODUCTION

Previous research studies have been completed within the Rocky Flats Environmental Technology Site (RFETS) that help define the current ecological condition of the site. Many of these studies were focused within the Aquatic Exposure Units (AEUs) specifically. For the purposes of the Comprehensive Risk Assessment (CRA), a review of the studies that focused on ecological effects within the AEUs was completed. Each study provides a "line of evidence" (LOE) that describes the ecological risk setting of RFETS. These LOEs helped to determine if an adverse chemical effect is affecting the aquatic populations within a given AEU. Although NN AEU, RC AEU, MK AEU, and SE AEU were not the primary target watersheds in many of these studies, they are included in the general discussion of these studies for their inclusion as reference areas and their proximity to the areas of study.

The information available in these previous studies includes tissue analyses, aquatic population studies, bioassay analyses, waterfowl/wading bird studies, and chemical loading analyses. Only those portions of each study that fell within these categories were reviewed. Information that was not used includes hazard quotient (HQ) analyses, wildlife studies, vegetation studies, and studies not focused upon the AEU areas. The types of LOE studies available from the reviewed literature are summarized in Table 7A.1.

Only studies completed since 1991 were reviewed. These studies, in essence, captured a moment in time that was encompassed by the CRA AEU comprehensive databases. Therefore, the results have a direct application to the CRA because they co-occur in time and location.

Several studies provided multiple lines of evidence. For instance, the U.S. Department of Energy (DOE) (1996) evaluation was a baseline Ecological Risk Assessment (ERA) of Operable Units (OUs) 5 and 6 (Woman Creek and Walnut Creek) using a multi-tiered approach. This study included tissue analyses, bioassay analyses, and food chain modeling for waterfowl species, thereby providing three different LOEs for the CRA.

Studies with common goals were combined into a single subsection (i.e., aquatic ecological characterization studies, etc.). The types of studies reviewed fall into a general set of LOEs categories that have ecological endpoints (i.e., impacts to populations of aquatic species), with one exception. Studies that describe chemical loading within a watershed were also reviewed as LOEs for surface water and/or sediment ecological contaminants of potential concern (ECOPCs) requiring further spatial analysis. These loading studies were not designed to address an ecological endpoint, but rather serve to define a chemical behavior within a watershed system. The categories of studies that were compiled are described below.

1.1 Tissue Analyses

The measure of chemical body burden in an aquatic receptor is a direct measure of bioaccumulation/concentration processes. These measures are useful in determining whether a given surface water or sediment ECOPC is bioavailable and, thus, potentially harmful. Studies reviewed and used for their tissue analysis evaluations included:

- Stiger, 1994. OU 3 Final RFI/RI – Appendix K. PCB Study: "Results of PCB Sediment and Tissue Sampling For Walnut and Woman Creek Drainages and Offsite Reservoirs – SGS-576-94.".

1.2 Aquatic Population Studies

The study of a given aquatic species population is a direct measure of surface water and/or sediment chemical effects. Sessile organisms such as benthic macroinvertebrates can be highly susceptible to habitat disturbance, including chemical releases. The measure of species and population indicators (biometrics) such as species richness, density, diversity, etc., is often a useful tool to determine chemical effects so long as a habitat reference condition is understood. Biometrics are influenced by chemical, physical, and biological factors, all of which need to be understood in order to isolate a single factor's effect on a given population. Numerous biological inventory studies have been completed within RFETS. A number of these were designed to define the aquatic health condition within a potentially affected watershed component (i.e., Woman Creek) as compared to a background or reference watershed component (i.e., Rock Creek). The endpoint of most of these studies was to determine the causative factor controlling the ecology, whether physical (habitat), biological (species inter or intra-actions), or chemical (RFETS chemical release). Many of these studies evaluated all the watershed components within RFETS at once. Some were focused on particular segments for a defined purpose (for example, ammonia spatial extent within Big Dry Creek). Aquatic population studies reviewed and integrated into the CRA included the following:

- Aquatics Associates Inc., 2003. Results of the Aquatic Monitoring Program in Streams at the Rocky Flats Site, Golden, Colorado 2001-2002. Prepared for: U.S. Department of Energy, Rocky Flats Field Office Golden, Colorado.

- Ebasco Environmental Consultants Inc., 1992. Baseline Biological Characterization of the Terrestrial and Aquatic Habitats at Rocky Flats Plant. Prepared for U.S. DOE, Rocky Flats Field Office. Golden, Colorado.

- Exponent, 1998. Final Report: Lower Walnut Creek Aquatic Sampling, Spring 1998. Prepared for: Kaiser-Hill Company, LLC, Rocky Flats Environmental Technology Site. Golden, Colorado.

- Kaiser-Hill, 1999, 2000, and 2001. Annual Wildlife Surveys for the Rocky Flats Environmental Technology Site. Kaiser-Hill Company, L.L.C., Rocky Flats Environmental Technology Site, Golden, Colorado. (three reports).

1.3 Waterfowl/Wading Bird Studies

Waterfowl, wading birds, and higher trophic organisms were not identified as target receptors for the AEU CRA. However, the CRA methodology (DOE 2004a) suggests that studies of these organisms may be useful LOEs within the CRA. For that purpose, these studies were evaluated and included:

- DOE, 1996. Final Phase I RFI/RI Report. Woman Creek Priority Drainage, Operable Unit 5. Appendix N. Ecological Risk Assessment for Woman Creek and Walnut Creek Watersheds at the Rocky Flats Environmental Technology Site.
- Stiger, 1994. OU 3 Final RFI/RI – Appendix K. PCB Study: "Results of PCB Sediment and Tissue Sampling For Walnut and Woman Creek Drainages and Offsite Reservoirs – SGS-576-94."

1.4 Chemical Loading Analyses

The spatial extent of a particular surface water and/or sediment ECOPC can be determined with a synoptic sampling that follows the course of a "slug" of water as it travels through a drainage. Measures of chemical concentration are synchronized with flow in order to determine load. Load is then compared from location to location as the slug of water progresses downgradient. Where a dramatic increase in load is observed, a potential source area may be the cause. Loading analyses therefore help describe the spatial distribution of a chemical and determine if it is gaining in concentration, losing in concentration, typical of the drainage, or potentially related to source areas. The following study describes such efforts and was used as a LOE for the CRA:

- DOE, 2004b. Rocky Flats Environmental Technology Site Automated Surface-Water Monitoring. Water Year 2003 Annual Report and Water Year 2004 Source Evaluations for Points of Evaluation GS10, SW027, and SW093. RF/EMM/WP-04-SWMANLRPT03.UN. Final.

2.0 TISSUE ANALYSES

2.1 Stiger, 1994

"Results of PCB Sediment and Tissue Sampling For Walnut and Woman Creek Drainages and Offsite Reservoirs – SGS-576-94."

Review

This study was completed in response to preliminary results of sediment and tissue samples collected during the OU 6 Remedial Investigation (RI) between August 1992 and June 1993, which indicated elevated PCB concentrations occur for some of the A- and B-series ponds. Because the potential exists for sediment and/or specific biota in Great Western Reservoir and Standley Lake Reservoir to have been impacted by PCB contaminants from RFETS prior to 1989 (prior to the diversion canal being constructed that routes flow coming from Walnut Creek around Great Western Reservoir and back into Walnut Creek below the dam), a sediment and tissue PCB sampling project was undertaken as part of the Environmental Evaluation (EE) portion of the OU 6 RI.

The effort entailed sampling of sediment and fish tissue from the A- and B-series ponds. Fish samples also were collected from the Walnut Creek terminal pond at Indiana Street (OU 6) and Great Western Reservoir to determine if any PCBs had migrated downstream of the terminal ponds; Mower Reservoir; Standley Lake Reservoir; and the C- and D-series ponds.

An attempt was made to collect three of each species of fish for whole body analysis. When additional numbers of the same species were sacrificed, they were used for filet or liver analysis. Results were compared to literature-derived values to determine potential effects. The following values were used to compare tissue results:

- Reproductive impairment in rainbow trout may occur at concentrations above 400 micrograms per kilogram (µg/kg) fresh weight (EPA 1980, as reported in Eisler 1986).
- The recommended maximum body burden for trout is 400 µg/kg fresh weight (Eisler 1986).
- A reported value of 5,000 µg/kg is protective of human health consumption (Hoeting 1983, as reported in Eisler 1986).
- An observed typical body burden concentration for fish is 1,000 µg/kg (Schnitt et al. 1983, as reported in Eisler 1986).
- Food concentration thresholds recommended by DOE (1994) for fish-eating birds are 667 parts per billion (ppb) for the belted kingfisher and 768 ppb for the great blue heron.

In addition, a sampling effort was undertaken to evaluate whether Preble's meadow jumping mouse (PMJM) might be impacted by the presence of PCBs in the RFETS buffer zone. Because the PMJM has a diet similar to deer mice, 13 deer mice were collected adjacent to ponds A-1, A-3, B-1, and B-4 for whole body tissue analysis to evaluate possible PCB contamination in PMJM. In addition, 12 voles were collected from the same locations to determine if they represent a pathway of PCBs to predatory birds, which include voles in their diet.

Results from the sediment sampling program (collected at depths of 0 to 6 inches) in both the A- and B-series ponds show a decreasing concentration of PCBs, primarily Aroclor-1254, with distance downstream. The mean values of Aroclor-1254 and Aroclor-1248 in the A and B ponds are summarized in Table A7.2. Conclusions drawn from the sediment analysis are as follows:

- Sediments collected from pond B-2 have a considerably higher mean Aroclor-1254 concentration than those collected from either Pond B-1 or B-3. It was speculated that this was due to the presence of an outfall that historically entered directly into pond B-2, bypassing pond B-1.
- Ponds B-1 and B-2 contain the only sediment sampling locations where Aroclor-1248 was detected.
- No PCBs were detected in either terminal ponds A-4 or B-5.
- No PCBs were detected in sediment collected from the C-1 and C-2 ponds.

PCB concentrations in both the A- and B-series ponds decrease with distance downstream to the point where no PCBs were detected in terminal ponds A-4 or B-5. In addition, no PCBs were detected in sediment samples collected from the C-1 and C-2 ponds. Therefore, it is highly unlikely that sediments derived from RFETS would be currently contributing PCBs to any of the offsite reservoirs.

In the A and B ponds, four types of whole body tissues were analyzed: largemouth bass (40-58 μg/kg), fathead minnows (14-479 μg/kg), tiger salamanders (26 – 134 μg/kg), and crayfish (BDL – 9.5 μg/kg). Summary conclusions are as follows:

- For the A-series ponds, no consistent trends could be observed. Species were either present and collected in one pond only or the PCB concentrations were below detection limits.
- For the B-series ponds, the PCB concentrations increased in tiger salamanders from the B-1 to B-2 ponds with no further specimens being found downstream, increased in plants from B-1 to B-4, and decreased in fathead minnows from B-4 to B-5. PCBs were detected in fathead minnows collected from the Walnut Creek terminal pond at Indiana Street in even lower concentrations than in B-5.
- Only one fish species was collected from Great Western Reservoir. Of the six carp specimens collected, only one contained detected quantities of PCBs (52.4 μg/kg).

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- Fish tissue samples collected from ponds C-1 and C-2 contained only low levels of PCBs (<100 μg/kg), and no PCBs were detected in fish tissues collected from ponds D-1 and D-2 or Mower reservoir.
- The highest concentration of PCBs found in any animal tissue during this study was in a carp (1,000 μg/kg) collected from Standley Lake Reservoir. Historically, less than 5 percent of the water flowing into Standley Lake Reservoir has come from RFETS. In addition, all of the Woman Creek drainage above the divide on Woman Creek below C-2 dam has been diverted to Mower Reservoir since 1989, and currently no surface water enters this reservoir. Therefore, it is highly unlikely that the PCBs found in the fish tissue samples collected from Standley Lake were derived from RFETS. Furthermore, the scarcity of detected PCBs in fish tissues collected from Great Western Reservoir supports the hypothesis that RFETS is not contributing PCBs to any of the offsite reservoirs.
- The only tissue samples collected on RFETS to exceed Eisler's (1986) recommended maximum body burden for trout (400 μg/kg fresh weight) were three fathead minnow specimens (464 – 498 μg/kg for whole body) collected from the B-4 pond.

Application to the CRA and Uncertainties

This study encapsulated several LOEs within its design. The A-, B-, and C-series ponds were sampled specifically to assess PCB transfer between abiotic (sediment) and biotic (fish tissue) media. The absence of PCB accumulation in excess of tissue threshold concentrations in almost all fish at the site indicates there is a low potential for risk to fish in the pond habitat within NW AEU, SW AEU, WC AEU, and SE AEU. Results of sediment samples did not yield any detectable levels of PCBs in terminal ponds A-4 and B-5.

The only tissue samples collected on RFETS to exceed Eisler's (1986) body burden for trout (400 μg/kg flesh weight) were three fathead minnow specimens collected from the B-4 pond that had an average aroclor-1254 content of 188 μg/kg. The results from the SW AEU sediment were compared to this value to determine if a potential bioaccumulation pathway may exist.

This study also evaluated the potential effects of PCBs in sediment on predatory birds that may feed on organisms that are exposed to the sediment. Results from this study revealed that there is no risk to predatory birds (i.e., higher trophic organisms) as a result of ingesting prey within the pond areas that may have accumulated PCBs from the sediment. The absence of PCB accumulation exceeding tissue threshold concentrations in prey species indicates that there is a low potential for risk to these organisms within NW AEU, SW AEU, WC AEU, and SE AEU.

The time period in which this study was completed represents an historic condition for RFETS. A significant number of accelerated action efforts have been completed since this time. The sediments from certain ponds (B-1, B-2, and B-3) have been removed, and the food web components that were initially sampled from each pond may no longer be present. Therefore, the study likely represents conservative conditions and over-estimates PCB risks when compared to current conditions at RFETS.

3.0 AQUATIC POPULATION STUDIES

3.1 DOE, 1996

Final Phase I RFI/RI Report. Woman Creek Priority Drainage, Operable Unit 5. Appendix N. Ecological Risk Assessment for Woman Creek and Walnut Creek Watersheds at the Rocky Flats Environmental Technology Site.

Review

This study was completed as a part of the ecological risk evaluation of aquatic life for OUs 5 and 6. Risks to aquatic life from chemical concentrations in sediments were evaluated by a weight-of-evidence approach. HQs and hazard indices (HIs) were generated as a screening tool and indicated a relatively high potential for toxic effects in sediments. As a next step in the ERA tiered process, characteristics of benthic community structure and results of sediment bioassay tests were used to check predictions of toxic stress as indicated by the screening results. Community characteristics are described here; results of the bioassay analyses are presented in Section 4.1 This multi-tiered approach is similar to the Sediment Quality Triad procedure (Chapman 1986; EPA 1992), which uses toxicity, chemistry, and benthic community data to investigate the biological impact of sediment pollution and identify mechanisms of effects-based sediment studies (Chapman et al. 1992; Power and Chapman 1992; Canfield et al. 1994).

Benthos samples were collected from all of the A-, B-, C-, and D-series ponds during May through July 1994. Five replicate multi-core composite samples were obtained from different water depths and submerged habitat types to ensure complete representation of the pond biota. Samples were analyzed for taxonomic composition and abundance. Taxa were recorded at the lowest practical taxonomic level for the sample period.

Conventional interpretation of benthic community structure suggests that communities with low densities of organisms or reduced richness and diversity are subject to physical or chemical stress. Under sustained chemical stress, the benthic community may also contain high densities of pollution-tolerant species, which in turn may result in low richness and low diversity. Benthic communities for ponds D-1 and D-2 were sampled to represent locations with no known contaminant input from RFETS.

Descriptive data were developed for community parameters including richness, density, Simpson and Shannon-Wiener diversity measures, number of dominant taxa, and abundance-based relationships for oligochaetes and dipterans. The data represent pond-level characteristics for a composite of data from the five different habitat samples.

A total of 81 different taxa representing all the major orders of aquatic organisms were identified in the pond benthos samples. A composite listing of identified taxa and mean abundance for each pond was compiled. Community description measures generated for each pond are summarized in Table A7.3. Oligochaete worms and dipterans dominated the benthos samples from all locations. General conclusions drawn from the study include the following:

- The B-series ponds contained the highest abundance of all taxa except pelecypoda (snails), which were most abundant in the A-series ponds.
- The C-series ponds did not support a wide variety of organisms other than oligochaetes and dipterans.
- Ponds A-1 and A-3 had the least pollution-tolerant communities of all ponds, including the D series reference ponds. Ponds A-2 and B-2 had the most pollution-tolerant communities.
- Ponds D-1 and D-2 exhibited a wide range of community characteristics including the second lowest (pond D-1) and highest (pond D-2) diversity values.
- A cursory review of the benthic community data indicates that ponds A-4, B-3, and C-1 may have been under the most persistent chemical or physical stress. In each of these ponds, oligochaetes and dipterans were the dominant taxa. These organisms are considered good colonizers and frequently are the dominant taxa from habitats with high physical variability. The highly variable environmental (physicochemical) conditions at RFETS may account for the dominance of colonizers.

The data were analyzed to identify sites with benthic communities that were similar in composition and structure to sites with no known exposure to contaminants (ponds D-1 and D-2). However, although the sediments from pond D-1 were considered to be uncontaminated, the low richness and diversity and the high abundance of a single taxon at this site appear to reflect some type of environmental stress.

Cluster analysis techniques were used to determine the relationship between the HI estimate and community structure for each pond. Results from the analysis indicate that none of the community structure parameters mirror the HI site patterns. This result suggests a lack of correlation between the magnitude of the HIs and pond benthic community structure. Further analysis involving regression methods were used to estimate whether the proportion of variation in community structure could be explained by differences in HIs. Results indicate that predicted toxicity accounts for some of the variation in community composition, but other factors are clearly important. Factors such as pond size, fluctuating water levels, and the presence or absence of upper trophic levels also are important.

Applications to the CRA and Uncertainties

This study evaluated benthos samples collected from all of the A-, B-, C- and D-series ponds during May through July 1994, which encapsulates a portion of the surface water and sediment data set time period used for this CRA. Therefore, the results represent a snapshot in time of the aquatic ecology within the time-frame of the data collected for the CRA analysis. Results indicate that the pond populations at the time of the study were comparable to reference conditions. In addition, there was little correlation of population biometrics to chemical indices, indicating that there is no correlation between possible chemical stressors and population conditions. The results indicate there were no ongoing chemical risk conditions during the sampling period in 1994.

Sampling captures aquatic population conditions during certain periods. Because the monitoring was completed over a short duration, it may not represent the year-round condition. In addition, the sampling took place prior to accelerated action efforts and likely represents worst-case conditions as compared to current conditions.

3.2 Ebasco Environmental Consultants Inc., 1992

Baseline Biological Characterization of the Terrestrial and Aquatic Habitats at Rocky Flats Plant.

Review

This study provided an inventory and cursory assessment of the ecological health of the aquatic habitats within the RFETS buffer zone. A variety of methods were used to collect and observe aquatic species. Fish sampling employed gill nets, minnow traps, and limited electro-shock sampling. Benthic macroinvertebrate sampling used grab sampling techniques to collect field samples and repeatable laboratory methods to quantify the occurrence and abundance of benthic samples.

The occurrence of taxa within the benthic communities of streams and ponds were assessed and generalizations about aquatic community health were made based on the presence or absence of various taxon, including those that may indicate tolerance or intolerance to pollutants.

The aquatic habitats were found to have high species richness, an indication of a healthy ecosystem. The report documents that aquatic habitats at RFETS have a high density of benthic macroinvertebrates. Fish species diversity is naturally low in the semiarid climate characterized by intermittent streams and small pools and ponds that are inadequate to support large fish populations. Nine species of fish were collected at RFETS, most in the minnow family *Cyprinidae* (six species). Most species were found in pools or impoundments that offer refuge from annual drought conditions. Several ponds had very high populations of golden shiners and fathead minnows.

The authors report that the most disruptive environmental factor to aquatic communities at RFETS is the naturally semiarid climate. All streams have sections that are intermittent, while the perennial sections are fed by groundwater seeps. Aquatic communities on RFETS thrive despite the environmental limitations. Many aquatic organisms present are adapted to low stream flow conditions. These organisms are often classified as "tolerant" considering general water quality.

Benthic macroinvertebrate samples from Walnut Creek contained 59 taxa during fall sampling. Diptera had the highest species richness with 24 species. One species of fish, fathead minnows, was collected from the B-series ponds. Two species of fish were collected from the A-series ponds, fathead minnow and golden shiner. No predatory fish were found.

The East Landfill Pond supports no fish and only a depauperate benthic macroinvertebrate community. Macrobenthic sampling documented eight taxa of macrobenthic organisms present in the pond, including organisms in the groups *Gastropoda, Pelecypoda, Oligochaeta, Hydracarina, Amphipoda,* and *Diptera.*

In Woman Creek, the benthic macroinvertebrate community was relatively rich and diverse. The most abundant and widespread groups overall in stream communities were the larvae of true flies (*Diptera*) and mayflies (*Ephemoptera*). The most common dipteran taxa are blackflies (*Simulidae*) and midges (*Chironomidae*). Both caenid and baetid mayflies also are common. Species richness for mayflies and caddisflies increased from headwater segments to the area east of Pond C-2, where flow in Woman Creek decreases (apparently due to loss to groundwater). Communities within the ponds are strongly dominated by midges and aquatic earthworms (*Oligochaeta*). Pond C-1 had a more developed aquatic plant community along the edge, supporting a more diverse assemblage of nektonic forms, including water striders (*Hemiptera: Gerridae*) and water boatmen (*Hemiptera: Corixidae*). Predatory dragonfly nymphs (*Odonota*) were present in the C ponds, as were crayfish (*Astacidae*).

Fish species within the streams of Woman Creek included the creek chub, stoneroller, fathead minnow, and green sunfish. Fish communities in the C ponds are influenced by the presence of suitable substrates, vegetation, and persistent water. The most common species included the golden shiner, white sucker, and largemouth bass found in pond C-1; however, creek chubs and stonerollers were observed frequently throughout the upper sections of Woman Creek. Golden shiners feed on a variety of small prey and algae and may themselves be important prey for larger fish or piscivorous birds because of the large populations they attain and their relatively large size. Aquatic vertebrates in C-2 comprise fathead minnows and the aquatic form of tiger salamanders (*Ambystoma tigrinum*).

Application to the CRA and Uncertainties

This study documented the baseline conditions of aquatic organisms present at RFETS in 1991. It investigated streams, ponds, and wetlands in Walnut and Woman Creeks. The results of the population studies provide LOE for NW AEU, SW AUE, WC AEU, and NN AEU in regard to populations and overall ecosystem health. The results indicate that the aquatic populations are at equilibrium with their environment and do not appear to be impacted by chemical stressors. The species composition is a reflection of the habitat condition. There does not appear to be any chemical stressor affecting the populations sampled from the ponds or stream channels.

The time period in which this study was completed represents an historic condition associated with RFETS. A significant amount of accelerated action efforts have been completed since this time period. The food web components that were initially sampled from certain ponds may no longer be present, and the flows of water into and out of some ponds have been altered. Pond C-1 was modified to have a lower depth, the B-series ponds receive less water, and the upper B ponds have been remediated by having sediments removed. Therefore, current conditions are likely different from those described in this study.

3.3 Exponent, 1998

Final Report: Lower Walnut Creek Aquatic Sampling for the Rocky Flats Environmental Technology Site.

Review

The objectives of this study of lower Walnut Creek were to determine the quality of aquatic habitat and richness and abundance of benthic macroinvertebrates; identify the fish species present; determine the condition of the benthic macroinvertebrate and fish populations in lower Walnut Creek; and compare these results to downstream areas. One site within RFETS and five sites located east (downstream) of RFETS were investigated. EPA-approved Rapid Bioassessment Protocols (RBP) were used to measure physical habitat characteristics, and habitat was then rated as optimal, suboptimal, marginal, or poor. Substrate composition and relative amounts of micro-habitats also were measured. Fish sampling was conducted during spring using seines and minnow traps. Macroinvertebrate sampling occurred in spring using kick nets to sample riffle, run, pool, and bank habitats. In addition, a Hess sampler was used in appropriate habitat.

The study concluded that aquatic life in Walnut Creek was limited by stream flow, which has been modified from natural flow conditions. However, the assessment presented findings of good habitat and a relatively healthy macroinvertebrate community, which typically equates to good water quality. Compared to an earlier study (WWE 1994), habitat scores in 1998 improved at one site below Great Western Reservoir. Habitat scores at the remaining sites declined. Real estate development may have affected water quality offsite by creating increased siltation. The RFETS site had more tolerant and hardy macroinvertebrate taxa compared to the downstream sites. This may have been an indication of the water management at RFETS, which often alternates from conditions of no flow to moderate flow and back to no flow within a short period.

Application to the CRA and Uncertainties

The study concluded that the water quality in Walnut Creek was good and there were no indications that pollution was limiting aquatic life. The observed species were controlled/affected by the intermittent flows in the Creek. This study provides more evidence that RFETS aquatic communities in lower Walnut Creek are limited by the physical conditions of the streams and ponds due to very limited or manipulated flows. Onsite water management and the general arid conditions limit the types of aquatic communities that are possible at RFETS. The findings that the aquatic communities are healthy downstream and are not impacted by chemical stressors were used as a LOE for NW AEU, SW AEU, and NN AEU.

The findings of this study describe the aquatic condition within the lower portions of the Walnut Creek watershed. They do not reflect conditions within RFETS, but rather the conditions just inside the boundary to off-site down-gradient areas. The findings of this study must be viewed with caution because there was only one sampling event in the spring of 1998 and, thus, it is a "snapshot" of the creek condition. The authors recognized the limitations of the study and recommended that further studies be completed. Habitat conditions of a stream can change rapidly over a season and can vary from year to year. The trend in the fluctuation of habitat and aquatic communities should be known in order to determine if conditions at RFETS are improving or declining.

3.4 Kaiser-Hill, 1999, 2000, and 2001

Annual Wildlife Survey for the Rocky Flats Environmental Technology Site.

Review

Fish surveys were preformed using minnow traps in streams and ponds over 3 consecutive years. The purpose of these surveys was to determine whether previously recorded fish species (Ebasco 1992) were still present within RFETS streams. Streams were systematically surveyed in each drainage during May 1998. Ten stream locations within each drainage (40 over the entire site) were selected based on water availability. Ponds were not surveyed. In early summer 1999, ponds and impoundments were surveyed. In summer 2000, Rock Creek was surveyed again. Nine stream locations were selected based on the availability of water in this ephemeral stream. Traps remained at each location for a minimum of 2 days and were checked by afternoon of each day. Any aquatic or semi-aquatic vertebrates captured in the traps were identified and enumerated before being released.

Selection of sampling locations was limited by water availability. In 1998, locations in Rock Creek were clustered because large sections of the creek were dry. It was determined that surveys in Rock Creek should be conducted during another year when conditions were better. Therefore, Rock Creek was surveyed again in 2000.

During the 1998 surveys, fathead minnow (*Pimephales promelas*) were captured in all major drainages at RFETS. This included locations in Rock Creek, Lower Walnut Creek, Upper Woman Creek, and Lower Smart Ditch. Additionally, creek chub (*Semotilus atromaculatus*) and stoneroller (*Campostoma anomalum*) were captured in Upper Woman Creek. The greater variety of fish species in Woman Creek was attributed to the relatively large seep-wetland complexes that discharge into the Woman Creek drainage. Due to these conditions, a greater portion of Upper Woman Creek has sustained water flows. Not all survey locations had fish observations. Notably, McKay ditch had no fish present, and Walnut Creek above the A-series ponds had no fish.

Pond and impoundment surveys in 1999 revealed fathead minnows in all locations, though it is unclear if all ponds and impoundments were surveyed. In pond C-1, fathead minnows, smallmouth bass (*Micropterus dolomieui*), and creek chub were captured. It is noteworthy that largemouth bass were collected just below pond C-1 during the baseline study (Ebasco 1992). This suggests that the bass observed in 1999 may have been misidentified. This study, along with the earlier stream surveys, demonstrates the higher species richness in Woman Creek compared to other RFETS drainages. In Rock Creek, largemouth bass (*Micropterus salmoides*) were captured in the Lindsay Pond.

When Rock Creek was surveyed again in 2000, sites were located in a more systematic fashion and better represented stream habitats throughout the drainage. Fathead minnows were the only species captured at eight of the nine survey locations. Only the location furthest downstream did not have fish. Higher numbers of fathead minnows corresponded to the upper reaches of the stream.

With the exception of the bass observations, all fish species observed during the baseline study (Ebasco 1992) were observed again over this 3-year survey and found in the same general locations as they were in 1992. Other animal taxa also were recorded over the 3 years. Leeches, crayfish, garter snakes, and leopard frogs were observed.

Application to the CRA and Uncertainties

These studies indicate that all the RFETS streams are intermittent and that perennial flows and better aquatic habitats occur in the upper reaches of these streams. It is unrealistic to expect that vibrant aquatic communities, especially fish communities, can occur in the lower reaches. Overall, fish species richness is very low at RFETS.

The studies also confirm that fish species are present with the same richness and in the same general locations as they were nearly a decade earlier. No analysis is presented on the abundance of fish over time, however.

The years 1998 through 2000 were very dry in terms of precipitation, and it is interesting to note that drought conditions presented a problem in finding enough sites to sample. This reinforces the point that habitat, especially water availability, limits fish communities at RFETS. This information was used as a LOE for NW AEU, SW AEU, WC AEU, and RC AEU that aquatic life does not appear to be impacted by chemical stressors but rather is controlled by physical habitat limitations such as flow.

3.5 Aquatics Associates Inc., 2003

Results of the Aquatic Monitoring Program in Streams at the Rocky Flats Site, Golden, Colorado, 2001-2002.

Review

The purpose of this study was to characterize the existing aquatic communities (fish and macroinvertebrates) and physical habitat conditions in streams within the Walnut, Woman, and Rock Creek drainages in order to provide a baseline for monitoring the potential influences of site closure activities. Sampling in ponds did not occur. RBPs were used to measure physical habitat characteristics, and habitat was rated as optimal, suboptimal, marginal, or poor. Substrate composition and relative amounts of micro-habitats were measured to supplement the RBP habitat analysis. Fish sampling was conducted during summer and/or fall using backpack electroshocking equipment. Macroinvertebrate sampling occurred in spring, summer, and fall using kick nets to sample riffle, run, pool, and bank habitats.

Findings from the study indicated that all of the streams at Rocky Flats were flow limited. Perennial flows were typical in the upper reaches of all three drainages, and flows diminish considerably in downstream reaches where the streams become largely intermittent. In the upper reaches where flows are perennial, habitat assessment scores were generally highest, indicating overall better habitat quality.

Woman Creek has more natural flows in the upper reaches. Below the C-2 pond, flows are greatly reduced and heavily influenced by pond releases and water management. The natural flows in the upper reaches are seep-fed and also influenced by seasonal precipitation. Rock Creek has natural seep-fed flows.

In the effluent-dominated reach of Upper Walnut Creek and the discharge-dependent Lower Walnut Creek, bank erosion results in poor bank stability and sediment inputs to the stream, which negatively affects physical habitat and aquatic life. Stream bank erosion was further aggravated by the periodic discharges from the terminal ponds.

Fish abundance and distribution in these streams is severely limited due to the lack of permanent water. Fish were collected at only seven of the twelve study sites, and only three species were collected. Fathead minnows were found in every drainage. Naturally self-sustaining populations of fathead minnows were found at site WC3 in South Walnut

Creek between ponds B-4 and B-5 and at site RC2 below the Lindsey Pond. A stable and healthy creek chub population was found at the upper two sites in Woman Creek. A single specimen of longnose dace also was collected in Woman Creek.

The macroinvertebrate community across all drainages was observed to be rich and diverse, and comprised mainly hardy and tolerant species. The dominant organisms were similar in each drainage, with oligochaetes most abundant in Woman Creek and dipterans most abundant in Walnut Creek. *Ephemeroptera* were relatively abundant throughout the drainages and included moderate to tolerant taxa. *Trichoptera* (caddisflies) in Walnut Creek were generally present in higher numbers compared to other RFETS drainages, likely due to the effluent-dominated flows. Amphipods are also found in higher numbers in Walnut Creek, thriving in the slower moving or standing water environments provided by the ponds.

A comparison of study results to other, earlier studies of Rocky Flats streams showed that community structure and abundance were somewhat similar to those found in Walnut, Woman, and Rock Creeks during the 2001- 2002 study and are similar to other transitional foothills-plains and plains type streams.

Application to the CRA and Uncertainties

This study concluded that, within the aquatic habitats present in Walnut and Woman Creeks, whether perennial or intermittent, aquatic communities persist over time and are comparable to communities found at other locations at RFETS and within the region. While only one fish species is prevalent (fathead minnows), the manipulated nature of the ponds and streams precludes the establishment of large or diverse fish populations. Macroinvertebrate populations so not appear as affected, likely due to their ability to re-colonize newly inundated habitats and their comparatively shorter life cycles. Macroinvertebrate communities in Walnut Creek and Woman Creek are similar to those found in Rock Creek. This supports the LOE that Walnut Creek and Woman Creek aquatic communities are healthy, albeit limited, and these creeks are capable of sustaining rich and diverse aquatic life that comprise hardy and tolerant species adapted to the limiting environmental conditions. The results indicate that there were no chemical stressors impacting the ecological setting within these streams. The study was used as a LOE for NN AEU, NW AEU, SW AUE, and WC AEU with regard to populations and overall ecosystem health.

The detention ponds were not sampled in this study. The RBP methods are not intended to sample large ponds. Therefore, conclusions about the aquatic health of the ponds cannot be made without some uncertainty. Only one sampling location was established in North Walnut Creek, and it was located above the A-series ponds. Because the ponds represent a significant habitat portion of the aquatic areas within RFETS, the lack of pond sampling presents uncertainty in the use of this study as a line of evidence.

4.0 WATERFOWL/WADING BIRD STUDIES

4.1 DOE, 1996

Final Phase I RFI/RI Report: Woman Creek Priority Drainage, Operable Unit 5. Volume 5. Appendix N Ecological Risk Assessment for Woman Creek and Walnut Creek Watersheds at the Rocky Flats Environmental Technology Site.

Review

As part of the multi-tiered ERA provided in this study, an evaluation of potential risk to waterfowl and wading birds was completed using standard screening-level risk methods. The mallard and great blue heron were selected to represent aquatic-feeding wildlife because they are common species and known to occur at RFETS. In addition, birds are more sensitive than mammals to organic contaminants because they lack the same capacity for detoxification and therefore represent a more limiting exposure and risk scenario. Exposure to these two receptors was assessed by using measured concentrations of contaminants in biota or by estimating the transfer of contaminants from sediments to prey species. The purpose of this study was to:

> *Determine if ECOC concentrations in surface water and sediments of the detention ponds could result in exposures that reduce the survivorship or reproductive capacity of aquatic feeding birds. (Ho: exposure less than TRV)*

The primary exposure pathway for both birds would be through ingestion of aquatic organisms that have become contaminated. Herons feed primarily on fish. Amphibians and invertebrates are usually minor components of their diets but can be important in localized areas. Herons have relatively little direct contact with sediments during feeding. Mallards have more contact with sediments because they may feed by filtering plant material and invertebrates. However, the amount of sediment ingested by mallards does not greatly exceed that of other more selective feeders (EPA 1993). Thus, the primary pathway for exposure of both birds to ecological chemicals of concern (ECOCs) in sediments is through ingestion of aquatic organisms that have become contaminated. The birds could also be exposed to surface water contaminants.

The risk characterization was based on exposure and risk to individual birds because both great blue herons and mallards are protected under the Migratory Bird Treaty Act. The exposure and risk evaluation was conducted under two exposure scenarios: 1) current aquatic community structure and contaminant distribution; and 2) more complex aquatic communities that could result in increased biological transport of sediment contaminants and increased PCB concentrations in prey.

Two methods were used to determine the potential risk to the mallard and great blue heron. The first relied on available, current tissue data. The second used a modeling approach to extrapolate and determine potential prey tissue burdens for aquatic areas that did not have measured values due the lack of prey species at the time of the study.

Chemicals identified as ECOCs for aquatic feeding birds included di-n-butylphthalate, PCBs, mercury, and antimony.

Preliminary investigations indicate that current concentrations of ECOCs in sediment and biota are probably non-toxic (Stiger 1994). However, ponds with the highest PCB concentrations apparently do not support significant fish or amphibian populations. More extensive colonization of the ponds could result in more complex food webs, increased biological transport of sediment contaminants, and exposure of birds or mammals to higher concentrations in biota. The risk characterization includes evaluation of potential exposures as well as those based on existing conditions.

Sitewide results of the exposure estimation indicated potentially significant risk in all source areas that might be used by great blue herons, including the Old Landfill in Woman Creek and ponds in Woman Creek and Walnut Creek. Based on the HIs calculated for all source areas, the ECOPCs that contributed substantially to the risk estimate were mercury, antimony, and di-n-butylphthalate. HIs for source areas are provided in Table A7.4. Receptor-specific HQs by source area are provided in Tables A7.5 and A7.6.

Unfortunately, no HIs or HQs are reported from individual ponds for aquatic-feeding birds. Because the ECOCs bioaccumulate, their concentrations in sediments and in aquatic life forms (e.g., macroinvertebrates) are relatively low. ECOCs that presented potential risk tended to be different for aquatic life than for aquatic-feeding birds. Therefore, knowing what ECOCs in ponds contribute the most risk to aquatic organisms does not translate to the risk to aquatic-feeding birds.

The A-series ponds HI for aquatic-feeding birds was primarily from di-n-butylphthalate in fish tissue eaten by great blue herons that spend 100 percent of their time foraging on site. Di-n-butylphthalate and mercury were the only ECOCs for the B-series ponds relevant to the great blue heron. Mercury was the only ECOC in the C-series ponds and the Old Landfill (upstream from the C-1 pond). Other exposure point concentrations (EPCs) came from estimated prey tissue values from 903 Pad (PCBs), with portions in both watersheds; 881 Hillside Area (magnesium) in the Woman Creek watershed; and the Ash Pits (cadmium) in the Woman Creek watershed.

Based on screening estimates, the A-, B-, and C-series ponds represent the highest risk of potential exposure to di-n-butylphthalate, with the A-series ponds presenting the greatest risk. However, all HIs were less than 5. Di-n-butylphthalate in surface water (EPC = 0.002, Intake = 4.79E-05) in the A-series ponds was the only potential contaminant of concern (PCOC) with an HQ greater than 1 and was identified as an ECOC. Di-n-butylphthalate risk to mallards was due to ingestion of benthic macroinvertebrates. Risk characterization for the mallard, therefore, focused on characterizing the potential for di-n-butylphthalate bioconcentration in the aquatic prey species in each of the A-series ponds. Unfortunately, sediment concentrations for individual ponds were not reported.

PCBs in pond sediments were a concern, and Table A7.7 presents a summary of the findings included in the report. The table includes total PCB concentrations in each pond and the Aroclor-1254 concentrations when reported. PCBs were included as an ECOC due to their potential bioconcentration in aquatic prey.

Aroclor-1254 EECs were compared to current concentrations of Aroclor-1254 in sediments at RFETS for the following:

- Great blue herons feeding in ponds with piscivorous fish present (i.e., long food chain);
- Great blue herons feeding in ponds without piscivorous fish present (i.e., short food chain); and
- Mallard feeding in ponds 100 percent of the time.

Risk was identified only for the first scenario, great blue herons feeding in ponds with piscivorous fish present. The long food chain resulted in the greatest amount of bioconcentration and the longest exposure period. The remaining two scenarios resulted in maximum concentrations of Aroclor-1254 below benchmark criteria. Because the first scenario is very unlikely to occur, the authors concluded that risk in Woman Creek did not exceed criteria developed for sediment at RFETS. Walnut Creek Aroclor-1254 concentrations in sediment exceeded the criteria for ponds B-1, B-2, and B-3 only if the top aquatic predators were present. These ponds did not support this type of community at the time.

In Woman Creek, mercury was detected in two of 24 fish taken from pond C-1. Fish from other areas (i.e., streams) had no mercury detections. Therefore, the risk to aquatic birds is significant only if all food is obtained exclusively from pond C-1. Although mercury was detected in 75 percent of the fish in the B-series ponds, the source of mercury in fish was unclear. Mercury does not appear to represent risk to herons as HQs from the ponds are low (max of 2). Mercury was not an ECOC for North Walnut Creek.

Other ECOCs include antimony in Woman Creek and di-n-butylphthalate in Walnut Creek. These chemicals were determined not to present risk to the great blue heron or mallard.

Application to the CRA and Uncertainties

This study documented the potential risk to great blue heron and mallard from ponds and streams of Walnut Creek and Woman Creek. It provides a risk characterization specific to aquatic-feeding birds. This risk characterization was used as a LOE for NN AEU, NW

AEU, SW AUE, and WC AEU in regards to populations and overall ecosystem health. The conclusions indicate that higher trophic organisms that rely on the AEUs for food items would not be at risk unless individual ponds represented their entire dietary intake, which is highly unlikely.

The time period in which this study was completed represents an historic condition at RFETS. A significant number of accelerated action efforts, especially in the B-series ponds, have been completed since this time. The food web components that were initially sampled in the ponds may no longer be present. Also, the flows of water into and out of certain ponds have been altered. Pond C-1 was modified to have a lower depth, the B-series ponds receive less water, and the upper B-series ponds have been remediated by having sediments removed. Therefore, current conditions are likely different from those described in the study.

As described previously, two methods were used to determine the potential risk to the mallard and great blue heron. The first relied upon available, current tissue data. The second used a modeling approach to extrapolate and determine potential prey tissue burdens for aquatic areas that did not have measured values due to the lack of prey species. There is uncertainty in the first method because it represents site conditions from an historic perspective and may not represent current conditions. There is uncertainty with the second method due to the extrapolation necessary for modeling approaches. This uncertainty can result in either over or under-conservative estimates of tissue burden.

4.2 Stiger, 1994

OU3 Final RFI/RI – Appendix K: PCB Study: Results of PCB Sediment and Tissue Sampling For Walnut and Woman Creek Drainages and Offsite Reservoirs – SGS-576-94.

Review

This study was completed in response to preliminary results of sediment and tissue samples collected during the OU 6 RI (August 1992 to June 1993), which indicated elevated PCB concentrations occur for some of the A- and B-series ponds. Because the potential exists for sediment and/or specific biota in Great Western Reservoir and Standley Lake Reservoir to have been impacted by PCB contaminants from RFETS prior to 1989 (prior to the construction of the diversion canal that routes flow coming from Walnut Creek around Great Western Reservoir and back into Walnut Creek below the dam), a sediment and tissue PCB sampling project was undertaken as part of the EE portion of the OU 6 RI.

This effort entailed collecting sediment, fish, and small mammal tissue samples from the A- and B-series ponds to evaluate whether PMJM might be impacted by the presence of PCBs in the RFETS buffer zone. Because PMJM have a diet similar to deer mice, 13 deer mice were collected adjacent to ponds A-1, A-3, B-1, and B-4 for whole body tissue

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analysis to evaluate possible PCB contamination in Prebles. In addition, 12 voles were collected from the same locations to determine if they represent a pathway of PCBs to predatory birds, which include voles in their diet.

Results of the deer mice and vole tissue analysis revealed that no PCBs were detected in any of the small mammal tissue samples (whole body) collected from around ponds A-1, A-3, B-1, and B-4. Comparison to PCB food threshold values for birds revealed that PCB levels in fish do not exceed food concentration threshold values prescribed by DOE (1994). These results suggest that PCBs have not bioaccumulated up the food chain further than the fish species collected at RFETS and that neither the PMJM nor predatory birds are threatened with PCB contamination from RFETS.

Application to the CRA and Uncertainties

This study encapsulated several LOEs within its design. The sediment and tissue analysis will be used as a LOE for NW AEU, SW AUE, and WC AEU with regard to pond bioaccumulation processes. The study evaluated the A-, B-, and C-series ponds specifically for PCB transfer between abiotic (sediment) and biotic (fish tissue) media. The absence of PCB accumulation at concentrations exceeding tissue threshold concentrations in almost all fish at the site indicates that there is a low potential for risk to fish in the pond habitat within NW AEU, SW AEU, WC AEU, and SE AEU.

This study also evaluated the potential effects of PCBs in sediment to predatory birds that may feed on organisms that are exposed to PCB-contaminated sediment. Results from this study were obtained for the A- and B-series ponds, and were used as a LOE for the NW AEU and SW AEU risk characterization of PCB ECOPCs in pond sediments.

The time period in which this study was completed represents an historic condition at RFETS. A significant number of accelerated action efforts have been completed since this time. The food web components that were initially sampled from each pond may no longer be present. Similarly, the sediments from certain ponds (i.e., B-1, B-2, and B-3) have been removed. Therefore, current conditions are different from those described in the study. The study likely represents conservative conditions because the sampling took place closer in time to historic events that lead to the initial release of the PCBs to the AEUs.

5.0 CHEMICAL LOADING ANALYSES

5.1 DOE, 2004b

RFETS Automated Surface-Water Monitoring. Water Year 2003 Annual Report and Water Year 2004 Source Evaluations for Points of Evaluation GS10, SW027, and SW093. Final.

DOE completes an annual automated surface-water monitoring evaluation as part of the Integrated Monitoring Plan (IMP). The RFETS automated surface-water monitoring network is designed to meet the requirements documented in the Site IMP, which groups all site surface-water monitoring objectives into five primary categories: Sitewide, Industrial Area, Industrial Area Discharges to Ponds, Water Leaving the Site, and Off-Site. The most recent reports for water years 2003 and 2004 were reviewed as LOEs for the purpose of describing chemical loading within the AEUs. The methods, conclusions, and application to the CRA for water year 2003 are provided here, and the 2004 report is summarized in Section 6.2.

The automated monitoring program is intended to provide a number of objectives, those that pertain to building LOEs for the AEU CRA include the following:

- Monitoring of flows and contaminant levels in subdrainages to allow for the location of contaminant sources;
- Routine monitoring of point-source discharges and reporting of results in compliance with the National Pollutant Discharge Elimination System (NPDES) permit program to control the release of pollutants into the waters of the United States; and
- Detection of statistically significant increases of contaminants in runoff from within the Industrial Area (IA) in general.

The automated program is designed to obtain a loading analysis of constituents of interest. Therefore, the amount of a given chemical is traced through the course of a drainage path, and additional load is identified over distance. This tool helps determine if the drainage is gaining or losing chemical over the course of its path, allowing the identification of source areas as well as chemicals that may be source-related and not a natural phenomenon.

During the water year 2003 effort, the site monitoring network included 62 monitoring locations. The automated network successfully fulfilled the targeted monitoring objectives as required by the Site IMP. Four new monitoring locations were installed to provide increased monitoring resolution as RFETS moves toward closure. From the 62 monitoring locations, 441 composite samples composed of 23,455 individual grabs were collected.

Application to the CRA and Uncertainties

Detected metals and radionuclides were evaluated as part of the professional judgment process. The results from this study helped to determine if certain constituents had site-related source areas or demonstrated a pattern of increased or decreased load through the site. The results were constituent- and AEU-specific and are provided in Section 2.0 of Volume 15B1.

The automated surface-water sampling program was developed with specific RFETS objectives in mind, specifically, to evaluate chemical transport within surface water and sediment throughout the site. These objectives do not necessary focus on ecological risk-based concerns. The locations and the hydrologic setting of all the site studies do not necessarily coincide with aquatic ecological habitat settings. Only those chemicals with a point of compliance understanding, or a site source relation, were evaluated further. Chemicals of potential interest from a toxicological standpoint from historic site activities that do not behave in a loading type hydrologic model (i.e., PCBs) were not evaluated. These studies prove useful, yet are limited to the understanding of inorganic and radionuclide chemical spatial extent at RFETS.

6.0 SUMMARY OF FINDINGS

This attachment provides a summary of the methods, results, conclusions, uncertainties, and applications of individual studies conducted within RFETS that provide supporting LOEs for the AEU risk characterizations. Numerous studies were available for the larger drainages such as the NW AEU, and few studies for smaller drainage components such as the MK AEU. The purpose of this effort was to compile the information gathered from these studies to determine if there are chemical stressors affecting the aquatic ecology within each AEU. Each study can be viewed as a single LOE for a given AEU. In combination, these lines of evidence, coupled with the ECOPC evaluation form the weight-of-evidence risk characterization of the chemical stressors.

A summary of the conclusions drawn from each study, and their application to each AEU, are provided in Section 5 of this report. As described here, the aquatic ecosystems are clearly impacted by stressors other than chemicals related to RFETS activities. Habitat conditions of flow appear to be the most significant controlling factor to the aquatic ecology. The aquatic ecology of RFETS is comparable to reference or background sites and does not exhibit signs of chemical stress. Given the fact that numerous accelerated action activities have occurred, a number of which will impact the receiving drainages that make up the AEUs, it is likely that future conditions within these drainages will improve further, re-establish as habitat over time, and equilibrate. The anticipated ecology will appear much as it has in the past, with opportunistic assemblages of aquatic invertebrates, plants, and fish. It will retain its warm-water ecology character and perhaps will provide sustainable wetted habitat of sufficient size to support smaller species of fish over time.

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TABLES

Table A7.1
Summary of Other/Drainage Lines of Evidence Available for each AEU

AEU	Line of Evidence Category and Source				
	Tissue Analysis	Aquatic Population Studies	Bioassay Analysis	Waterfowl/Wading Bird Evaluations	Chemical Loading Analysis
NN AEU	N/A	Ebasco, 1992	N/A	DOE, 1996	DOE, 2004
		DOE, 1996			
		Exponent, 1998			
		Kaiser-Hill, 1999, 2000 and 2001			
RC AEU	N/A	Kaiser-Hill, 1999, 2000 and 2001	N/A	DOE, 1996	DOE, 2004
MK AEU	N/A	Kaiser-Hill, 1999, 2000 and 2001	N/A	DOE, 1996	DOE, 2004
SE AEU	N/A		N/A	DOE, 1996	DOE, 2004

N/A = Not available.

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Table A7.2
Unvalidated Sediment Sampling Results (units ug/kg)

A Ponds	Mean* A-1254	Mean A-1248	B Ponds	Mean* A-1254	Mean* A-1248
A 1	75.9	ND	B 1	868	253.6
A 2	83.8	ND	B 2	2073	589
A 3	25	ND	B 3	572	ND
A 4	ND	ND	B 4	188	ND
			B 5	ND	ND

*Calculated using 20 ug/kg, one-half of the instrument detection limits of 40 ug/kg, for nondetects where averaged with detects; n = 5.

ND indicates that PCB was not detected in sediment samples of the pond.

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Table A7.3
Pond Benthos Community Structure Summary

Characteristic	Pond A-1	Pond A-2	Pond A-3	Pond A-4	Pond A-5	Pond B-1	Pond B-2	Pond B-3	Pond B-4	Pond B-5	Pond C-1	Pond C-2	Pond D-1	Pond D-2
Total Richness	48	24	27	7	19	36	35	12	20	17	6	18	13	31
Mean Density	25,256.6	10,354.7	30,557.4	8,509.8	4,960.0	17,591.3	11,145.2	55,047.4	32,415.2	26,919.6	66.4	117.6	24,762.9	4,962.0
Simpson's Diversity	0.65	0.43	0.75	0.57	0.19	0.16	0.16	0.84	0.44	0.44	0.44	0.22	0.75	0.1
Shannon-Weiner Diversity	1.07	1.39	0.53	0.81	2.1	2.35	2.22	0.32	1.04	1.16	1.11	1.95	0.51	2.73
Shannon-Weiner Max.[a]	3.87	3.17	3.29	1.94	2.94	3.58	3.55	2.48	2.99	2.83	1.79	2.89	2.56	3.43
Percent Max. Diversity	27.7	43.85	16.11	41.75	71.43	65.64	62.54	12.9	34.78	40.99	62.01	67.47	19.92	79.59
Number Dominant Taxa	2.9	4	1.7	2.2	7.5	10.5	9.2	1.4	2.8	3.2	3	7	1.7	15.4
Dominant Taxa Density	21,917.7	9,120.4	29,790.8	7,951.2	4,544.0	15,863.4	10,172.9	49,538.8	31,388.8	21,592.8	61.6	105.4	24,204.2	4,482.1
% Density Dominant Taxa	86.7	88.1	97.5	93.4	91.6	90.1	91.3	89.9	96.8	80.2	92.7	89.6	97.7	90.3
Oligochaeta Density	20,241.7	1,676.0	26,257.0	6,145.3	1,720.0	5,014.9	194.9	4,586.2	17,455.0	16,837.7	41.6	42.0	21,255.0	39.0
% Density Oligochaeta	80.1	16.2	85.9	72.2	34.6	28.5	1.8	8.3	55.3	62.5	62.6	35.7	85.8	8
Diptera Density	3,167.8	8,367.1	4,066.5	1,974.9	2,552.0	1,232.5	3,339.0	571.7	12,263.6	5,105.9	24.8	68.4	3,422.1	3,001.1
% Density Diptera	12.5	80.8	13.3	23.2	51.4	7	30	1	37.8	19	37.4	58.1	13.8	60.4

[a] Maximum Shannon-Weiner Diversity based on richness.

Source: DOE 1996.

Table A7.4

Source Area Hazard Index for Mallard and Great Blue Heron

Source Area	Watershed	Mallard HI	GB Heron HI
OU6 A-Ponds	Walnut	4.55	23.5
OU6 B-Ponds	Walnut	1.61	18.7
OU2 903 Pad	Walnut/Woman	0.5	7.84
OU5 C-Ponds	Woman	1.65	17.19
OU1 881 Hillside	Woman	0.26	8.91
OU5 Old Landfill	Woman	0.7	41.23
OU5 Ash Pits	Woman	0.04	8.05

Table A7.5
Hazard Quotients Contributing to Risk in Great Blue Heron

Source Area	ECOC	GB Heron HQ (% if HI)	Prey Est. Value Intake (mg/kg)	Sediment Concentration (mg/kg)	Total Intake Concentration[1] (mg/kg)
OU6 A-Ponds	DBP	16.56 (70.45%)	0.744	ND	0.745
OU6 B-Ponds	DBP	8.27 (44.21%)	0.372	ND	0.372
OU6 B-Ponds	Hg	2.40 (12.83%)	0.011	0.001	0.012
OU2 903 Pad	Aroclor-1254	5.78 (73.66%)	0.78	0	0.78
OU5 C-Ponds	Hg	6.40 (37.24%)	0.031	0.002	0.032
OU1 881 Hillside	Mg	1.95 (21.95%)	No BCF	22.681	23.292
OU5 Old Landfill	Hg	28.80 (69.85%)	0.132	0.013	0.144
OU5 Ash Pits	Cd	2.98 (37.03%)	3.466	0.005	3.471

1 = total intake may be larger due to surface water contaminant intake, usually small portion.
ND = Not detected in laboratory samples.

Table A7.6
Hazard Quotients Contributing to Risk in Mallard

Source Area	ECOC	Mallard HQ (% if HI)	Prey Est. Value Intake (mg/kg)	Sediment Concentration (mg/kg)	Total Intake Concentration [1] (mg/kg)
OU6 A-Ponds	DBP	2.00 (43.92%)	0.114	ND	0.114
OU6 B-Ponds	DBP	0.47 (29.66%)	0.027	ND	0.027
OU6 B-Ponds	Hg	0.25 (15.65%)	0.006	6.93E-05	0.006
OU2 903 Pad	Aroclor-1254	0.31 (61.27%)	0.053	3.64E-06	0.053
OU5 C-Ponds	Zn	1.00 (53.90%)	2.613	0.016	2.718
OU1 881 Hillside	Phenanthrene	0.06 (21.33%)	ND	6.08E-06	0.002
OU5 Old Landfill	Zn	0.26 (37.27%)	0.692	0.051	0.791
OU5 Ash Pits	Al	0.01 (21.67%)	0.005	0.06	0.533

1 = total intake may be larger due to vegetation, soil or surface water contaminant intake, usually small portion.
ND = Not detected in laboratory samples.

Table A7.7

PCB Concentrations in Sediments, 1996[1]

Pond	PCB Conc.[2] (mg/kg)	Aroclor-1254 Conc.[3] (ug/kg)	TRV[4]	HQ
A-1	0.48	350	270	1.3
A-2	0.3	270	518	0.5
A-3	0.17	NR	-------	-------
A-4	0.17	NR	-------	-------
B-1	1.7	4,100	460	8.9
B-2	2.3	NP	-------	-------
B-3	1.5	NP	-------	-------
B-4	0.2	430	258	1.7
B-5	0.1	NP	-------	-------

1 = Information taken from Figure N5-11 (Sediment PCB's) and Attachment 4 –Table 1 Summary of Sediment ECOC Screen).

2 = Concentrations are estimated from the figure and not used in the HQ calculation.

3 = Exposure Point Concentration.

4 = Pond-specific TRVs for sediment.

NR = Not reported, noted that PCOCs with records less than TRV were not shown.

NP = Not presented; a table was not presented for this pond.