DRAFT FINAL
GROUP X4B
SITE SPECIFIC WORK PLAN
(RSA-53 AND RSA-60)

REDSTONE ARSENAL, ALABAMA

DACA87-95-D-0018

TASK ORDER 0005

PREPARED FOR

U.S. ARMY CORPS OF ENGINEERS
HUNTSVILLE CENTER

PREPARED BY

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SEPTEMBER 1996

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LIST OF ACRONYMS

ARARs	Applicable or Relevant and Appropriate Requirements
BRAs	Baseline Risk Assessments
CEHNC	U.S. Army Corps of Engineers, Huntsville Center
CLP	Contract Laboratory
COPCs	Chemicals of Potential Concern
CPSS	Chemicals Present in Site Samples
CSM	Conceptual Site Model
DQOs	Data Quality Objectives
EPA	Environmental Protection Agency
ERA	Ecological Risk Assessment
ESE	Environmental Science and Engineering, Inc.
FS	Feasibility Study
FSP	Field Sampling Plan
HHRA	Human Health Risk Assessment
IDW	Investigation-Derived Waste
IFF	Interchange File Format
MCLs	Maximum Concentration Limits
NWI	National Wetland Inventory
OVA	Organic Volatile Analyzer
PAHs	Polycyclic Aromatic Hydrocarbons
PELA	P.E. LaMoreaux and Associates
PID	Photoionization Detector

QC	Quality Control
RAGS	Risk Assessment Guidance For Superfund
RBC	Risk-Based Concentrations
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
RSA	Redstone Arsenal
SAP	Sampling Analysis Plan
SOW	Statement of Work
SVOCs	Semi-Volatile Organic Compounds
SWMUs	Solid Waste Management Units
TAL	Target Analyte List
TBC	To Be Considered
TCL	Target Compound List
TOC	Total Organic Compound
VOCs	Volatile Organic Compounds
WNWR	Wheeler National Wildlife Refuge

SECTION 1
INTRODUCTION

1.0.a This document was prepared by Parsons Engineering Science of Atlanta, Georgia, for the U.S. Army Corps of Engineers, Huntsville Center (CEHNC), Huntsville, Alabama. The preparation of this document was conducted under Task Order 0005 of Contract No. DACA87-95-D-0018.

1.1 PURPOSE OF REPORT

1.1.a This document presents site-specific information concerning Sites RSA-53 and RSA-60, also referred to as Group X4B, at Redstone Arsenal (RSA), Alabama. This document also identifies specific requirements for RI/FS activities requested by CEHNC and Environmental Science and Engineering, Inc. (ESE) to be conducted at these sites. General information applicable to all RSA sites is presented in the Generic RI/FS Work Plan (Parsons ES, 1996).

1.2 REPORT ORGANIZATION

1.2.a Conditions at Sites RSA-53 and RSA-60 are described in Section 2. Section 3 presents the conceptual site models (CSMs). Remedial technologies that are potentially applicable at these sites, the preliminary identification of applicable or relevant and appropriate requirements (ARARs), and data quality objectives are also discussed in Section 3. The RI task plan, including requirements for pre-field activities, field investigations, data reduction, baseline risk assessments, and data reporting, is presented in Section 4. The feasibility study (FS) methodology is presented in Section 5. Requirements for plans and project management are discussed in Section 6. References cited in this document are listed in Section 7. Appendices to this document include the Site-Specific Safety and Health Plan, the Field Sampling Plan, and the Chemical Data Acquisition Plan.

1.3 PROJECT PERSONNEL

1.3.a The following Parsons ES personnel provided significant contributions to the preparation of this document:

- Thomas M. Roth, P.E. — Project Manager
- Kenneth J. Stockwell, P.E. — Technical Director

• Alyse Getty	Ecological Assessment
• Janet Hall	Data Quality
• Cindy Lewis	Health and Safety
• Karen Scruton	Risk Assessment
• Ronda Simmons, Ph.D, P.G.	Geology and Field Investigations

SECTION 2
SITE CONDITIONS

2.0.a This section presents background information on Sites RSA-53 (Area Q3) and RSA-60 (Area Q4), referred to collectively as Group X4B, and describes the physical setting of these sites. Regional and arsenal-wide information is presented in the General RI/FS Work Plan (Parsons ES, 1996).

2.1 SITE BACKGROUND

2.1.a Group X4B is located in the central part of RSA and is comprised of two SWMUs, RSA-53 and RSA-60 (Figure 2-1). Group X4B is located adjacent to and east of Unit 1 (RSA-10) and north of Huntsville Spring Branch, which is part of Wheeler National Wildlife Refuge. It is south of the former DDT manufacturing plant and is bounded on the east by a former DDT wastewater drainage ditch. From 1977 to 1982, as part of the DDT Migration Abatement Program, DDT-contaminated residues and sediments were excavated from the drainage ditch.

2.1.1 RSA-53 (Former Sanitary and Industrial Landfill)

2.1.1.a RSA-53, also known as Area Q3, is a closed unlined landfill located near the geographical center of RSA. It occupies approximately 50 acres (Figure 2-2) and is located in the northwestern part of Group X4B. It is located adjacent to and east of the active/inert sanitary landfill (RSA-10), west of a tank farm, northwest of the RSA-60 landfill, and north of the Wheeler National Wildlife Refuge and associated wetlands. The land surface and surface water drainage generally slopes southeast toward Huntsville Spring Branch. Surface water drainage along the western site boundary flows toward a drainage ditch that separates RSA-53 from RSA-10.

2.1.1.b RSA-53 was used to landfill sanitary and industrial wastes from 1963 to 1973. The landfill was closed in 1973 except for a small DDT landfill. North-south trenches, typically greater than 15 ft deep and extending the length of the site, were reportedly used to bury household, administrative, sanitary, and industrial wastes (PELA, 1988b and 1989). Test pit excavations across the trenches exposed paper waste, some of which was partially incinerated, and construction debris (G&M, 1993). In 1976, the small DDT landfill was closed on the site. Residues from this landfill were excavated as a part of the DDT Migration Abatement Program in 1979 and were reburied in the approved DDT waste landfill in RSA-10 (Unit 1). Several former waste oil pits and a closed acid pit are located in the northern area of the site. When the landfill was closed in 1973, the trenches were covered with 3 to 5 ft of soil and revegetated with grasses and pine trees (G&M, 1991a).

2.1.2 RSA-60 (Former Sanitary and Industrial Landfill)

2.1.2.a RSA-60, also known as Area Q4, consists of approximately 25 acres (Figure 2-2) and is located near the geographic center of RSA and in the southeastern part of Group X4B. A portion of RSA-60 is located within the boundaries of Wheeler National Wildlife Refuge. RSA-60 is located southeast of the RSA-53, north of Huntsville Spring Branch, and south of Mills Road and the former DDT manufacturing area. The area is bounded on the east by a surface water diversion ditch and former DDT ditches, and on the south and west by the remediated former channel and floodplain of Huntsville Spring Branch, now wetlands. Surface drainage from RSA-60 is generally west and south toward the floodplain of Huntsville Spring Branch and east toward the DDT drainage ditch.

2.1.2.b RSA-60 was operated as a sanitary and industrial landfill from 1963 to 1968 (PELA, 1988b and 1989). A variety of household, administrative, sanitary, and industrial wastes were disposed in northeast-southwest trending trenches and covered with soil. Test pit excavations across the trenches revealed primarily paper and plastics and some construction debris to depths ranging from 8 to 14 feet bls (G&M, 1992). DDT wastes from the DDT manufacturing operations were reportedly buried at various locations throughout RSA-60. A former unlined waste oil disposal pit is located in the south-central area of RSA-60. Disposal trenches remain visible and grasses and pine trees have grown over the disposal areas (G&M, 1992).

2.2 PHYSICAL SETTING

2.2.a The topography and surface features of RSA-53 and RSA-60 are described below.

2.2.1 RSA-53 (Former Sanitary and Industrial Landfill)

2.2.1.a RSA-53 occupies approximately 50 acres. The topography of Site RSA-53 is relatively flat, with elevations ranging from approximately 615 feet on the northeast corner of the site to 565 on the southeast corner. Surface water drainage follows the land surface and slopes gently to the south-southeast toward the wetlands of the Wheeler National Wildlife Refuge. Surface water drainage along the west boundary of the site flows toward a drainage ditch that separates RSA-53 from RSA-10 (active sanitary and industrial landfill). The drainage ditch flows to the south toward the Wheeler National Wildlife Refuge. RSA-53 is covered by trees, shrubs and other vegetation.

2.2.2 RSA-60 (Former Sanitary and Industrial Landfill)

2.2.2.a Site RSA-60 occupies approximately 25 acres. The land surface is relatively flat and slopes from an elevation of approximately 580 feet at the northwest corner to 560 feet at the southern boundary of the site. Surface water drainage is to the south toward the wetlands of the Wheeler National Wildlife Refuge. The site is bounded on the east by a surface water diversion ditch and former DDT ditches, which flow south, and on the south and west by the remediated former channel and floodplain of the Huntsville Spring Branch, which is now part of the wetlands of the Wheeler National Wildlife Refuge. RSA-60 is covered by trees, shrubs and other vegetation.

2.3 GEOLOGY

2.3.a The geologic settings of RSA-53 and RSA-60 are described below.

2.3.1 Regional Geology

2.3.1.a A discussion of the regional geologic setting is provided in the General RI/FS Work Plan (Parsons ES, 1996).

2.3.2 Geology of RSA-53

2.3.2.a The overburden at RSA-53 consists primarily of sandy clay with varying amounts of weathered limestone and chert fragments. The amount of weathered lithic fragments generally increases with depth toward the underlying bedrock. The thickness of the overburden ranges from 42 to 88 feet across the site.

2.3.2.b The bedrock unit, the Tuscumbia Limestone, is capped by a weathered zone of limestone and clay in the southern part of RSA-53.

2.3.3 Geology of RSA-60

2.3.3.a The overburden at RSA-60 consists primarily of sandy clay with varying amounts of weathered limestone and chert fragments. The amount of weathered lithic fragments generally increases with depth toward the underlying bedrock. The thickness of the overburden ranges from 12.5 to 50 feet across the site. The bedrock unit is the Tuscumbia Limestone.

2.4 HYDROGEOLOGY

2.4.a The hydrogeologic settings of RSA-53 and RSA-60 are described below.

2.4.1 Regional Hydrogeology

2.4.1.a A discussion of the regional hydrogeologic setting is provided in the General RI/FS Work Plan (Parsons ES, 1996).

2.4.2 Hydrogeology of RSA-53

2.4.2.a A hydrogeologic profile across RSA-53 is presented in Figure 2-3. Four distinct hydrogeologic zones were determined for the area: (1) perched, water-bearing clayey sands in the upper portions of the overburden in the north and central parts of the area; (2) a lower sandy clay and chert rubble zone at the base of the (deep) overburden; (3) the weathered upper bedrock of the Tuscumbia Limestone; and (4) fracture zones and cavities in the deeper bedrock of the Tuscumbia (G&M, 1993).

2.4.2.b The perched water table ranges in depth from 5.22 feet below land surface (bls) in monitoring well RS033 to 22.10 feet bls in monitoring well RS031 (G&M, 1992). A water table surface map (G&M, 1993) for RSA-53 is shown in Figure 2-4. Boring logs indicate that a partially-continuous clay lens in the overburden in the east-central portion of RSA-53 supports the perched water table found there. The clay lens is absent elsewhere at the site. Water levels in these isolated, perched zones are approximately 20 feet higher than water levels in the basal overburden and do not appear to be hydraulically connected with each other. Hydraulic conductivities are on an order of magnitude of 10^{-5} centimeters per second (cm/sec). At the southern end of the site, the overburden is sandy clay, and there are no perched zones.

2.4.2.c Depths to water in wells screened in the basal overburden range in depth from 5.90 feet bls in monitoring well RS139 to 38.12 feet bls in monitoring well RS274 (G&M, 1992). Water-level data and boring logs indicate that the sandy clay and chert rubble zone in the basal overburden is laterally continuous and hydraulically connected with the upper strata of the Tuscumbia Limestone. A potentiometric surface map of the deep overburden aquifer is shown on Figure 2-5. The average hydraulic gradient is 0.007 (G&M, 1992). Hydraulic conductivities are within an order of magnitude of 10^{-4} cm/sec. The wetlands south of RSA-53 are the discharge area for the basal overburden aquifer.

2.4.2.d Depths to water in wells screened in the upper Tuscumbia Limestone aquifer range from 2.73 feet bls at monitoring well RS280 to 40.84 feet bls in monitoring well RS333 (G&M, 1993). The potentiometric surface of the upper bedrock aquifer is shown in Figure 2-6. In the Tuscumbia Limestone aquifer, groundwater flows primarily through weathered limestone and solution-enlarged fractures in the upper strata of the limestone unit with an average hydraulic gradient of 0.006. Hydraulic conductivities are within an order of magnitude of 10^{-3} cm/sec. Groundwater flow is to the southeast.

2.4.2.e Depths to water in wells screened in the deep bedrock aquifer range from 6.79 feet bls at monitoring well RS358 to 53.06 feet bls at monitoring well RS355 (G&M, 1993). The potentiometric surface of the deep bedrock are shown in Figure 2-7. Groundwater in the deep bedrock aquifer occurs in fractures and cavities in the limestone. The apparent groundwater flow direction is to the southeast. The hydraulic conductivity is dependent upon the presence of interconnected, open cavities and solution-enlarge fractures. Hydraulic conductivities may be as high as 10^{-3} cm/sec in the deep bedrock aquifer.

2.4.3 Hydrogeology of RSA-60

2.4.3.a A hydrogeologic profile across RSA-60 is presented in Figure 2-8. Three distinct hydrogeologic zones were determined for the area: (1) a sandy clay and chert rubble zone at the base of the (deep) overburden; (2) the weathered upper bedrock of the Tuscumbia Limestone; and (3) fracture zones and cavities in the deeper bedrock of the Tuscumbia (G & M, 1993). The perched zone occurring at RSA-53 is absent at RSA-60.

2.4.3.b Depths to water in wells screened in the overburden range from 3.77 feet bls in monitoring well RS290 to 13.2 feet bls in monitoring well RS284. Water-level data and lithologic logs indicate that the basal overburden zone is laterally continuous and hydraulically connected with the upper strata of the Tuscumbia Limestone. The potentiometric surface of the deep overburden aquifer at RSA-60 is shown in Figure 2-9. Water level elevations ranged from 571.30 ft msl (RS281) to 560.06 ft msl (RS024). The groundwater flow direction in the aquifer is to the south, and the aquifer has a reported hydraulic conductivity of 10^{-4} cm/sec. The groundwater flow within the basal overburden aquifer appears to radiate from a potentiometric high located in the north central portion of RSA-60 and flows toward and discharges into the wetlands along the western and southern boundaries of the site.

2.4.3.c Depths to water in wells screened in the upper bedrock aquifer range from 3.67 feet bls in monitoring well RS288 to 13.09 feet bls in monitoring well RS284. The potentiometric surface of the upper bedrock aquifer at Site RSA-60 is shown in Figure 2-10. Water level elevations ranged from 566.79 ft msl (RS283) along the eastern boundary of the site to 561.10 ft msl (RS198) in the southwestern corner of Site RSA-60. Water-level data indicate that the direction of groundwater flow in this aquifer is toward the southwest with an average hydraulic gradient of 0.006. The aquifer has a reported hydraulic conductivity of 10^{-2} cm/sec.

2.4.3.d Depths to water in wells screened in the deep bedrock aquifer at RSA-60 range from 7.45 feet bls in monitoring well RS291 to 24.96 feet bls in monitoring well RS361. Groundwater within this aquifer occurs in a solution-enlarged fracture zone. The potentiometric surface within the deep bedrock aquifer at RSA-60 is shown in Figure 2-11. Water level elevations ranged from 559.11 (RS362) to 559.79 (RS361). Water-level data indicate that the deep bedrock aquifer may be hydraulically connected with the upper bedrock aquifer. Groundwater flow in the deep aquifer is to the south. The aquifer has a reported hydraulic conductivity of 10^{-2} cm/sec.

2.5 RESULTS OF PREVIOUS INVESTIGATIONS

2.5.a A number of studies have been conducted at RSA-53 and RSA-60. The results of these studies are summarized below.

2.5.1 Previous Investigations

2.5.1.a In 1979, USATHAMA hired Testing, Inc. to install 3 groundwater monitoring wells at RSA-53 and 10 groundwater monitoring wells at RSA-60 as part of the Geohydrology Characterization Survey of Wells and Lysimeter Locations, and Monitoring Well Installation Program. In 1986, PELA was contracted by CEHNC, to perform RI/FS-type studies at 22 closed and abandoned SWMUs at Unit 3, including RSA-53 and RSA-60. The results of their investigation are included in a 1988 report entitled "Confirmation Report, Unit 3 Investigations, Redstone Arsenal, Alabama" (PELA, 1988a). The report includes soil/waste quality data, water-level and water-quality data, geologic logs and cross sections, and monitor well construction details. Additional studies at 11 of the sites (including RSA-53 and RSA-60) were recommended by PELA and authorized by CEHNC.

2.5.1.b The results of PELA's subsequent investigation were presented in a report entitled "Upgrade Confirmation Report and Assessment of Remedial Alternatives for Selected Unit 3 Sites, Redstone Arsenal, Alabama" (PELA, 1989). PELA (1989) concluded that soil and groundwater contamination as a result of disposal activities had occurred at RSA-53 and RSA-60. Soil/waste samples from disposal trenches at RSA-53 had detectable levels of VOCs, SVOCs, pesticides, and metals. Groundwater samples from the overburden in the north-central and southern parts of RSA-53 contained VOCs and metals. No bedrock wells were installed or sampled in areas where contamination in the overburden at RSA-53 was detected. VOCs, SVOCs, metals, and organochlorine pesticides were detected in soil/waste samples collected from RSA-60. Metals and VOCs were detected in groundwater and surface water samples from RSA-60. PELA (1989) recommended continuous monitoring and additional studies at both RSA-53 and RSA-60 to identify and characterize the sources of contamination and to assess the horizontal and vertical extent of contamination at both SWMUs.

2.5.1.c Geraghty & Miller was contracted by CEHNC in 1989 to perform RCRA facility investigations (RFIs) at selected sites throughout RSA. These sites included RSA-53 and RSA-60. The results of the investigation are included in two reports, "Phase I Report RCRA Facility Investigations at Unit 1, Unit 2, and Selected Unit 3 Areas Redstone Arsenal, Alabama (G&M, 1992) and "Final Phase II Addendum RCRA Facility Investigations at Unit 1, Unit 2, and Selected Unit 3 Areas Redstone Arsenal, Alabama" (G&M, 1993). Field activities at both SWMUs included geophysical surveying, test pit excavations, air monitoring, surface soil sampling, soil borings with subsurface soil sampling, sediment and surface water sampling, monitor well installation, and groundwater sampling. The results of the RFI for each site are described in detail below.

2.5.1.d No remediation has been conducted at Group X4B. The landfill at RSA-53 was closed in 1973. The trenches were covered with three to five feet of soil and revegetated with grass and pine trees. The landfill at RSA-60 was closed in 1968 and the wastes there were covered with soil and volunteer vegetation.

2.5.2 Results of Previous Investigations at RSA-53

2.5.2.a The scope of the RFI at RSA-53 was to address contamination related to the closed disposal trenches of the sanitary landfill. Soil gas sampling, geophysical surveying, test pit excavations, waste sampling, air monitoring, shallow and deep soil sampling, sediment and surface water sampling, monitor well installation, and groundwater sampling were conducted during Phases I and II of the RFI (G&M, 1992 and 1993). The potential sources of contamination for RSA-53 include the following:

- The trench system formerly used for disposal of sanitary and industrial wastes;
- Waste oil and DDT disposal areas; and
- Activities in adjacent SWMUs.

2.5.2.b Results of groundwater sampling indicate that the most significant VOC detected at the site was chlorobenzene, a compound typically associated with the production and disposal of 4,4'-DDT. Chlorinated hydrocarbons including chloroform, tetrachloroethene, trichloroethene, and 1,2-dichloroethane were detected along with 2-butanone, benzene, toluene, and traces of chlorinated pesticides. The most significant concentrations of chlorinated hydrocarbons were found in the groundwater at the northwestern quarter of RSA-53. Contamination was detected in all hydrogeologic zones, but the lateral and vertical extent of contamination has not yet been defined. G&M (1993) interpreted the groundwater contamination as having the highest concentrations in the west-central part of the site diminishing towards the east, south and north.

2.5.2.c The most significant contaminants found in the soils at RSA-53 were PAHs and organochlorine pesticides (G&M, 1993). The most significant concentrations were found in the test pits and in soil borings installed within the limits of the closed disposal trenches. The horizontal contamination extent generally corresponds with the outline of the "Approximate Area of Disposal" shown on Figure 2-2.

2.5.2.d Surface water and sediment samples were collected from the wetlands south of RSA-53 and from a drainage ditch running along the western boundary of the area. Analytical results indicate that the sediments to the south of RSA-53 are contaminated with low levels of pesticides. Sediments in the ditch contained elevated levels of metals, PAHs and DDT. The source for the contamination in the ditch could be from RSA-53, RSA-10 or other upgradient sites.

2.5.3 Results of Previous Investigations at RSA-60

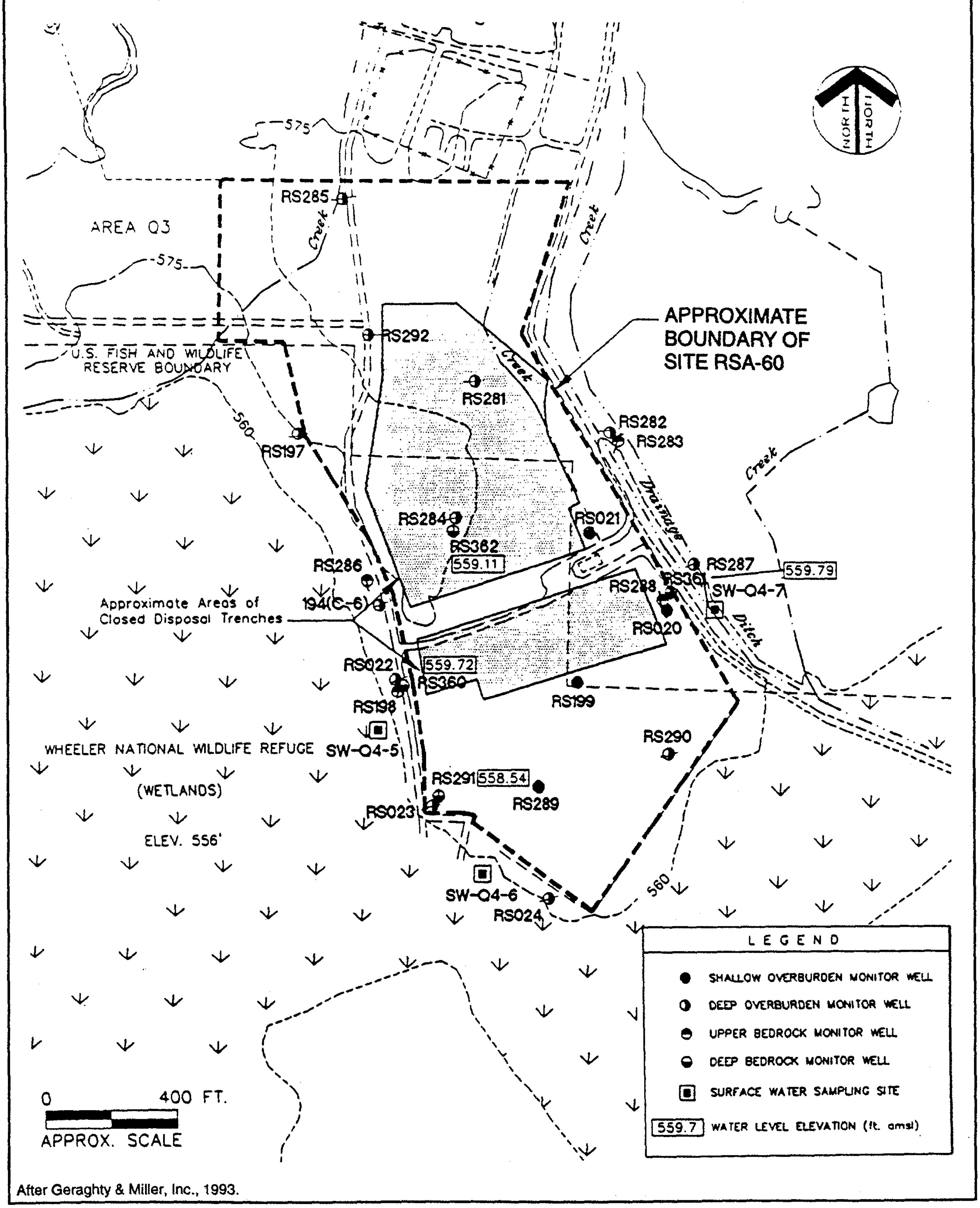
2.5.3.a The scope of the RFI at RSA-60 was to address contamination related to the former waste oil pits and the closed disposal trenches of the sanitary landfill (G & M, 1993). Soil gas sampling, geophysical surveying, test pit excavations, waste sampling, air monitoring, shallow and deep soil sampling, sediment and surface water sampling, monitor well installation, and groundwater sampling were conducted during Phases I and II of the RFI (G&M, 1992 and 1993). The potential sources of contamination at RSA-60 include the following:

- The northern trench system previously used for disposal of sanitary and industrial wastes;
- The southern trench system previously used for sanitary and industrial wastes and waste oil;
- Random DDT burial areas;
- The DDT wastewater drainage ditches along the east boundary of RSA-60; and
- The former channel and floodplain of the Huntsville Spring Branch.

2.5.3.b Results of groundwater and surface water sampling indicate that the most significant contaminants detected at the site were chlorobenzene and organochlorine pesticides. The highest concentration of chlorobenzene in the groundwater in the overburden occurred in the mid-central region of RSA-60 and along the western, downgradient boundary of the area. The upgradient boundaries and southern boundaries of the contamination have been well defined. The wetlands and Wheeler National Wildlife Refuge to the west limit access for monitor well installation, and the areal limit of contamination in the overburden aquifer is undefined. Trichloroethene detected in the upper bedrock wells along the eastern boundary of RSA-60 probably originates from the southern portions of RSA-53 and Unit 1 and is not related to activities at RSA-60. Chlorobenzene concentrations in the upper bedrock aquifer are defined to the east but undefined elsewhere. Groundwater samples collected from the deep bedrock wells across the site were relatively free of chlorobenzene and organochlorine pesticides, indicating the vertical extent of contamination is confined primarily to the upper bedrock and above.

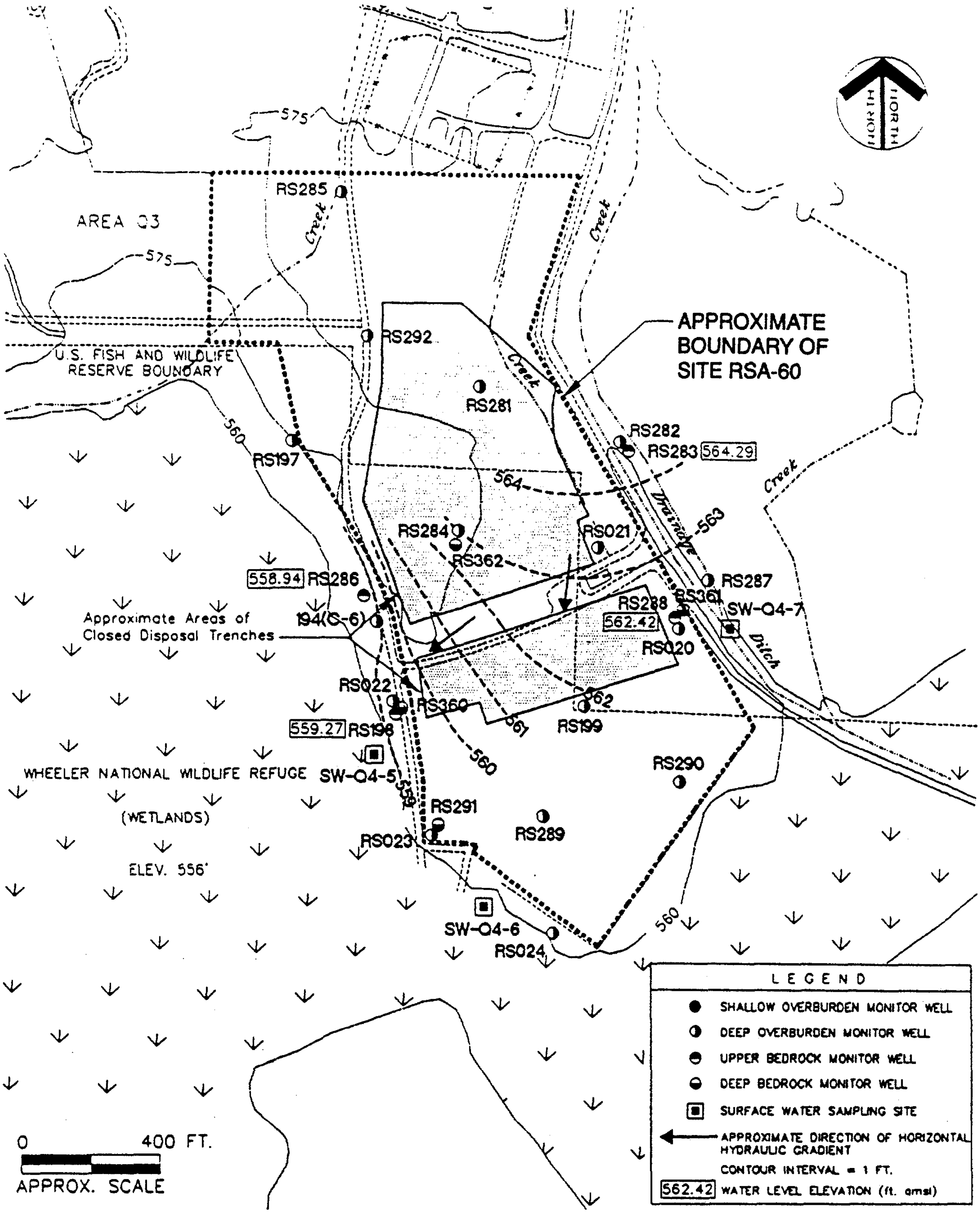
2.5.3.c The principal constituents of concern found in the soils at RSA-60 are organochlorine pesticides (primarily DDT) and VOCs (primarily chlorobenzene). VOA constituents and chlorobenzene appear to be restricted to the disposal areas, however,

LOWER BEDROCK POTENTIOMETRIC SURFACE AT SITE RSA-60 REDSTONE ARSENAL



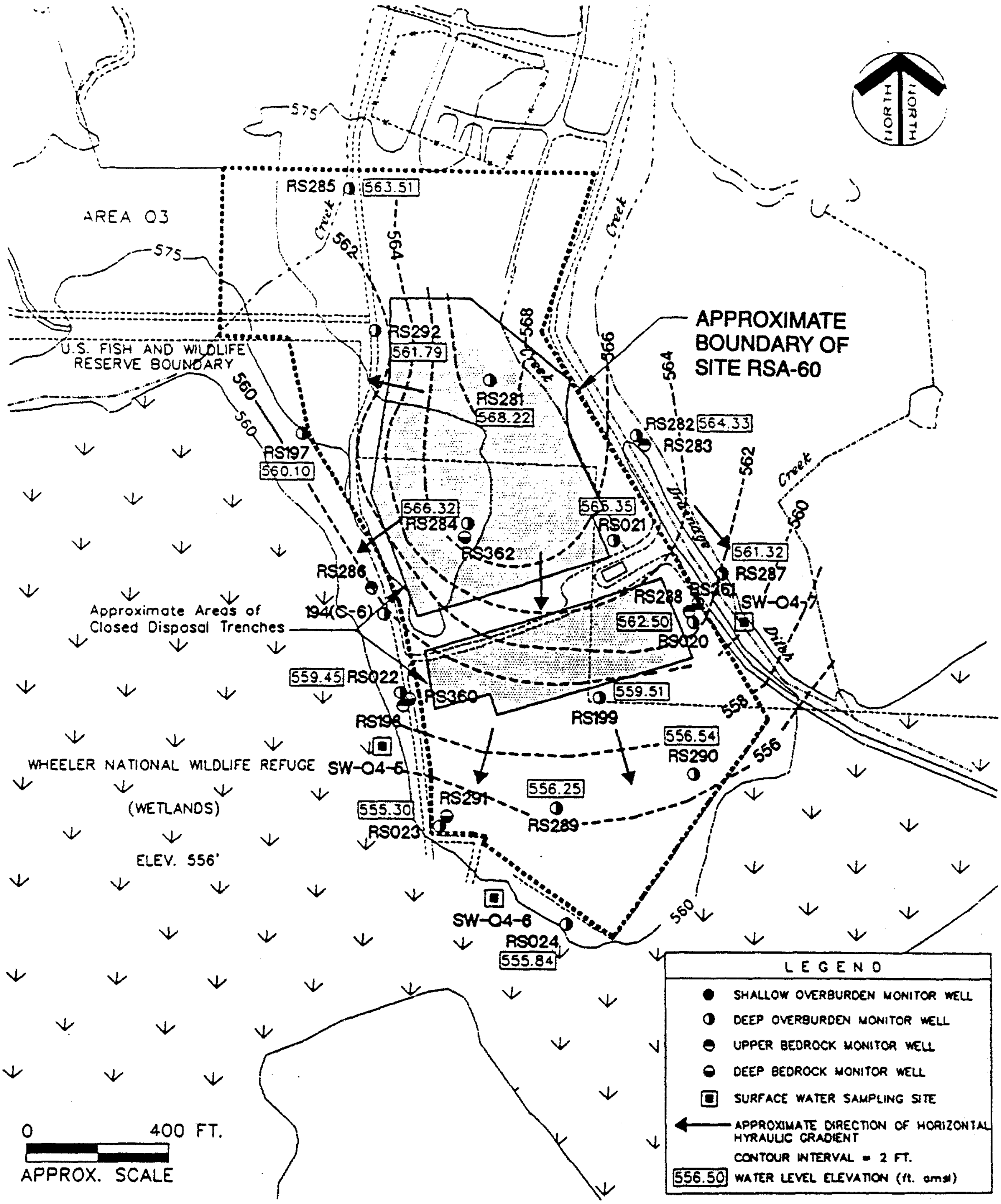
After Geraghty & Miller, Inc., 1993.

UPPER BEDROCK POTENTIOMETRIC SURFACE AT SITE RSA-60
REDSTONE ARSENAL



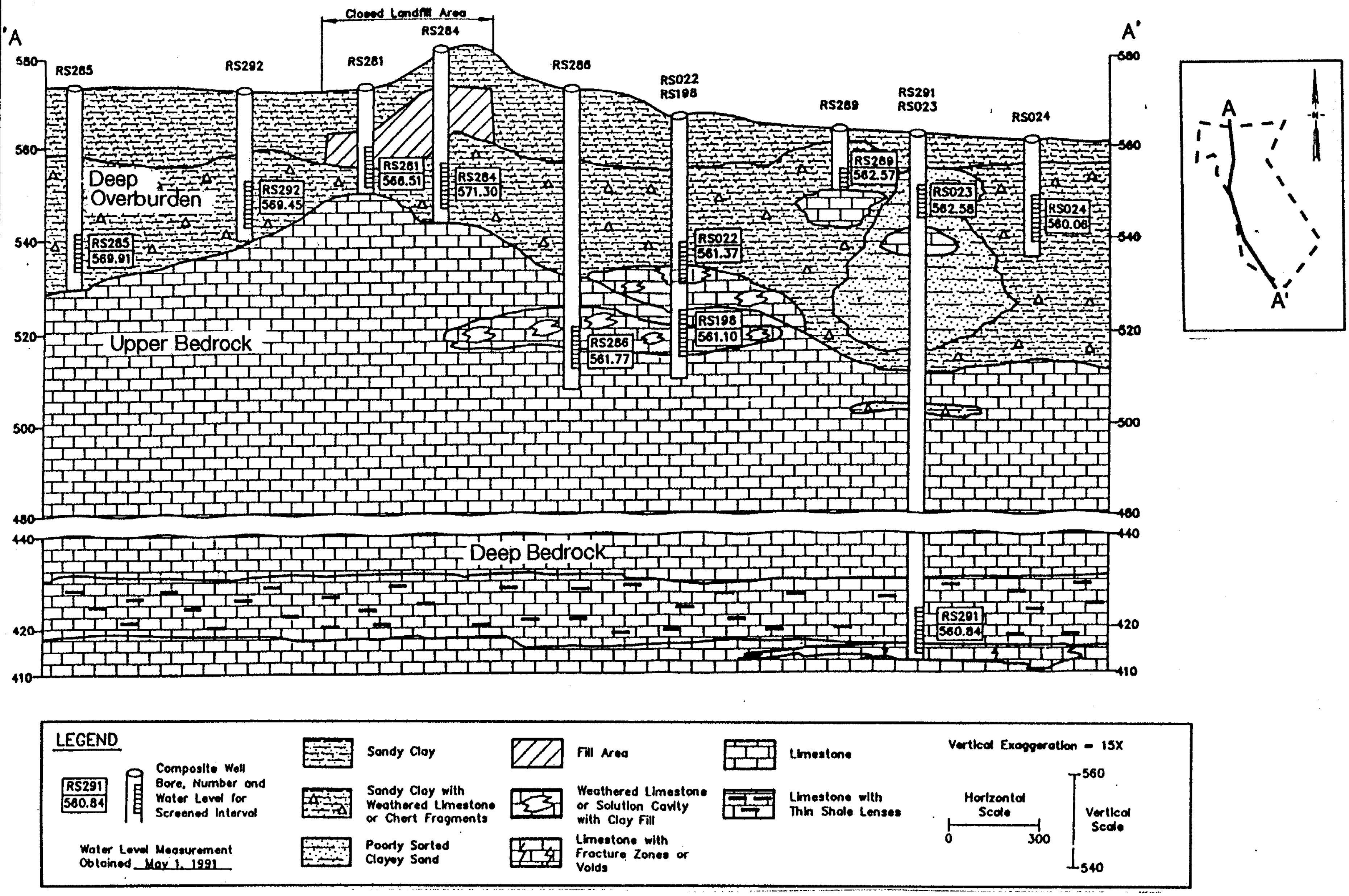
After Geraghty & Miller, Inc., 1993.

DEEP OVERBURDEN POTENTIOMETRIC SURFACE AT SITE RSA-60
REDSTONE ARSENAL



After Geraghty & Miller, Inc., 1993.

HYDROGEOLOGICAL PROFILE ACROSS SITE RSA-60
REDSTONE ARSENAL

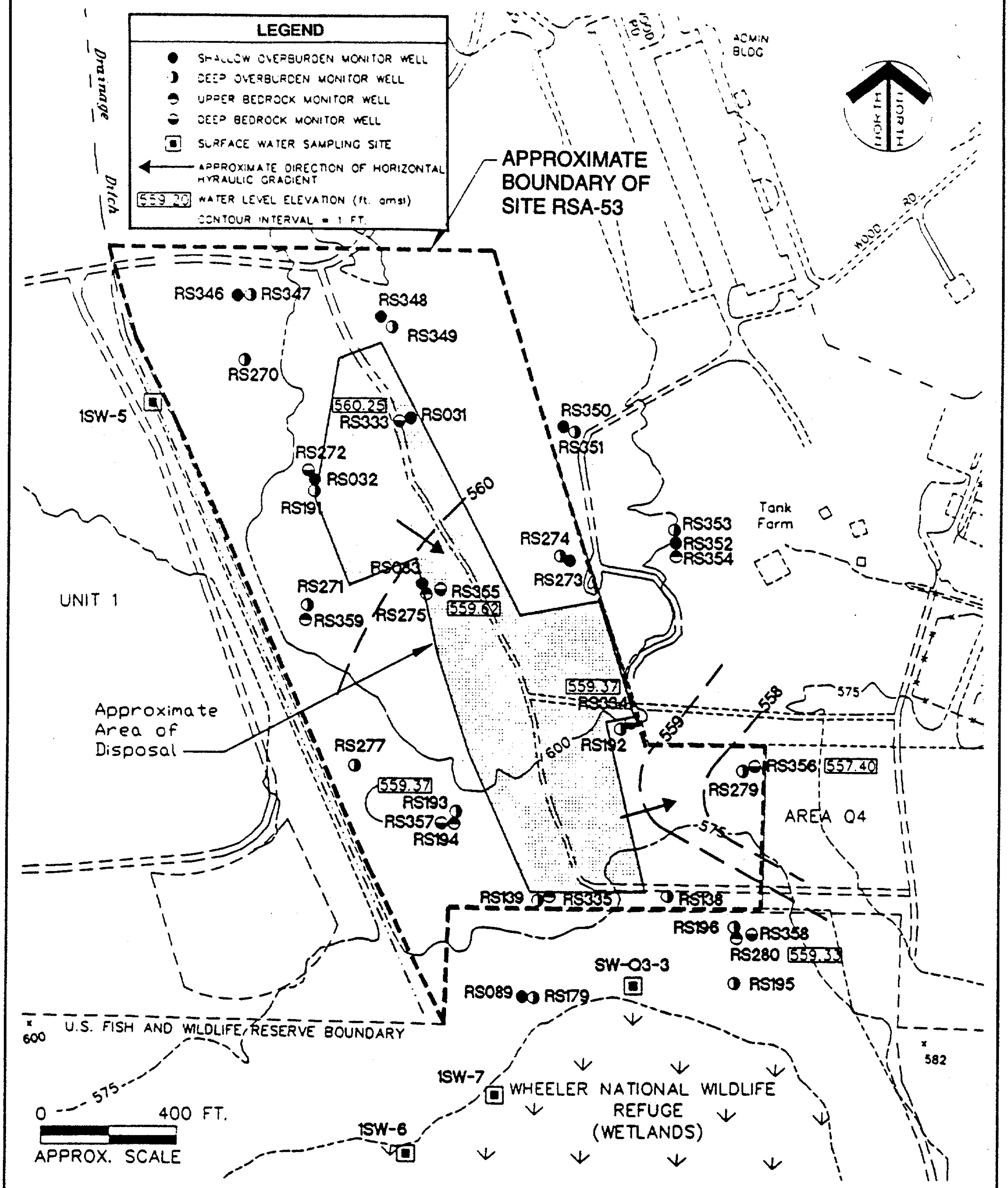


After Geraghty & Miller, Inc., 1993.

PARSONS ENGINEERING SCIENCE, INC.

Figure 2-8

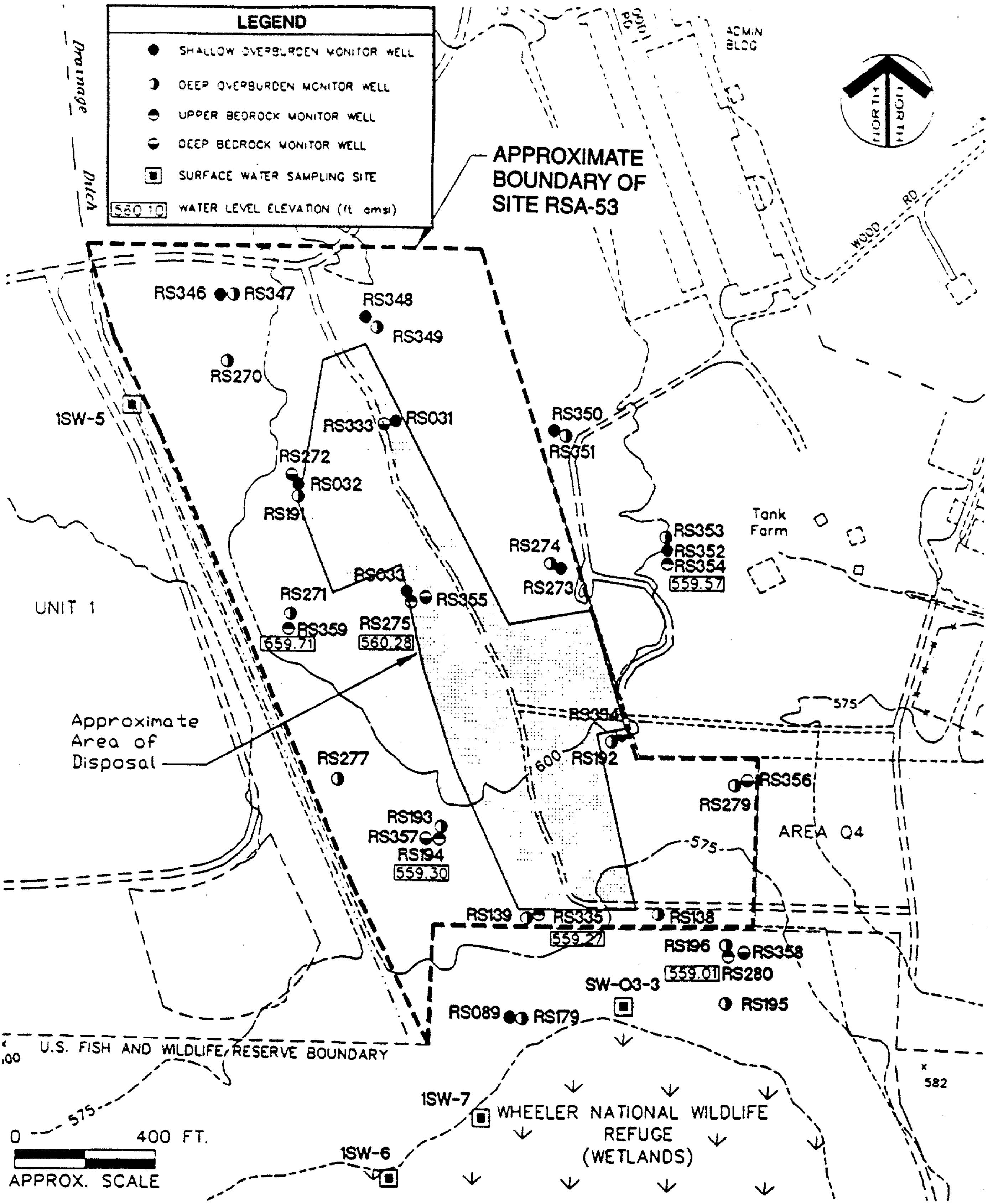
LOWER BEDROCK POTENTIOMETRIC SURFACE AT SITE RSA-53 REDSTONE ARSENAL



After Geraghty & Miller, Inc., 1993.

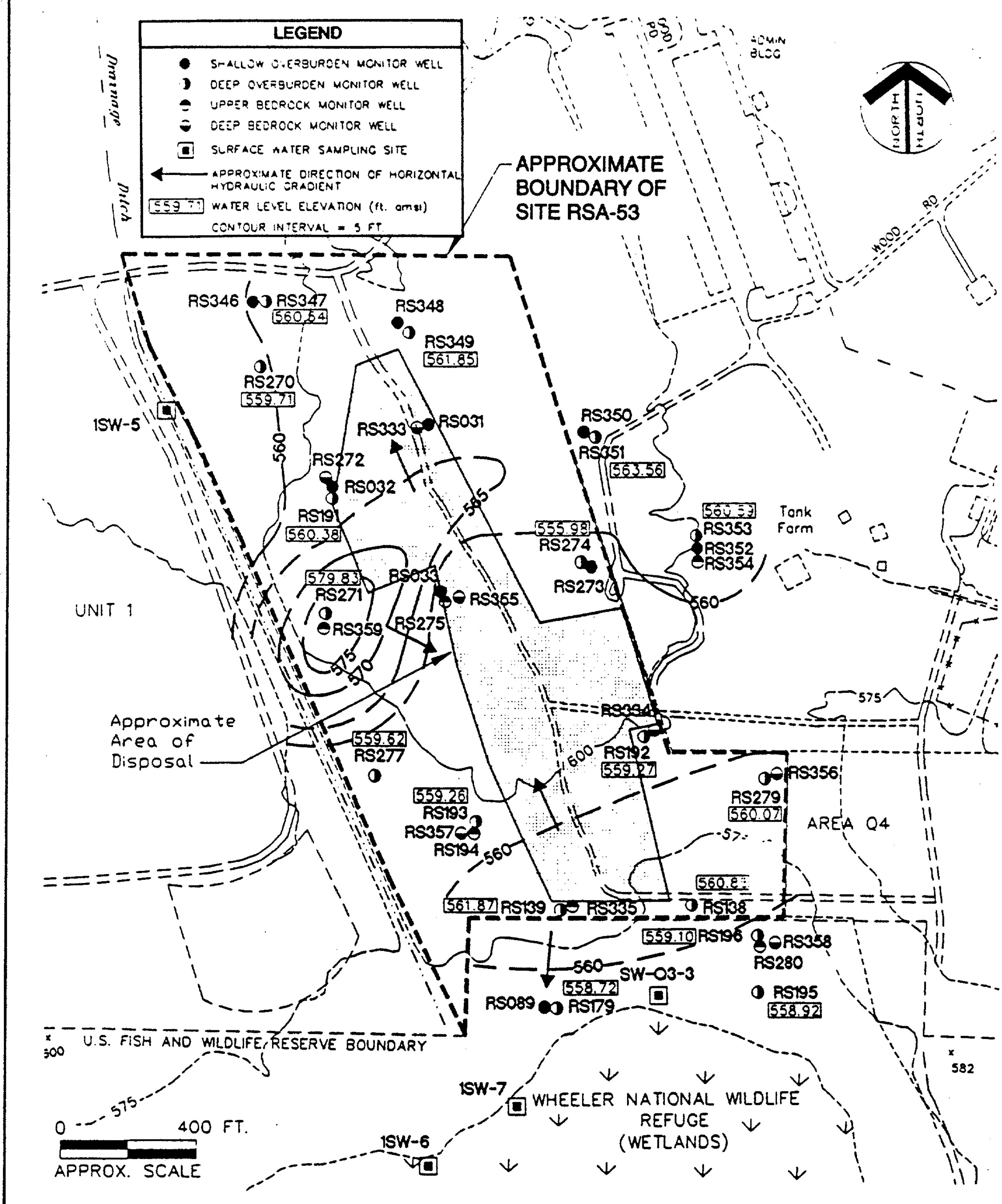
Figure 2-6

UPPER BEDROCK POTENTIOMETRIC SURFACE AT SITE RSA-53
REDSTONE ARSENAL



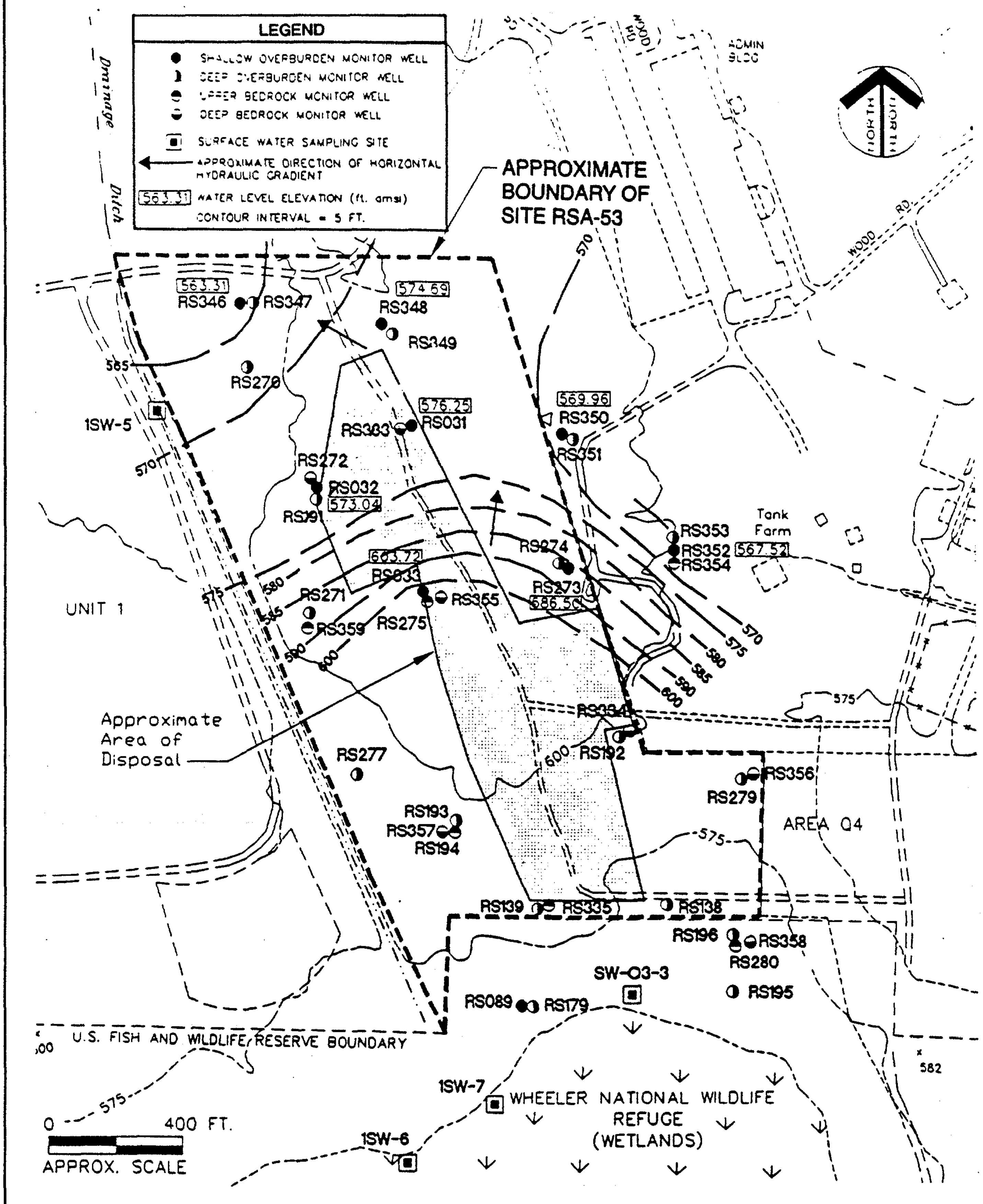
After Geraghty & Miller, Inc., 1993.

DEEP OVERBURDEN POTENTIOMETRIC SURFACE AT SITE RSA-53 REDSTONE ARSENAL



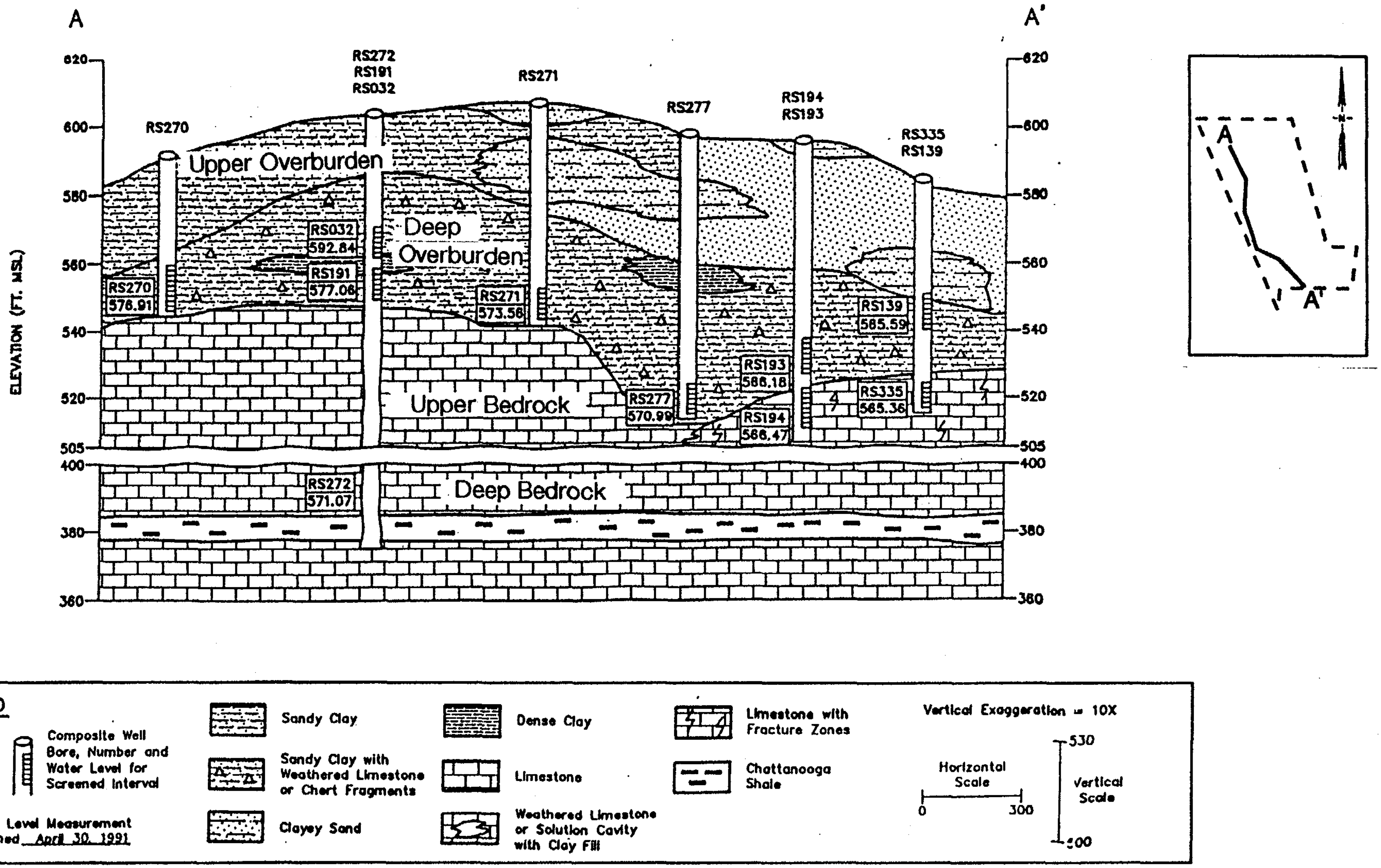
After Geraghty & Miller, Inc., 1993.

WATER TABLE SURFACE MAP AT SITE RSA-53
REDSTONE ARSENAL



After Geraghty & Miller, Inc., 1993.

HYDROGEOLOGICAL PROFILE ACROSS SITE RSA-53
REDSTONE ARSENAL

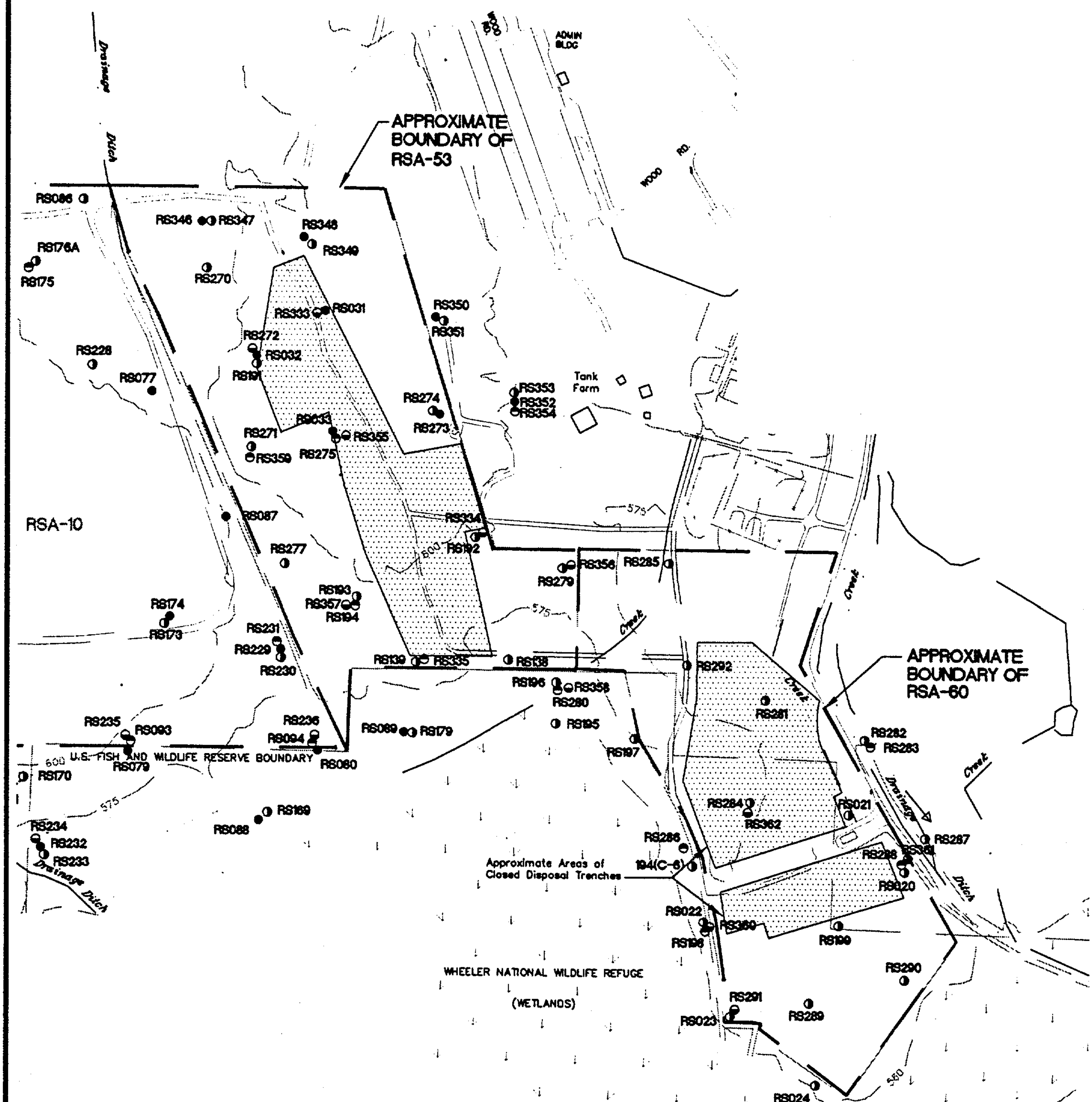


After Geraghty & Miller, Inc., 1993.

PARSONS ENGINEERING SCIENCE, INC.

Figure 2-3

SITE MAP
RSA-53 AND RSA-60 (GROUP X4B)
REDSTONE ARSENAL



LEGEND

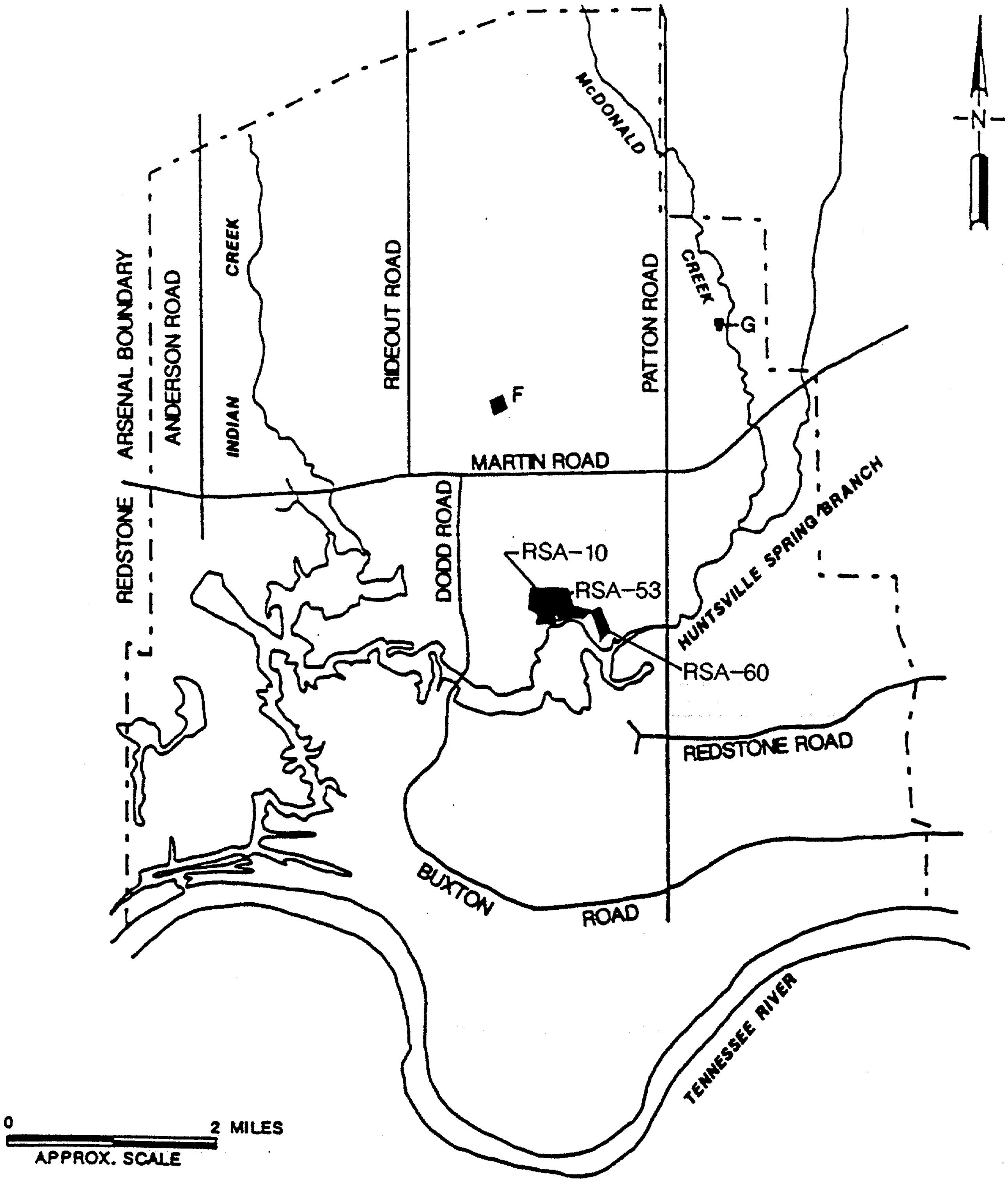
- ● SHALLOW OVERBURDEN MONITOR WELL
- ◑ DEEP OVERBURDEN MONITOR WELL
- ⊖ UPPER BEDROCK MONITOR WELL
- ⊖ DEEP BEDROCK MONITOR WELL

0 600 1200
SCALE IN FEET

AFTER GERAGHTY & MILLER, 1993.

PARSONS ENGINEERING SCIENCE, INC.

LOCATION OF SITES RSA-53 AND RSA-60 (GROUP X4B) AND RSA-10
REDSTONE ARSENAL



After Geraghty & Miller, Inc., 1993.

other contamination, primarily DDT, is not. The vertical and horizontal extent of soil contamination and of solid debris was determined during the RFI (G&M, 1993).

2.5.3.d The manufacture of DDT north of RSA-60 was ongoing from 1947 to 1971. DDT-contaminated wastewater was discharged through the drainage ditches along the eastern boundary of RSA-60, and into the former Huntsville Spring Branch to the south and west. These discharges took place before, during, and after the time that RSA-60 was operated as a landfill (1963 to 1968). As the majority of RSA-60 is in the floodplain of the former Huntsville Spring Branch, it is likely that RSA-60 has been periodically flooded with DDT-contaminated waters. The presence of DDT in the wastes, in the native clays underlying the wastes, and in shallow soils both inside and outside the boundaries of the disposal trenches in RSA-60 may be due to either or both site activities and activities related to the DDT manufacturing operations.

2.5.3.e Analysis of surface water samples indicate ubiquitous, background pesticide contamination throughout the local Wheeler National Wildlife Refuge and former channel and floodplain of Huntsville Spring Branch.

2.5.3.f The Alabama Geological Survey (AGS) is currently completing a detailed subsurface investigation at RSA-10. The results of the AGS investigation will be incorporated into this study if available and applicable.

SECTION 3
SCOPING OF THE RI/FS

3.0.a This section presents information used for developing the scope of activities to be conducted during the RI/FS, including potential remedial action technologies, preliminary identification of ARARs, data quality objectives, and data gaps and data needs.

3.1 CONCEPTUAL SITE MODEL

3.1.a The CSM depicts the relationship between potential sources of contamination, exposure pathways, and receptors. The number of contaminant pathways is determined by the characteristics of the contaminants, complexity of the site and ecosystem, and potential for exposure to both human and ecological receptors. Site-specific CSMs for RSA-53 and RSA-60 are discussed in Section 4 and are presented in Figures 4-3 and 4-4 (human receptors) and Figures 4-5 and 4-6 (ecological receptors).

The media of concern identified at RSA-53 and RSA-60 are as follows:

- surface soil;
- subsurface soil;
- groundwater;
- surface water/sediment in the wetland area; and
- surface water/sediment in the drainage ditches.

3.2 SCOPING OF POTENTIAL REMEDIAL ACTION TECHNOLOGIES

3.2.a The following remedial alternatives were identified in the draft CMS Report (ESE, 1993) as being potentially applicable:

- RSA-53
  - Alternative 1 - Capping
  - Alternative 2 - Excavation/Offsite Landfill
  - Alternative 3 - No action

- RSA-60
  - Alternative 1 - Excavation/Offsite Landfill
  - Alternative 2 - No action

3.3 PRELIMINARY IDENTIFICATION OF ARARS

3.3.a Potential chemical specific ARARs or To Be Considered (TBC) criteria must be identified initially in order to establish data quality objectives (Section 3.4). Quantitation limits for the analytical methods used during the RI should not exceed the ARAR values for given contaminants.

3.3.b Applicable requirements are defined as those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site. Relevant and appropriate requirements are those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable," address problems or situations reasonably similar to those encountered at the site. Potential sources for ARARs for RSA are described below. TBC criteria include state or federal screening criteria that may be used to evaluate contaminants when ARARs are not available.

3.3.1 Groundwater ARARs

3.3.1.a Potential ARARs for groundwater are listed on Table 3-1 of the General RI/FS Work Plan (Parsons ES, 1996) and include Safe Drinking Water MCLs and Alabama Maximum Contaminant Levels and Secondary Drinking Water Standards. Potential TBC criteria include EPA Region III Risk-Based Concentrations (RBC) for tap water issued for the protection of human health.

3.3.2 Surface Water ARARs

3.3.2.a Potential ARARs for surface water are listed on Table 3-2 of the General RI/FS Work Plan (Parsons ES, 1996) and include Federal and Alabama water quality criteria for freshwater organisms and Federal water quality criteria for human health with respect to ingestion of organisms. Potential TBC criteria include EPA Region IV freshwater surface water screening values for freshwater organisms.

3.3.3 Soil and Sediment ARARs

3.3.3.a ARARs are not available for soil or sediment. Potential TBC criteria for sediment include EPA Region IV sediment screening values for EPA Ecotox threshold and ecological receptors (Table 3-3 of the General RI/FS Work Plan(Parsons ES, 1996)). EPA Region III RBCs may be used as TBC criteria for soil and sediment for the evaluation of potential impacts to human health from these media (Table 3-4 of the General RI/FS Work Plan).

3.4 DATA QUALITY OBJECTIVES

3.4.a Data quality objectives (DQOs) are qualitative statements that define the acceptability of data generated by an investigation. The DQO process and data categories are described in Section 3 of the Generic RI/FS Work Plan.

3.4.1 Intended Uses of Data

3.4.1.a The data generated by the investigations at the Group X4B Sites must be of sufficient quality to complete the RI and FS efforts.

3.4.2 Data Quality

3.4.2.a Both screening and definitive data will be required to meet the data quality necessary to support the BRA and FS efforts. The screening data will be generated by the following field analyses.

- **Groundwater** screening will be conducted for pH, conductivity, temperature, and turbidity to ensure that the samples are representative of the formation water and to determine general water quality for evaluation of treatment in FS. Testing for pH, conductivity, and temperature will be conducted using direct reading probes. Testing for turbidity will be conducted using a turbidity meter.
- **Surface water** screening will be conducted for pH and hardness to establish existing water quality characteristics. Since availability of metals for uptake by plants and animals is related in part to pH and hardness, these measurement are also required for the Ecological Risk Assessment. Hardness will be measured using a Hach® test kit and pH will be measured with a direct reading probe.
- **Sediment** analyses for pH will be conducted to determine basic chemical characteristics of the sediment. Measurement of pH is also required for the Ecological Risk Assessment, since availability of metals in sediments is pH-dependent. Measurements of pH will be made with a direct reading probe or with pH paper.
- **Soil** screening for pH will be conducted to determine physical characteristics of the soil. Screening for volatile organics using a portable photoionization detector or organic vapor analyzer will be conducted to aid in the selection of samples to be sent to the laboratory for definitive analyses.

3.4.2.b The definitive data, to be used for the BRA, will be generated by the following laboratory analyses.

- **Groundwater** definitive chemical analyses for target compound lists (TCL) VOCs by USEPA CLP SOW for Organic Analyses OLM03.1 and target analyte list (TAL) metals by USEPA CLP SOW for Inorganic Analyses ILM3.0
- **Surface water** definitive chemical analyses for TCL VOCs, TCL SVOCs; and TCL pesticides by USEPA CLP SOW for Organic Analyses OLM03.1; and TAL metals by USEPA CLP SOW for Inorganic Analyses ILM3.0
- **Sediment** definitive chemical analyses for TCL VOCs, TCL SVOCs and TCL pesticides by USEPA CLP SOW for Organic Analyses OLM03.1; TAL metals by USEPA CLP SOW for Inorganic Analyses ILM3.0; and total organic carbon (TOC) by USEPA Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (SW846), SW9060 method.
- **Sediment Bioaccumulation Testing**. A whole sediment bioaccumulation study using *Lumbriculus variegatus* (Oligochaeta) will be conducted. For bioaccumulation studies, *L. variegatus* is frequently a preferred type of organism because it remains in contact with the sediment serving as a source, is readily cultured in the laboratory, and tolerates varying physico-chemical characteristics of sediments. For testing sediments from the RSA-53 and RSA-60-associated stations, a 28-day exposure to whole sediment from each station is proposed in accordance with USEPA Test Method 100.3 in *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates*, EPA 600/R-94/024 (1994). Five replicate assays will be performed for each sediment sample. A clean negative control will also be included. Following a 24-hr washout period to allow the *L. variegatus* to clear their intestines, analytical chemistry and lipid analysis will be performed. The *L. variegatus* from the five replicates for each sediment sample will be combined as a composite sample for chemical analysis. Chemical analyses will be in accordance with the relevant USEPA protocols for the contaminants of interest, and the USEPA recommended Bligh-Dyer method will be used for lipid analysis. Comparison of the results with the corresponding chemical concentrations in the sediment samples will allow estimation of bioaccumulation in the *L. variegatus* tissue.
- **Soil** definitive chemical analyses for TCL VOCs, TCL SVOCs and TCL pesticides by USEPA CLP SOW for Organic Analyses OLM03.1; TAL metals by USEPA CLP SOW for Inorganic Analyses ILM3.0; and TOC by SW846 SW9060 method.

- **Soil** definitive geophysical analyses for hydraulic conductivity by ASTM D5084, identification of soils by ASTM D-2488, particle size by ASTM D422; and distribution ratios (the short-term batch method) by ASTM D4319.

A summary of the accuracy and precision DQOs for the definitive laboratory chemical data is presented in Table 3.5 of the General Work Plan.

SECTION 4
TASK PLAN FOR THE RI

4.0.a This section identifies the activities that will be conducted during the RI at Sites RSA-53 and RSA-60. Field activities will be conducted under Task Order 0006 of Contract No. DACA87-95-D-0018.

4.0.b A total of 20 soil samples, 68 groundwater samples, 14 surface water, and 14 sediment samples will be collected from Group X4B for chemical analysis. Six subsurface soil borings will be analyzed for limited geotechnical testing. Analyses for all of the media to be sampled are summarized in Section 3, Data Quality Objectives.

4.1 PRE-FIELD ACTIVITIES

4.1.a Prior to commencement of field activities, underground utilities will be cleared by RSA and the Parsons ES field personnel will assure that all locations scheduled for drilling, borings, and sampling will be accessible. If local conditions, such as flooding, preclude planned field work from being performed at a specific location, the well, borings, or sample point will be relocated in consultation with the CEHNC project manager.

4.2 FIELD INVESTIGATIONS

4.2.a Field activities to be conducted during this investigation include:

- Soil investigation;
- Surface water and sediment investigation;
- Groundwater investigation;
- Ecological investigation; and
- Surveying.

4.2.b All field procedures are provided in the Field Sampling Plan (FSP, Appendix B) and in the Monitoring Well Installation Plan and Field Sampling Procedures (General RI/FS Work Plan (Parsons ES, 1996) Appendix D). Investigation-derived waste (IDW) generated during this field effort will be handled according to the procedures described in the IDW Plan (General RI/FS Work Plan (Parsons ES, 1996)

Appendix E). All field activities will be performed in compliance with the site-specific Safety and Health Plan (Appendix A) and the Ordnance Management Plan (General RI/FS Work Plan Appendix C, Parsons ES, 1996).

4.2.c Background data is currently being compiled for groundwater and soil at RSA by CESAS. If available, it will be incorporated in this study.

4.2.1 Soils Investigation

4.2.1.a Ten chemical soil borings will be installed at Group X4B at the locations shown in Figure 4-1 following the procedures outlined in the FSP. Two soil samples will be collected from each chemical soil boring, a surface soil sample from 0 to 1 foot below land surface (ft bls) and a subsurface sample from 1 to 6 ft bls. The second sample will be selected according to the following procedure: samples will be collected from 1 to 6 ft bls at two foot intervals. The samples will be screened for VOCs using a portable PID or OVA. A duplicate of the sample showing the greatest VOC concentration will be shipped for chemical analysis. If no VOCs are detected, the deepest sample from the boring will be shipped for analysis. The soil borings have been located in areas of documented soil contamination or areas where data gaps exist for soils. The purpose of the soil analyses is to provide information to support the RI and FS. Soil borings will be advanced into the overburden with a drill rig using a hollow stem auger. The samples will be analyzed for the compounds discussed in Section 3.5, which includes VOCs, SVOCs, metals, pesticides, pH, and TOC.

4.2.1.b Four borings will be installed within the boundaries of RSA-53: one soil boring each will be installed at Q3TP-4, Q3TP-5, and Q3TP-6 [locations of test pits from a previous investigation (G&M, 1993)] and one soil boring will be installed in the southwestern corner of RSA-53 to determine if activities within the landfill have affected this downslope, downgradient location.

4.2.1.c The six remaining soil borings will be installed within the boundaries of RSA-60: one soil boring each will be installed at Q4TP-1, Q4TP-3, and Q4TP-6 [locations of test pits from a previous investigation (G&M, 1993)], one soil boring will be installed at Q4SB-2 [the location of a soil boring from G&M (1993)], and one soil boring will be installed in the southwestern corner of RSA-60 to determine if activities within the landfill have affected this downslope, downgradient location.

4.2.1.d Soil samples for geotechnical testing will be collected from six soil borings, three at each site. One sample will be collected from each boring. Boring locations and sample depths will be selected after reviewing boring logs from the collection of samples for chemical analysis. Final depths and locations of samples for geotechnical analysis will be selected in consultation with the CEHNC project manager. Undisturbed samples for geotechnical testing will be collected using Shelby tubes following the procedures outlined in the FSP (Appendix B). The samples will be tested for porosity, permeability, organic carbon, and ion-exchange capacity. Laboratory testing methods are identified in Section 3.

4.2.2 Surface Water and Sediment Investigation

4.2.2.a Fourteen surface water samples and 14 sediment samples will be collected from the locations shown on Figure 4-1. Surface water and sediment sample locations will be co-located. Seven of the samples will be collected south of the sites within the wetlands associated with Huntsville Spring Branch in and along the border of the Wheeler National Wildlife Refuge (WNWR). Two samples will be collected from the drainage ditch separating RSA-10 (Unit 1) from RSA-53. Two samples will be collected from the creek located in the northwestern corner of RSA-60. Three samples will be collected from the former DDT wastewater drainage ditch that runs along the eastern border of RSA-60.

4.2.2.b All surface water and sediment samples will be analyzed for VOCs, SVOCs, metals, pesticides, pH, hardness, and TOC. Analytical methods are identified in Section 3 and specific analytes are listed in Appendix B.

4.2.2.c Whole sediment bioaccumulation studies (using *Lumbriculus variegatus*) will be conducted on eight of the sediment samples collected. These eight samples include four of the stations within the wetlands of WNWR, the two stations on the drainage ditch separating RSA-10 and RSA-53, one station located along the drainage on the western border of RSA-60, and one station located along the former DDT wastewater drainage ditch that runs along the eastern border of RSA-60. For testing sediments from the RSA-53 and RSA-60 stations, a 28-day exposure to whole sediment from each station is proposed in accordance with methods provided in Section 3.

4.2.3 Groundwater Investigation

4.2.3.a The groundwater investigation will include:

- Water level measurements;
- Installation of 5 monitoring wells, 2 recovery wells, and 3 piezometers;
- Two aquifer tests; and
- Groundwater sampling and analysis.

4.2.3.1 Water Level Measurements

4.2.3.1.a Prior to beginning any other field work, water levels will be measured in 68 monitoring wells on and surrounding the sites. Table 4.1 identifies the monitoring wells for groundwater level monitoring. Procedures for water level measurement are provided in the Field Sampling Plan (Appendix B).

4.2.3.2 Monitoring Well Installation

4.2.3.2.a Five monitoring wells will be installed at the locations shown in Figure 4-1. All of the wells will be screened within the deep overburden aquifer and have been placed to increase the understanding of the lateral extent of contamination within this aquifer.

4.2.3.2.b Two monitoring wells will be installed at RSA-53: one near the northeastern corner of RSA-53 to determine the composition of groundwater entering the site, and one along the western border of RSA-53 near existing monitoring well RS087. Three monitoring wells will be installed at RSA-60: one within the WNWR along the western border of RSA-53, one near existing monitoring wells RS291 and RS023 in the southwestern corner of RSA-53, and one in the southeastern corner of RSA-53.

4.2.3.2.c Well installation procedures are provided in the Monitoring Well Installation Plan and Field Investigation Procedures (General RI/FS Work Plan (Parsons ES, 1996) Appendix D).

4.2.3.3 Aquifer Testing

4.2.3.3.a Aquifer tests will be performed on two proposed recovery wells screened in the upper bedrock aquifer. The tests will be performed to determine aquifer characteristics such as transmissivity, storage coefficient, hydraulic conductivity, leakage, and radius of influence. Additional information on the interconnectivity between hydrologic units will also be gathered by observing drawdown effects in observation wells screened in other zones.

4.2.3.3.b The pumping test will consist of three steps: 1) installation of recovery and observation wells, 2) conducting 6-hour step tests in the pumping wells to determine the optimum pumping rate for the aquifer tests, and 3) conducting 72-hour pumping tests. Details of the test methodology are presented in the Field Sampling Plan (Appendix B).

4.2.3.3.c The proposed recovery and observation well locations are based on current information available on the site. The proposed locations for the recovery wells and observation wells are shown in Figure 4-2. Where possible, the locations have been selected to use existing wells as observation wells. Where no wells are available, piezometers will be installed.

4.2.3.3.d The recovery wells will have 4-inch ID screen and casing diameters and will be screened in the upper bedrock aquifer. Observation wells and monitoring wells used as observation wells will be screened in the shallow overburden, basal overburden, upper bedrock, and deep bedrock aquifers and will be located downgradient of the recovery well, if possible. One observation well screened in the upper bedrock aquifer will be located along strike from each of the recovery wells to allow determination of directional differences (anistotropy) in drawdown during pumping of the aquifer. Water levels in selected nearby monitoring wells will also be measured periodically to provide additional information on aquifer characteristics. The maximum distance between the recovery well and an observation well will be about 225 feet.

4.2.3.3.e One recovery well will be installed at RSA-53 north of existing monitoring well RS272. Monitoring wells RS272, RS032, and RS191 will be used as observation wells for the deep bedrock aquifer, the shallow overburden aquifer and the deep overburden aquifer, respectively. Two piezometers screened in the upper bedrock aquifer will be installed and used as additional observation wells. One piezometer will be installed near the observation well cluster and one will be installed 100 feet west of the recovery well.

4.2.3.3.f A second recovery well will be installed at RSA-60 north of existing monitoring well RS022. Monitoring wells RS022, RS360, and RS198 will be used as observation wells for the deep overburden aquifer, the deep bedrock aquifer, and the upper bedrock aquifer, respectively. One piezometer screened in the upper bedrock aquifer will be installed 100 feet east of the recovery well for use as an additional observation well.

4.2.3.4 Groundwater Sampling

4.2.3.4.a Groundwater samples will be collected from each of the five newly-installed wells and from 68 existing wells at the sites. Well locations are shown in Figure 4-1. The wells to be sampled, and the hydrogeologic units in which they are screened, are listed in Table 4.1. The wells are located within RSA-53, RSA-60, RSA-10, the WNWR and in the area east of RSA-53 and north of RSA-60 that includes a tank farm.

4.2.3.4.b Groundwater samples will shipped to the laboratory for analysis of VOCs, metals, hardness, and TOC. The samples will also be field-tested for pH, temperature, turbidity, and conductivity. Sampling methods are provided in the Field Sampling Plan (Appendix B).

4.2.4 Ecological Investigation

4.2.4.a The ecological characterization of RSA-53 and RSA-60 will be based on the methods described in the General RI/FS Work Plan (Parsons ES, 1996). Specific methods to be employed for the ecological characterization are detailed below.

4.2.4.b RSA-53 and RSA-60 are located in the center of the RSA approximately 1.5 miles south of the confluence of Huntsville Spring Branch and McDonald Creek. This system ultimately drains into the Tennessee River. RSA-60 is approximately 50 acres in extent and is located approximately 1,200 feet southeast of RSA-53. RSA-53 is approximately 170 acres in extent. RSA-53 and RSA-60 border a large wetland complex associated with the WNWR, located immediately to the south (Figure 4-1). The entire western edge of RSA-60 directly borders the eastern edge of the WNWR. The southeastern corner of RSA-53 directly borders the refuge (Figure 4-1).

4.2.4.c Available information on the ecology of RSA-53 and RSA-60 will first be obtained and reviewed as described in the General RI/FS Work Plan (Parsons ES, 1996). The most recent information on the actual or potential presence of state- and federally-listed threatened and endangered species, species of special concern, and wildlife and fisheries resources in the vicinity of RSA-53 and RSA-60 will be obtained. A protected species review completed for the area in 1995 in conjunction with the RFI will be updated in view of the changes in status of federally-listed Category 2 species to species of special concern (a change that was published in the Federal Register on February 27, 1996). Information on unique and special-concern habitats, other preserves, and natural areas associated with RSA-53 and RSA-60 will also be obtained and reviewed.

4.2.4.d A field survey of the area within a 0.5-mile radius of RSA-53 and RSA-60 will be conducted in order to collect qualitative information on the types, extent, values, and locations of biological resources. The field survey will include the follows elements:

- **Plant communities.** A general description of upland and wetland plant communities within the boundaries of RSA-53 and RSA-60 and within the areas of WNWR bordering the site will be developed based on the dominant species observed. A formal wetland delineation is not proposed. Wetland habitats will be mapped using information available from soil maps, WNWR maps, National Wetland Inventory (NWI) maps, available aerial photographs, and observations made during the field survey.
- **Dominant plant species.** Dominant plant species will be identified qualitatively within each major terrestrial and wetland plant community. This will include the large wetland complex associated with WNWR. Wetland areas will be qualitatively assessed on foot where accessible.
- **Terrestrial fauna**. Observations of terrestrial fauna will be made within the boundaries of RSA-53 and RSA-60 and along the adjacent WNWR, and any upland areas. Mammals will be identified by tracks, scat, burrows, and actual sightings. Bird, reptile, and amphibian identifications will be made by actual sightings. All observations will be qualitative in nature.

- **Aquatic life.** Aquatic resources will be qualitatively evaluated from selected locations in the WNRW/Huntsville Spring Branch wetlands, as site conditions allow. Small streams and drainage ditches adjacent to or within RSA-53 and RSA-60 will be described and qualitatively addressed. Major species present will be identified in a qualitative manner. Sediment bioassay samples will be collected from 8 stations identified in Section 4.2.3. Physical location of the sampling stations may vary based on actual site conditions.
- **Vegetation stress.** Upland and wetland vegetation within the boundaries of RSA-53 and RSA-60 will be examined for vegetative stress, including plants displaying stunted growth, poor foliage growth, tissue discoloration, and a loss of leaf coverage.

4.2.4.e A map will be prepared that illustrates the major upland and wetland plant communities within a 0.5-mile radius of RSA-53 and RSA-60. Aquatic habitats and sampling locations will also be indicated on the map, as well as habitat or actual occurrence of any state- or federally- listed species, or federal species of special concern.

4.2.4.f A description of the ecological features of RSA-53 and RSA-60 will be prepared based on the updated literature review and field survey. This will provide the basis for selection of representative receptors, refinement of exposure scenarios for the risk assessment, and identification of protected species or valuable habitats in the area within a 0.5-mile radius of RSA-53 and RSA-60.

4.2.5 Surveying

4.2.5.a Coordinates and elevations will be established for each monitoring well, soil boring, and surface water/sediment sampling site per methods described in Appendix B. The location, identification, coordinates and elevations of the wells, borings, and surface water/sediment sampling sites will be plotted on planimetric maps to show their location with reference to surface features within the project area.

4.3 DATA REDUCTION, VALIDATION, AND DOCUMENTATION

4.3.a Data generated during the Group X4B investigation will be managed to document findings and to support the DQOs presented in Section 3. Qualitative data will be assembled and where possible, copied, for the project files. Quantitative data will be assembled both in hard-copy and electronic format for subsequent comparisons, evaluation, and reporting. Quantitative data will become part of the site file also. The data reporting requirements of ERDMIS and USEPA's interchange file format (IFF) format shall be part of the data management process.

4.3.b The descriptions of the data reduction, validation and documentation processes for the RSA projects may be found in Section 4 of the General RI/FS Work Plan (Parsons ES, 1996).

4.4 BASELINE RISK ASSESSMENT

4.4.a A baseline risk assessment, composed of a human health risk assessment (HHRA) and an ecological risk assessment (ERA), will be performed to provide an estimate of current and future human health risk and ecological risk associated with hazardous substance releases at potentially contaminated sites. The results of the HHRA and the ERA will contribute to the overall characterization of the sites and serve as part of the baseline used to develop, evaluate, and select appropriate remedial alternatives.

4.4.b A risk-based screening of the data will be performed to identify chemicals of potential concern (COPCs) for both human health and ecological endpoints. The screening process and the methodology for performing the HHRA and ERA are briefly described below. The screening process and methodology are detailed in Section 4 of the General Work Plan (Parsons ES, 1996) and in Section 2 of the pre-approved Revised Final Work Plan to prepare Baseline Risk Assessments (USACE, 1994).

4.4.c Pre-existing data will be evaluated for use in the HHRA and ERA. Sample data collected as outlined in this work plan will be quantitatively evaluated where appropriate.

4.4.1 Identification of Chemicals of Potential Concern

4.4.1.a Prior to initiation of a baseline HHRA, a list of chemicals present in site samples (CPSS) and COPCs will be compiled. All chemicals detected in site media at RSA-53 and RSA-60 are considered CPSSs. From the list of CPSSs, COPC are selected using the pre-approved Work Plan screening methodology. The details of the pre-approved Work Plan screening methodology are presented in Section 2.2 of Revised Final Work Plan to prepare Baseline Risk Assessments (USACE, 1994).

4.4.1.b Chemicals not eliminated using the screening process will be considered COPCs and will be quantitatively evaluated in the HHRA and/or ecological evaluation.

4.4.2 Human Health Risk Assessment

4.4.2.a Following identification of COPCs for the HHRA, the following major steps will be completed as detailed in Section 4 of the General RI/FS Work Plan and Section 2 of the pre-approved Work Plan.

- Data evaluation
- Exposure assessment

- Toxicity assessment
- Risk characterization

4.4.2.b Components of these steps are discussed in this section where specific information is warranted. Otherwise, the General RI/FS Work Plan (Parsons ES, 1996) and the pre-approved Work Plan (USACE, 1994) provide detailed methods and background material.

4.4.2.c RSA-53 and RSA-60 will be evaluated using site-specific exposure scenarios. Evaluation of past site activities and comparison of on-site and downgradient sample analytical data to background analytical data will be considered to determine which chemicals detected are likely to be site-related. Conceptual site models (CSMs) for RSA-53 and RSA-60 are presented in Figures 4-3 and 4-4, respectively. The CSM depicts the relationship between potential sources of contamination, exposure pathways, and receptors.

4.4.2.1 Data Evaluation

4.4.2.1.a COPCs will be identified as discussed in Section 4.4.1.1. Environmental media to be considered in the HHRA include shallow soil (0-1 ft), subsurface soil (0-6 ft), surface water, sediment, and groundwater. Validated data from the most recent sampling efforts will be used, along with appropriate historical data, to quantify potential human health risks. Water media will be expressed in units of mg/L (ppm) and solid media (soil, sediment) in units of mg/kg (ppm).

4.4.2.2 Exposure Assessment

4.4.2.2.a The objective of the exposure assessment is to estimate the type and magnitude of exposures to the chemicals of potential concern that are present at or migrating from a site. A completed pathway is comprised of the following four elements:

- A source and mechanism for chemical release;
- An environmental transport medium;
- An exposure point; and
- A human or ecological receptor and a feasible route of exposure at the exposure point.

4.4.2.2.b A pathway is not considered complete unless each of these elements is present.

4.4.2.2.c Consistent with Risk Assessment Guidance for Superfund (RAGS)(EPA, 1989a) and EPA Region IV policy (EPA, 1995a), current and reasonably foreseeable future land-use scenarios will be considered for RSA-53 and RSA-60. The sites are located in an area used by industrial workers; therefore, exposure of these workers will be assessed. Given the presence of the wetland in the area, the site may also be used for recreational purposes. Given that the areas are located in a restricted area, however, these recreators must be considered trespassers. In the future, land use will remain industrial; therefore, potential future receptors include industrial workers and recreational trespassers. The Master Plan for RSA indicates that RSA-53 and RSA-60 are located in an area that is designated for Operational Facilities in the future (US Army, 1996). Per EPA's "Land Use in the CERCLA Remedy Selection Process" (OSWER Directive No. 9355.7.04, 1995c), residential exposure is only considered appropriate when the current land use at the site is residential, or when there is a strong probability that residential development will occur at the site in the future. Given that neither of these criteria apply at RSA-53 and RSA-60, residential development is not considered a likely future land use.

Receptor Definitions

4.4.2.2.d The potential receptors are defined as follows for RSA 53 and RSA 60:

4.4.2.2.e **Current and Future Workers:** Workers are defined as individuals that are employed at or near the site, and who have unlimited access to site media. Current and future workers are assumed to be exposed to surface soil (0 to 1 foot in depth). However, future workers are considered exposed to mixed soil, given natural erosion effects and potential excavation. Incidental ingestion of soil, dermal contact with soil, inhalation of fugitive dust from soil, and inhalation of volatiles from soil are potential pathways for exposure to soil. Future workers are also assumed to be exposed to groundwater (drinking water) via ingestion and dermal contact. Inhalation of volatiles while showering/bathing will not be considered for these receptors assuming showering activities will occur at home rather than at the site.

4.4.2.2.f **Current and Future Recreational Trespassers:** Residents living near RSA-53 and RSA-60 may be exposed to site soil, surface water, and sediment during recreational activities at the sites. These sites are located near a wetland area, which would result in recreational activities, such as hunting. Given the restrictions at these sites, current and future recreators will be trespassing into restricted areas.

4.4.2.2.g Current and future recreators are assumed to be exposed to site media via ingestion of, dermal contact with, and inhalation of surface soils, and dermal contact with surface water and sediment.

4.4.2.2.h Current and future recreators are assumed to be exposed to surface soil (0 to 1 foot in depth). However, future recreators are considered exposed to mixed soil (mixture of both surface and subsurface soils), as a result of natural erosion effects and potential excavation. Pathways for exposure to surface water and sediment are dependent upon site conditions. Ingestion of sediment will be unlikely given that the sediments will be located at depth beneath the surface water. Also, given the nature of the wetland area, swimming activities are unlikely; therefore, ingestion of surface water is unlikely. Recreators are more likely to be exposed to surface water via dermal contact.

4.4.2.2.i Details concerning the methodology to be used for determining exposure estimates (RME and CT), exposure point concentrations, and the toxicity assessment are provided in Section 4.4. of the General RI/FS Work Plan (Parsons ES, 1996) and in Section 2 of the pre-approved Work Plan (USACE, 1994).

4.4.2.2.j Current and future risks for each receptor at each site will be calculated and depicted in the Risk Characterization Section of the BRA, in accordance with the pre-approved Work Plan (USACE, 1994). An uncertainty assessment will also be completed as outlined in the pre-approved Work Plan (USACE, 1994). Remediation goals will be calculated in accordance with EPA Region IV guidance as described in Sections 2.5.1.1 and 2.5.2.1 of the pre-approved Work Plan (USACE, 1994).

4.4.3 Ecological Risk Assessment

4.4.3.a Methods used to conduct the ERA are outlined in Section 2 of the pre-approved Work Plan (USACE, 1994). The purpose for collecting additional data is to supplement pre-existing data from previous investigations and fill data gaps identified. Previous data will be evaluated for use in the risk assessment. The data to be collected as described in this risk assessment will be quantitatively evaluated.

4.4.3.1 Problem Formulation

4.4.3.1.a The protection of ecological resources, such as habitats and species of non-domesticated plants and animals, is a principal motivation for conducting the ERA. Ecological endpoints will be identified in the text of the ERA to assess whether significant adverse ecological effects have occurred or may occur at RSA-53 and RSA-60 as a result of ecological receptors' exposure to COPCs. COPCs will be selected for use in the ERA in accordance with the methodology described in the pre-approved Work Plan (USACE, 1994).

4.4.3.1.b The ecological characterization will be performed as described in Section 4.2.5 Ecological Investigation. The result of the ecological characterization will be to provide the risk assessors with information to select representative receptors, refine exposure scenarios for the ERA, and provide information on protected species.

Ecological endpoints will be defined in the ERA in accordance with the guidance set forth in the pre-approved Work Plan (USACE, 1994). Given the diversity at RSA-53 and RSA-60, ecological endpoints will consider sensitive habitats and species associated with the RSAs and the adjacent WNWR.

4.4.3.1.c Receptors will be selected based on the results of the site characterization and other selection factors as identified in Section 4.4.3 of the General RI/FS Work Plan (Parsons ES, 1996) and in Section 2.3.2 of the pre-approved Work Plan (USACE, 1994). The terrestrial receptors identified in previous ERA for RSA-53 and RSA-60 and considered for this ERA include: the mouse (*Peromyscus* sp.), white-tailed deer (*Odocoileus virginianus*), common bobwhite quail (*Colinus virginianus*), gray bat (*Myotis grisescens*), and bald eagle (*Haliaeetus leucocephalus*). Potential aquatic receptors include: slackwater darter (*Etheostoma boschungi*), green frog (*Rana clamitans*), caddisfly (*Cheumatopsyche* sp. and *Hydropsyche* sp.), and chironomid (*Chironomus* sp). Habitat conditions will be verified to determine whether site conditions would support the slackwater darter. Receptors selected will be identified and described in the ERA.

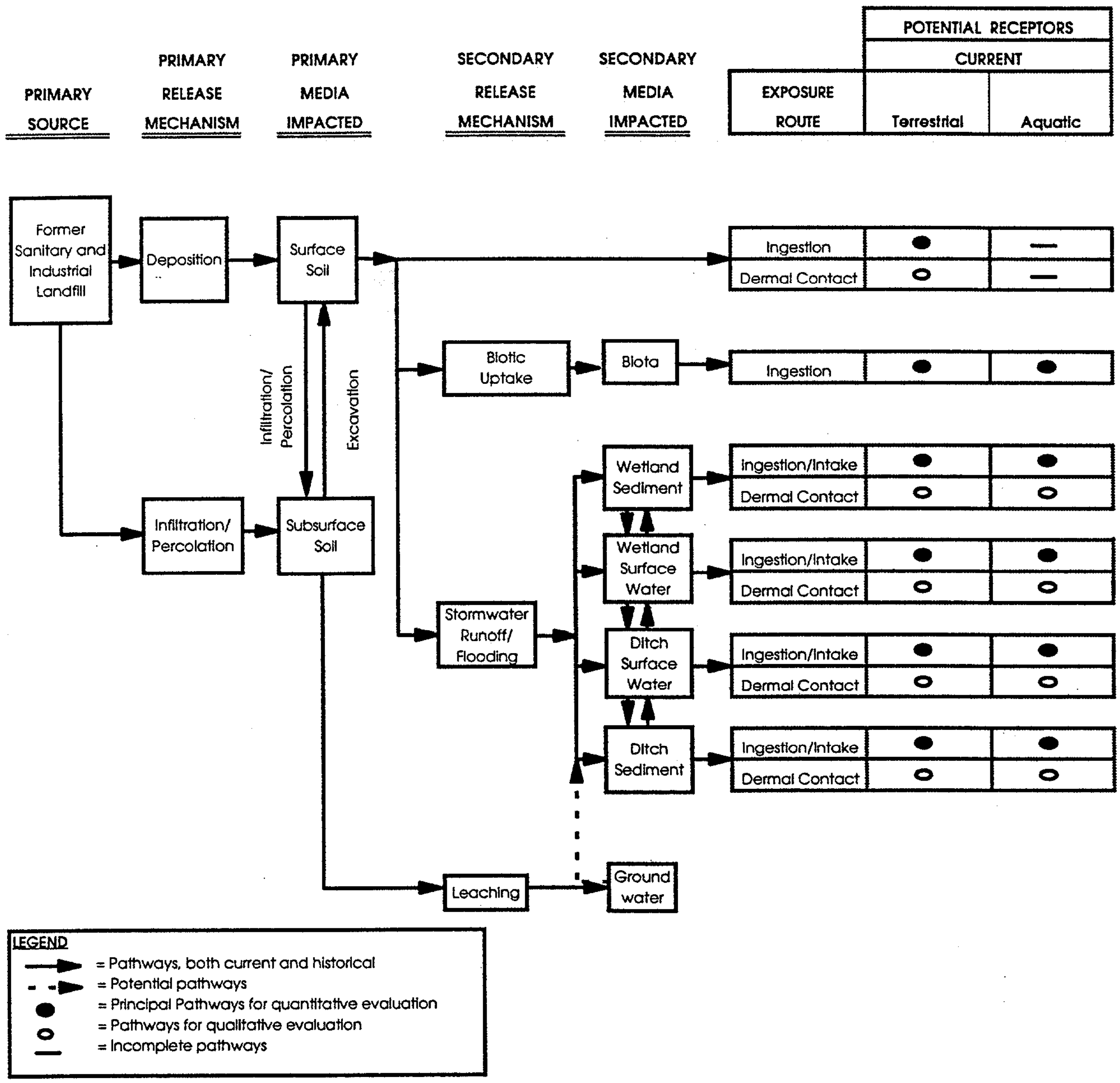
4.4.3.1.d Conceptual site models are presented in Figures 4-5 and 4-6 for RSA-53 and RSA-60, respectively. These CSMs are based on previous investigation results, a brief site visit, and evaluation of the site investigation results. Professional judgment will be used to select the most appropriate risk hypotheses and document the rationale for selection of endpoints.

4.4.3.2 Exposure Characterization

4.4.3.2.a Potential exposure pathways are depicted in the CSMs, Figures 4-5 and 4-6. Soil, sediment, and surface water pathways will be evaluated. The exposure profile will be detailed in the ERA to include a discussion of endpoint selection. Empirical and site specific data will be used to determine endpoints. Toxicity reference values will be developed in accordance with methods provided in the General RI/FS Work Plan (Parsons ES, 1996) and the pre-approved Work Plan (USACE, 1994).

4.4.3.2.b Site-specific bioconcentration factors will be derived where appropriate based on results of bioaccumulation studies. Whole sediment bioaccumulation studies using *Lumbriculus variegatus* (Oligochaeta) will be conducted. Sediment samples will be collected as described in Section 4.3. *L. variegatus* is frequently a preferred type of organism because it remains in contact with the sediment serving as a source, is readily cultured in the laboratory, and tolerates varying physico-chemical characteristics of sediments. For testing sediments from RSA-53 and RSA-60 associated stations, a 28-day exposure to whole sediment from each of 8 stations is proposed in accordance with EPA methods outlined in Section 3.

ECOLOGICAL CONCEPTUAL SITE MODEL FOR RSA-60: FORMER SANITARY AND INDUSTRIAL LANDFILL REDSTONE ARSENAL



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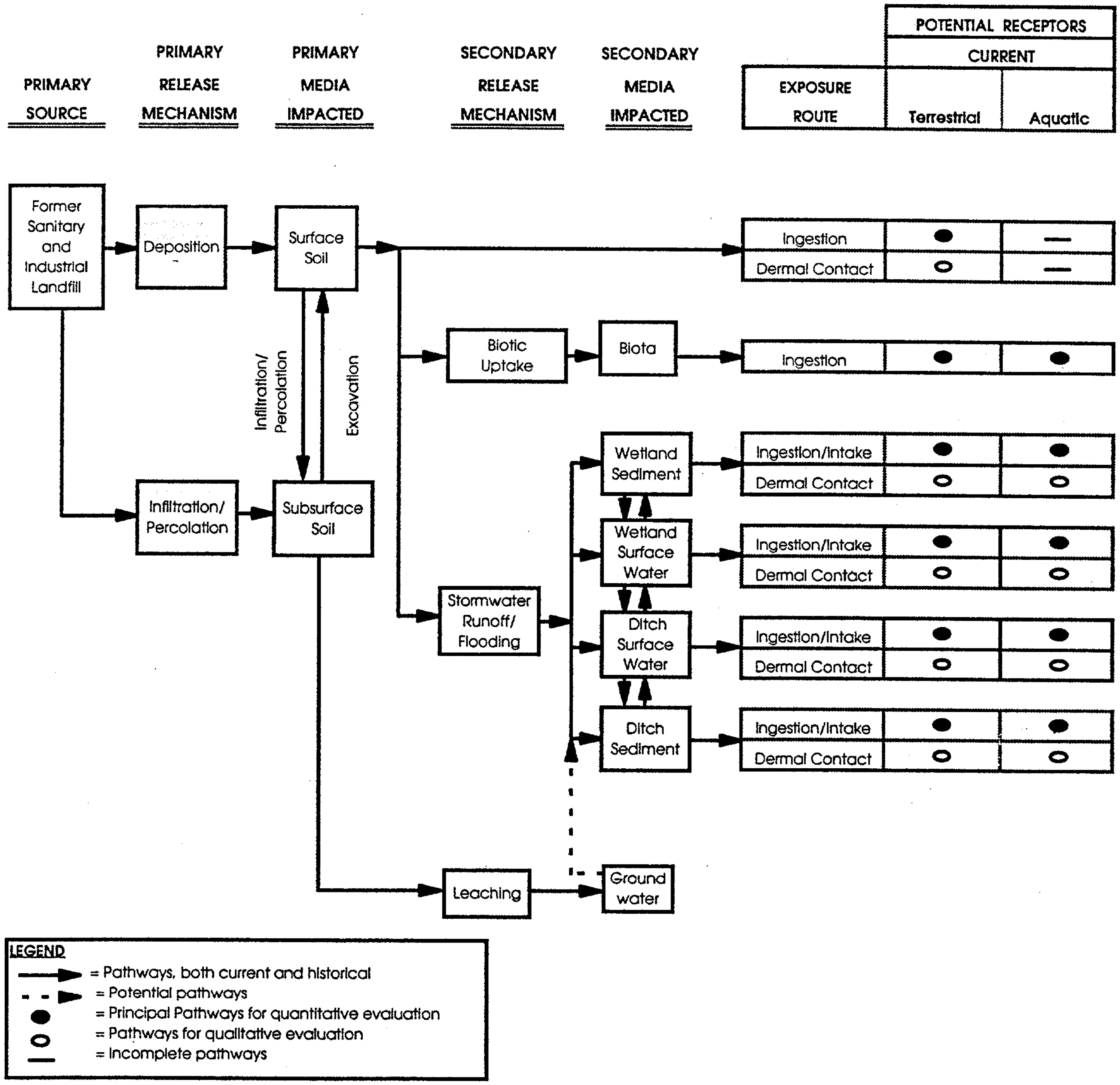
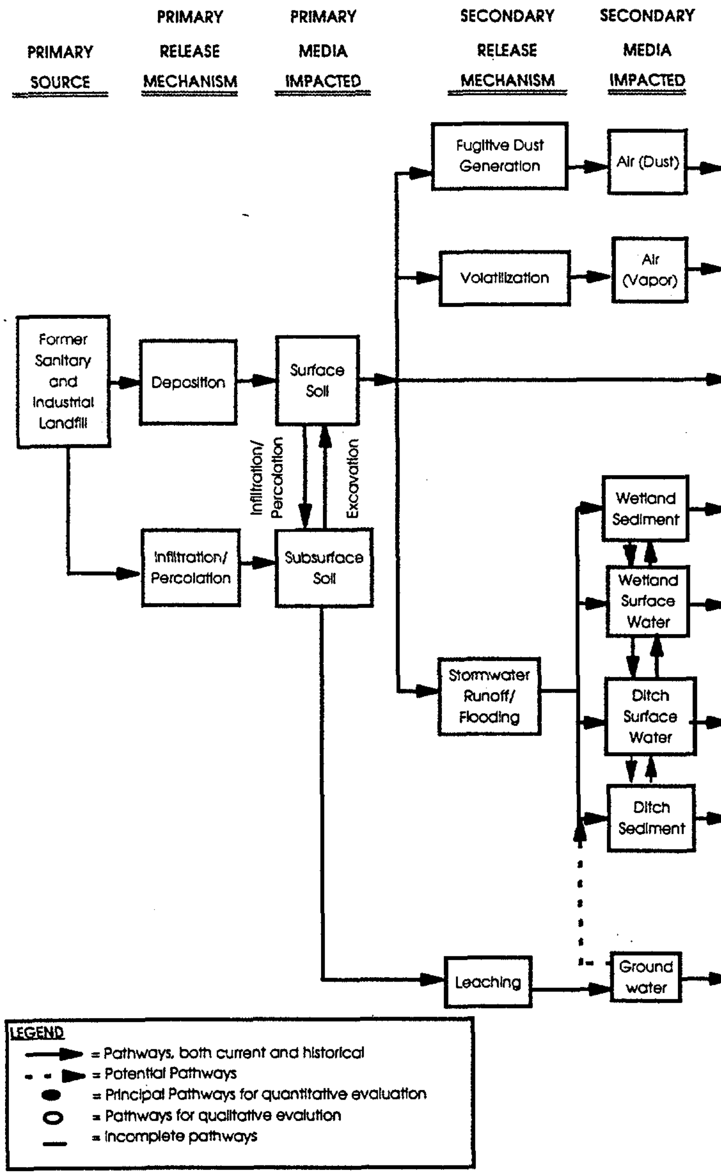
RSA-60

PARSONS ENGINEERING SCIENCE, INC.

ECOLOGICAL CONCEPTUAL SITE MODEL FOR RSA-53: FORMER SANITARY AND INDUSTRIAL LANDFILL REDSTONE ARSENAL



HUMAN HEALTH CONCEPTUAL SITE MODEL FOR RSA-60: FORMER SANITARY AND INDUSTRIAL LANDFILL REDSTONE ARSENAL



	POTENTIAL RECEPTORS			
	CURRENT		FUTURE	
EXPOSURE ROUTE	Recreational Trespasser	Industrial Worker	Recreational Trespasser	Industrial Worker
Inhalation	●	●	●	●
Inhalation	●	●	●	●
Ingestion	●	●	●	●
Dermal Contact	●	●	●	●
Ingestion	O	—	O	—
Dermal Contact	●	—	●	—
Ingestion	O	—	O	—
Dermal Contact	●	—	●	—
Ingestion	O	—	O	—
Dermal Contact	●	—	●	—
Ingestion	O	—	O	—
Dermal Contact	●	—	●	—
Ingestion	—	—	—	●
Inhalation	—	—	—	O
Dermal Contact	—	—	—	●

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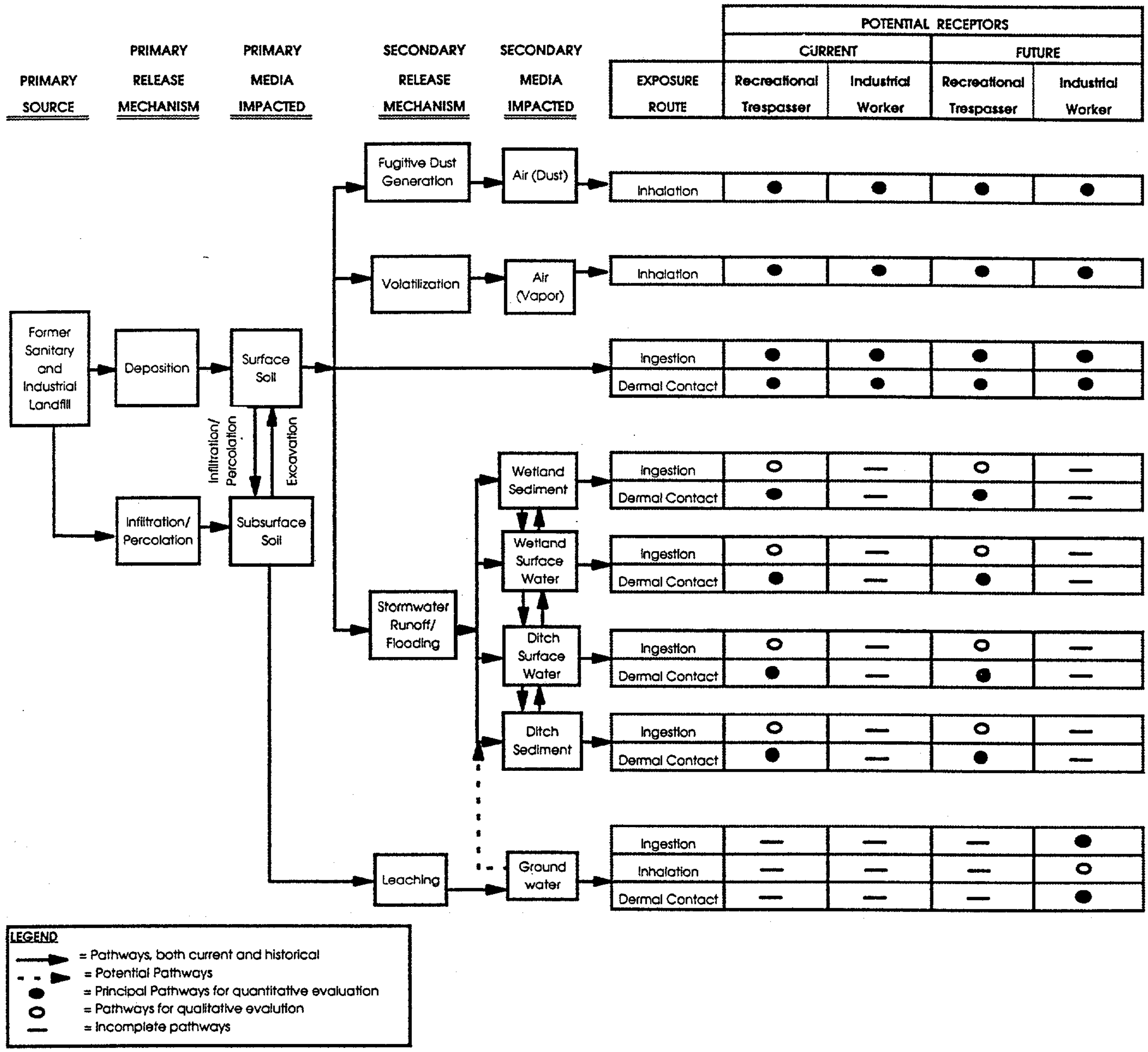
RSA-60

HUMAN HEALTH CONCEPTUAL SITE MODEL FOR RSA-53: FORMER SANITARY AND INDUSTRIAL LANDFILL REDSTONE ARESENAL



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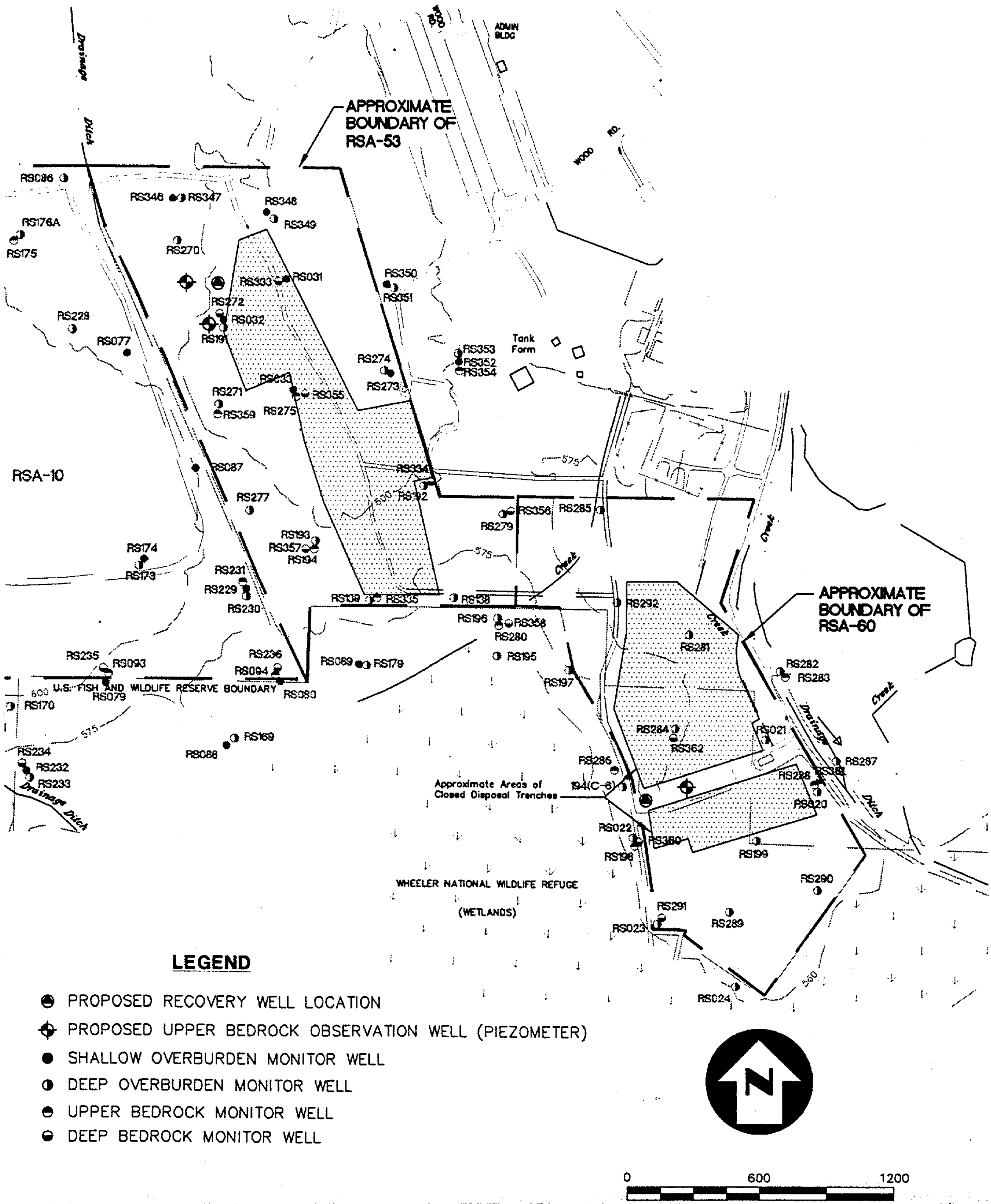
RSA-53

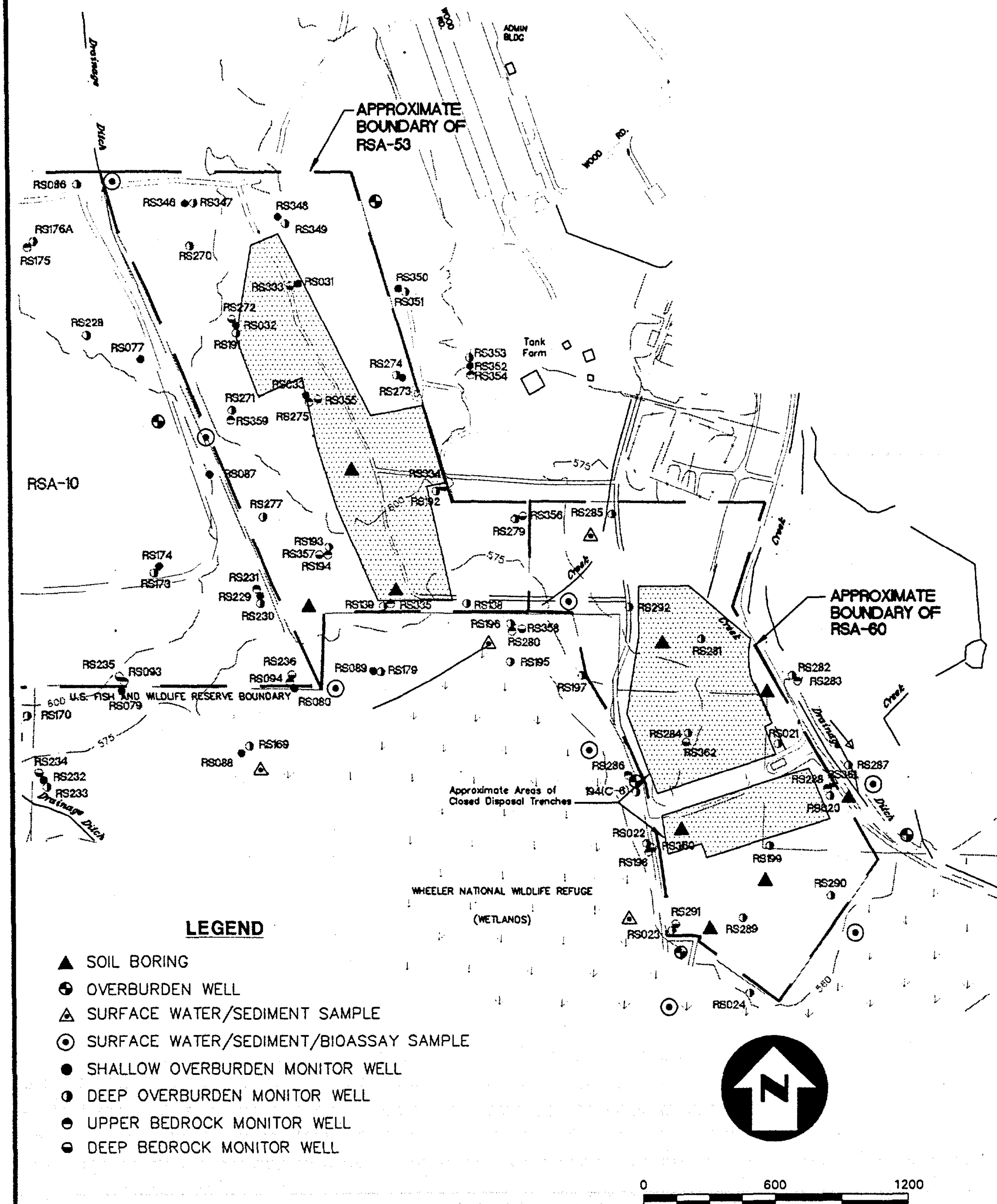
PROPOSED RECOVERY AND OBSERVATION WELL LOCATIONS

RSA-53 AND RSA-60 (GROUP X4B)
REDSTONE ARSENAL



AFTER GERAGHTY & MILLER, 1993.

PROPOSED SAMPLE LOCATION MAP
RSA-53 AND RSA-60 (GROUP X4B)
REDSTONE ARSENAL



AFTER GERAGHTY & MILLER, 1993.

PARSONS ENGINEERING SCIENCE, INC.

Table 4.1 Group X4B
Existing Monitoring Wells for Groundwater Sampling

RSA-53		RSA-60		RSA-10	
Well Name	Aquifer	Well Name	Aquifer	Well Name	Aquifer
RS031	Shallow Overburden	RS020	Deep Overburden	RS169	Deep Overburden
RS032	Shallow Overburden	RS021	Deep Overburden	RS173	Deep Overburden
RS033	Shallow Overburden	RS022	Deep Overburden	RS228	Deep Overburden
RS089	Shallow Overburden	RS023	Deep Overburden	RS230	Deep Overburden
RS138	Deep Overburden	RS024	Deep Overburden	RS231	Upper Bedrock
RS139	Deep Overburden	RS197	Deep Overburden		
RS179	Deep Overburden	RS198	Upper Bedrock		
RS191	Deep Overburden	RS199	Deep Overburden		
RS192	Deep Overburden	RS281	Deep Overburden		
RS193	Deep Overburden	RS282	Deep Overburden		
RS194	Upper Bedrock	RS283	Upper Bedrock		
RS195	Deep Overburden	RS284	Deep Overburden		
RS196	Deep Overburden	RS285	Deep Overburden		
RS270	Deep Overburden	RS286	Upper Bedrock		
RS271	Deep Overburden	RS287	Deep Overburden		
RS272	Deep Bedrock	RS288	Upper Bedrock		
RS273	Shallow Overburden	RS289	Deep Overburden		
RS274	Deep Overburden	RS290	Deep Overburden		
RS275	Upper Bedrock	RS291	Deep Bedrock		
RS277	Deep Overburden	RS292	Deep Overburden		
RS279	Deep Overburden	RS360	Deep Bedrock		
RS280	Upper Bedrock	RS361	Deep Bedrock		
RS333	Deep Bedrock	RS362	Deep Bedrock		
RS334	Deep Bedrock	194(C-6)	Deep Overburden		
RS335	Upper Bedrock				
RS346	Shallow Overburden				
RS347	Deep Overburden				
RS348	Shallow Overburden				
RS349	Deep Overburden				
RS350	Shallow Overburden				
RS351	Deep Overburden				
RS352	Shallow Overburden				
RS353	Deep Overburden				
RS354	Upper Bedrock				
RS355	Deep Bedrock				
RS356	Deep Bedrock				
RS357	Deep Bedrock				
RS358	Deep Bedrock				
RS359	Upper Bedrock				

4.4.3.3 Risk Characterization

4.4.3.3.a The risk characterization section of the ERA will describe the likelihood, severity, and characteristics of adverse effects to environmental stressors present at RSA-53 and RSA-60. Hazard quotients will be developed as described in the pre-approved Work Plan (USACE, 1994).

4.4.3.4 Analysis of Risk Uncertainty

4.4.3.4.a A qualitative analysis will be made of the uncertainties associated with the ERA. The components of the uncertainty analysis are described in the pre-approved Work Plan (USACE, 1994).

4.5 DATA REPORTING

4.5.a Upon completion of all field and analytical work specified in the SAP, a QC Summary Report will be submitted by Parsons ES. The report will summarize the QC activities, non-conformance reports and the Parsons ES's review of field and laboratory data. A description of the contents of the report may be found in Section 4.5 of the General RI/FS Work Plan (Parsons ES, 1996).

SECTION 5
TASK PLAN FOR THE FEASIBILITY STUDY

5.0.a The Feasibility Study (FS) will be performed according to the procedures outlined in the *Final Work Plan to Prepare Feasibility Studies at RSA Unit 1, Unit 2, and Various Sites at Unit 3 Redstone Arsenal* (ES&E, 1994). A RCRA CMS has previously been conducted for the site (ESE, 1993). Information gathered during the CMS, as applicable, will be used during preparation of the FS.

SECTION 6
PLANS AND MANAGEMENT

6.0.a This section presents the schedule for RI activities and identifies key project personnel.

6.1 SCHEDULING

6.1.a The anticipated schedule of activities is presented as Figure 6-1. The schedule of deliverables is as follows:

Deliverable	Date
Draft - Site Characterization Report for Sites RSA-53 and RSA-60	3-Jan-97
Draft Final - Site Characterization Report for Sites RSA-53 and RSA-60	14-Feb-97
Final - Site Characterization Report for Sites RSA-53 and RSA-60	7-Apr-97
Task Order completion date	30-Jun-97

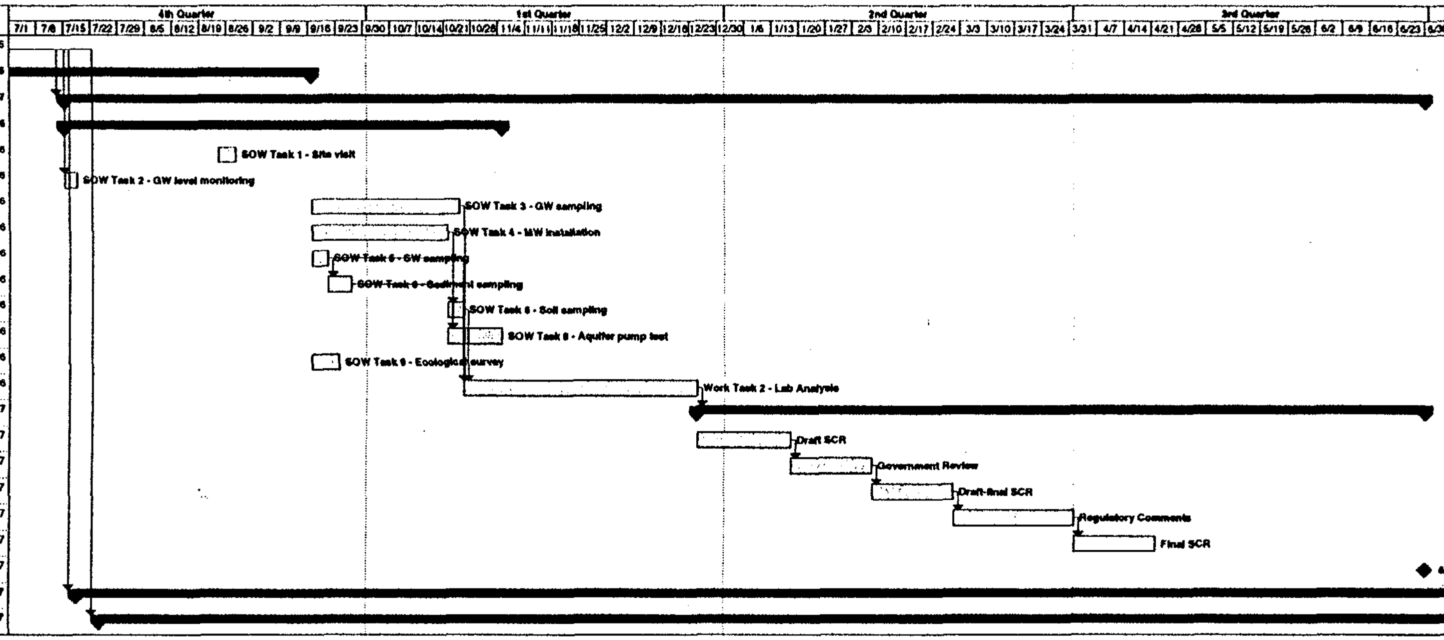
6.2 STAFFING

6.2.a Key Parsons ES personnel on this project are:

- Thomas M. Roth, P.E. Project Manager;
- Ken Stockwell, P.E. Technical Director;
- Ronda Simmons, P.G. Field Team Leader, RSA-53, -60, -66, -68;
- Alyse Getty Risk Assessment Coordinator;
- Janet Hall Quality Assurance Officer, Data Coordinator;
- Ed Grunwald Health and Safety Officer.

6.2.b The project organization is shown on Figure 6-2.

ID	Task Name	Start	Finish
1	Notice to Proceed	Fri 3/29/96	Fri 3/29/96
2	**Task Order 0005 - Plans Preparation**	**Fri 3/29/96**	**Mon 9/16/96**
8	**Task Order 0006 - Sites RSA-53, 60**	**Mon 7/15/96**	**Mon 6/30/97**
9	**Work Task 1 - Field Investigation**	**Mon 7/15/96**	**Mon 11/4/96**
10	SOW Task 1 - Site visit	Fri 8/23/96	Wed 8/28/96
11	SOW Task 2 - GW level monitoring	Mon 7/15/96	Thu 7/18/96
12	SOW Task 3 - GW sampling	Mon 9/16/96	Thu 10/24/96
13	SOW Task 4 - MW installation	Mon 9/16/96	Mon 10/21/96
14	SOW Task 5 - SW sampling	Mon 9/16/96	Fri 9/20/96
15	SOW Task 6 - Sediment sampling	Fri 9/20/96	Thu 9/26/96
16	SOW Task 6 - Soil sampling	Mon 10/21/96	Fri 10/25/96
17	SOW Task 8 - Aquifer pump test	Mon 10/21/96	Mon 11/4/96
18	SOW Task 9 - Ecological survey	Mon 9/16/96	Mon 9/23/96
19	Work Task 2 - Lab Analysis	Fri 10/25/96	Tue 12/24/96
20	**Work Task 3 - Site Characterization Report**	**Tue 12/24/96**	**Mon 6/30/97**
21	Draft SCR	Tue 12/24/96	Fri 1/17/97
22	Government Review	Fri 1/17/97	Fri 2/7/97
23	Draft-final SCR	Fri 2/7/97	Fri 2/28/97
24	Regulatory Comments	Fri 2/28/97	Mon 3/31/97
25	Final SCR	Mon 3/31/97	Mon 4/21/97
26	Contract Completion	Mon 6/30/97	Mon 6/30/97
27	**Task Order 0007 - Sites RSA-13, 14, 132, 133**	**Thu 7/18/96**	**Thu 7/31/97**
46	**Task Order 0008 - Sites RSA-66, 68**	**Wed 7/24/96**	**Tue 9/30/97**



SCHEDULE OF ACTIVITIES
REDSTONE ARSENAL

Project: Redstone Arsenal
Date: Mon 6/10/96

Task | Progress | Milestone ◆ | Summary | Rolled Up Task | Rolled Up Milestone ◇ | Rolled Up Progress

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PARSONS ENGINEERING SCIENCE, INC.

Figure 6.1

PROJECT ORGANIZATION

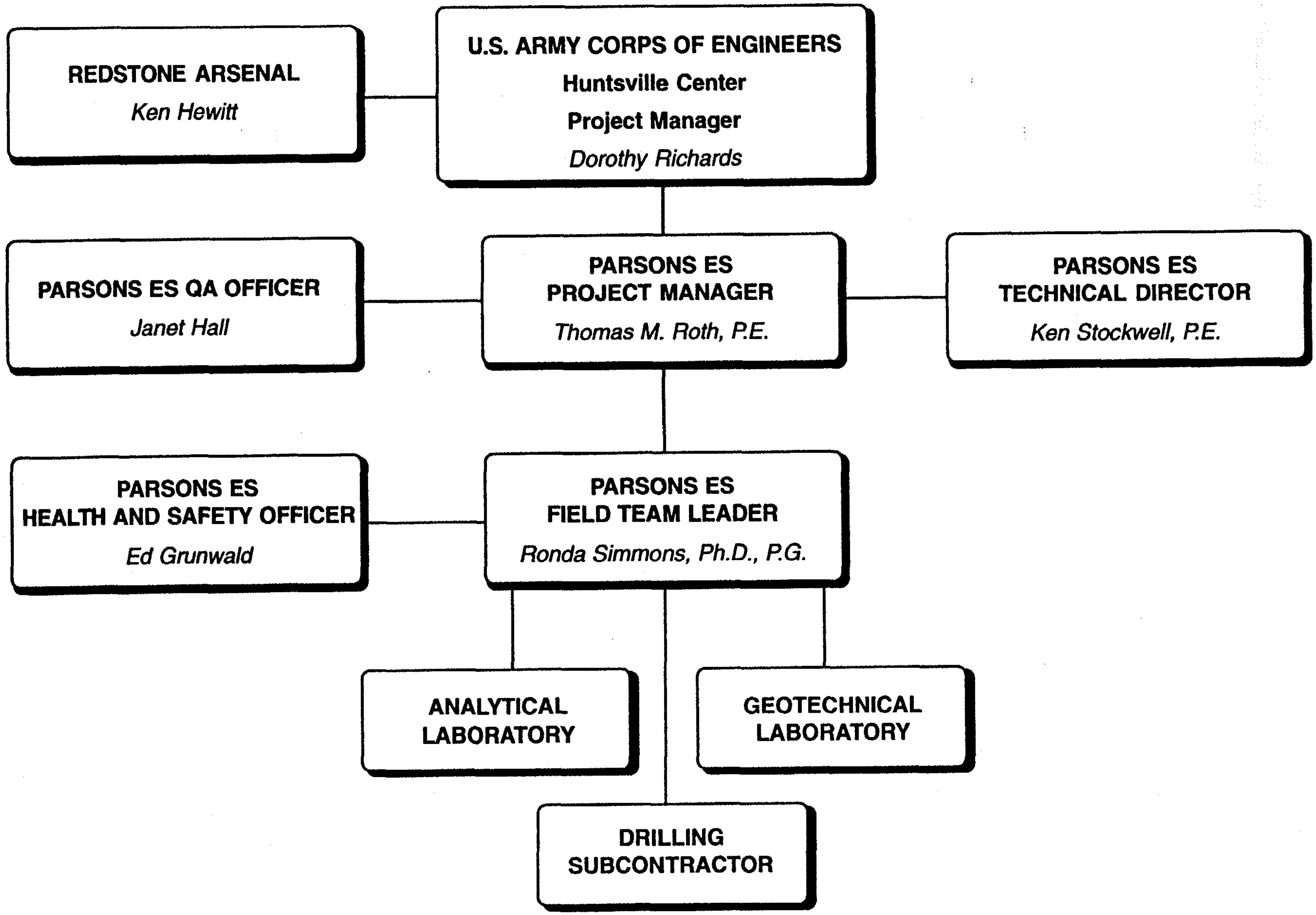

Figure 6.2

SECTION 7
REFERENCES

Environmental Science & Engineering (ESE). 1995. Internal-Draft Baseline Risk Assessment for RSA-10, RSA-53, and RSA-60. Redstone Arsenal, Alabama. Prepared for U.S. Army Corps of Engineers, Huntsville Division. Contract No. DACA-87-92-D-0018.

Environmental Science and Engineering (ESE), 1994. Final Work Plan to Prepare Feasibility Studies at RSA Unit 1, Unit 2, and Various Sites at Unit 3, Redstone Arsenal. Prepared for U.S. Army Corps of Engineers, September 1994.

Geraghty and Miller (G & M). 1991a. Phase I RCRA Facility Investigations at Unit 1, Unit 2, and Selected Unit 3 Areas. Redstone Arsenal, Alabama. Prepared for the U.S. Army Corps of Engineers, Huntsville Division. Contract No. DACA87-89-C-0075.

Geraghty and Miller (G & M). 1991b. Final Identification and Evaluation of Potential Solid Waste Management Units and Areas of Concern. Redstone Arsenal, Alabama. Prepared for the U.S. Army Corps of Engineers, February 1991.

Geraghty and Miller (G & M). 1991c. Quality Control Summary Report, Phase I RCRA Facility Investigations at Unit 1, Unit 2, and Selected Unit 3 Areas. Redstone Arsenal, Alabama. Prepared for the U.S. Army Corps of Engineers.

Geraghty and Miller (G & M). 1992a. Phase II Addendum RCRA Facility Investigations at Unit 1, Unit 2, and Selected Unit 3 Areas. Redstone Arsenal, Alabama. Prepared for the U.S. Army Corps of Engineers, Huntsville Division. Contract No. DACA87-89-C-0075.

Geraghty and Miller (G & M). 1992b. Quality Control Summary Report, Phase II RCRA Facility Investigations at Unit 1, Unit 2, and Selected Unit 3 Areas. Redstone Arsenal, Alabama. Report Prepared for the U.S. Army Corps of Engineers, October 1992.

LaMoreaux, P. E. and Associates (PELA). 1988a. Confirmation Report, Unit 3 Investigations, Redstone Arsenal, Alabama. Volumes I through VI. Report Prepared for U.S. Army Corps of Engineers, July 1988.

APPENDIX A
INSTALLATION RESTORATION PROGRAM
SAFETY AND HEALTH PLAN

SITE SPECIFIC SAFETY AND HEALTH PLAN FOR SITES RSA-53 AND RSA-60 (GROUP X4B) REDSTONE ARSENAL, ALABAMA

PREPARED FOR

U.S. ARMY CORPS OF ENGINEERS
HUNTSVILLE CENTER
Huntsville, Alabama

Contract No. DACA 87-95-D0018
Task Order No. 0005

PREPARED BY

PARSONS ENGINEERING SCIENCE, INC
57 Executive Park South, N.E.
Suite 500
Atlanta, Georgia 30329

June 1996

Reviewed and Approved:

Thomas M. Roth, P.E.
Project Manager

Edward L. Grunwald, C.I.H.
Health and Safety Officer

TABLE OF CONTENTS

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SECTION 1
PURPOSE AND POLICY

1.0.a The purpose of this Site Safety and Health Plan (SSHP) is to identify safety and health (S&H) policies, practices, and procedures to be followed during field activities at Sites RSA-53 and RSA-60 (former industrial and sanitary landfills) at Redstone Arsenal, Alabama. The site activities will be conducted in support of a remedial investigation/feasibility study (RI/FS) under Delivery Order 0005 of Contract Number DACA87-95-D-0018. All work performed under this contract will be in compliance with the Ordnance Management Plan (Appendix C, Generic RI/FS Work Plan, Parsons ES, 1996).

1.0.b The provisions of this Plan represent mandatory minimum requirements for activities conducted during the field work at these sites. This Plan meets the requirements of the Occupational Safety and Health Administration's (OSHA) final rule on Hazardous Waste Operations and Emergency Response (29 CFR 1910.120). Any supplemental plans used by subcontractors shall conform to this Plan at a minimum. The provisions of this Plan are applicable to Parsons Engineering Science (Parsons ES) personnel and subcontractors. Personnel who engage in activities covered by this Plan shall be familiar with its contents and comply with its requirements.

1.0.c This SSHP is supplemented with a generic Safety and Health Plan (SHP). As previously described, the SSHP provides site- and activity-specific S&H protocols and procedures to be used during field operations at RSA-53 and RSA-60. The SHP establishes *general* personnel protective standards, safety practices, and safety procedures for use during all remedial investigation/feasibility study (RI/FS) activities at Redstone Arsenal. The generic document is intended to provide guidance to contractors in preparing the SSHP, stipulate consistent S&H related activities for the site, and aid in the cost-effective production of SSHPs.

SECTION 2
PROJECT TEAM ORGANIZATION

2.0.a The following personnel are designated to perform the stated job function for this project:

Project Manager	Tom Roth, P.E.
Project Safety & Health Officer	Ed Grunwald, C.I.H.
Site Safety & Health Officer	Cindy Lewis
Field Team Leader	Ronda Simmons, Ph.D, P.G.
Field Team Member	TBD

Table 2.1 lists project team responsibilities.

Table 2.1 Field Activities Supporting RI/FS
RSA-53 and RSA-60
Redstone Arsenal
Project Team Responsibilities

Title	General Description	Responsibilities
Project Manager	Reports to upper-level management. Has authority to direct response operations. Controls site activities.	• Ensures that the Work Plan is completed on schedule. • Serves as the liaison with public officials. • Uses the Project Safety and Health Officer to ensure that safety and health requirements are met. • Assigns personnel to develop Work Plan and Site Safety and Health Plan (SSHP). • Coordinates activities with appropriate officials. • Briefs the field team on specific assignments. • Prepares the final report and support files on the response activities.
Project Safety and Health Officer	Advises the Project Manager on all aspects of safety and health.	• Confirms each team member's suitability based upon training and medical surveillance report. • Develops Site Safety and Health Plan • Selects Site Safety and Health Officer • Conducts periodic inspections to determine if the SSHP is being followed.
Site Safety and Health Officer	Informs Project Safety and Health Officer of site safety and health issues. Stops work if any operation threatens workers or public.	• Periodically inspects protective clothing and equipment. • Conducts daily safety and health inspections. • Maintains a safety and health logbook. • Ensures that protective clothing and equipment are properly stored and maintained. • Monitors the work parties for signs of stress, such as cold stress and fatigue. • Implements the SSHP. • Enforces the "buddy" system.

Table 2.1 (Continued) Field Activities Supporting RI/FS RSA-53 and RSA-60 Redstone Arsenal Project Team Responsibilities

Title	General Description	Responsibilities
Site Safety and Health Officer (Continued)		• Knows emergency procedures, evacuation routes, and the telephone numbers of the ambulance, local hospital, poison control center, fire department, and police department. • Ensures decontamination lines and decontamination solutions are appropriate for the type of chemical contamination on the site. • Controls the decontamination of all equipment, personnel and samples from the contaminated areas. • Assures proper disposal of contaminated clothing and materials.
Field Team Leader	Responsible for field team operations.	• Manages field operations. • Executes the Work Plan. • Enforces safety procedures. • Coordinates with the Site Safety and Health Officer in determining protection level. • Enforces site control. • Documents field activities and sample collection. • Serves as a site liaison with public officials. • Controls entry and exit at the Access Control Points.
Field Team Members	Other ES personnel and subcontractor entering site to conduct activities covered by plan.	• Safely complete the on-site tasks required to fulfill the Work Plan. • Read and comply with SSHP. • Notify Site Safety and Health Officer or Field Team leader of suspected unsafe conditions. • Practice the "buddy" system.

SECTION 3
SCOPE OF WORK AND SITE DESCRIPTIONS

3.0.a Parsons ES has been contracted by the U.S. Army Corps of Engineers, Huntsville District (CESHND) to conduct field activities supporting remedial investigation/feasibility studies at two sites at Redstone Arsenal (RSA). The sites included under this phase of activities are:

- RSA-53, Inactive Sanitary and Industrial Landfill; and
- RSA-60, Inactive Sanitary and Industrial Landfill;

3.0.b The locations and descriptions of the study sites are provide in the RSA-53 and 60 RI/FS Work Plan. The following sections summarize the scope of work to be performed and provide background information on each of the areas to be visited. This information was excerpted from ESE, 1996.

3.1 SCOPE OF WORK

3.1.a The scope of work covered by this SSHP includes:

- installation of deep overburden groundwater monitoring wells. Borings will be conducted by drill rig and mud rotary methods;
- groundwater level measurements;
- groundwater sampling;
- surface water sampling;
- sediment sampling;
- soil sampling using hand augers and split spoons; and
- aquifer pump tests;

3.1.b These activities will be conducted in order to provide sufficient data for completion of a baseline risk assessment and remedial action feasibility study for RSA-53 and RSA-60. Field activities should be conducted in late summer and should be completed within one calendar month.

SECTION 4
PHYSICAL AND CHEMICAL HAZARD ANALYSIS

4.0.a This section describes the physical and chemical hazards associated with the field investigations at RSA-53 and RSA-60. General hazards and S&H concerns are addressed in Appendix A (Generic Safety and Health Plan) of the Generic RI/FS Work Plan.

4.1 PHYSICAL AND CHEMICAL HAZARDS AT RSA-53 AND RSA-60

4.1.a Field activities planned for RSA-53 and RSA-60 (to include monitoring well installations, groundwater sampling, surface water sampling, sediment sampling, soil sampling, and aquifer pump testing) could result in employee exposure via several pathways, including inhalation exposure to volatiles from all media (including subsurface soil and sediment), and semi- and non-volatiles adhering to particulates. Monitoring well installation could also result in dermal exposure to contaminants of subsurface soil. Therefore, no chemical class or media can be excluded from evaluation.

4.1.b General pathways for exposure during field investigation activities at RSA along with potential chemical and physical hazards are included in Table 4.1 in Appendix A (General Safety and Health Plan) of the General RI/FS Work Plan.. Additional physical hazards posed by the specific activities to be conducted at this site include:

- slip, trip, and fall hazards during mud rotary drilling, and
- dermal contact with drilling mud and entrained contaminated soil.

4.1.c Drilling safety practices will be in accordance with Corps of Engineers EM385-1-1 16.M. The following is a partial list of the safety practices that will be required:

- Drilling equipment will operated, inspected, and maintained as specified in the manufacturer's operating manual;
- Prior to brining drilling equipment to the job site, a survey will be performed to identify potential hazards;
- Training for all drilling crews;

Table 4.1 Exposure Point Concentrations of Chemicals of Potential Concern at RSA-53

MEDIA	CHEMICAL	CONCENTRATION
Groundwater	Arsenic	0.0105 mg/l
	Barium	0.319 mg/l
	Lead	0.0510 mg/l
	Mercury	0.00041 mg/l
	Benzene	0.0230 mg/l
	Carbon tetrachloride	0.182 mg/l
	Chloroform	7.21 mg/l
	Chlorobenzene	15.4 mg/l
	1,2-dichloroethane	0.182 mg/l
	Methylene chloride	1.15 mg/l
	Vinyl Chloride	0.0080 mg/l
	Chlordane	0.0042 mg/l
	DDT	0.178 mg/l
	Endrin	0.00016 mg/l

Notes:

*Exposure point concentrations were excerpted from ESE, 1996. They represent the 95% UCL value of concentrations detected during the Phase I and II investigations, as determined and reported by ESE. If the number of samples precluded determination of the 95% UCL, the maximum values were reported.

Although exposure to non-volatiles in groundwater is not typically a hazard, the use of mud rotary drilling increases the potential for entraining groundwater in the drilling mud, with subsequent aerosolization.

SECTION 5
PERSONAL PROTECTIVE EQUIPMENT

5.0.a The initial Personal protective equipment (PPE) levels to be employed for each planned activity at RSA-53 and RSA-60, are shown in Tables 5.1 and 5.2, respectively. The appropriate equipment to be used for each respective PPE level is provided in Appendix A (Generic Safety and Health Plan) of the Generic RI/FS Work Plan. The level of PPE employed at each activity is subject to change, based on air monitoring results and as stipulated in Section 6.

TABLE 5.1 PERSONAL PROTECTIVE EQUIPMENT LEVEL FOR RSA-53

Activity	PPE Level
Installing groundwater monitoring wells	D
Measuring groundwater level	D
Sampling groundwater	D
Sampling soil	D
Aquifer pump test	D
Biota sampling	D

TABLE 5.2 PERSONAL PROTECTIVE EQUIPMENT LEVEL FOR RSA-60

Activity	PPE Level
Installing groundwater monitoring wells	D
Measuring groundwater level	D
Sampling groundwater	D

SECTION 6
AIR MONITORING AND ACTION LEVELS

6.0.a Air monitoring at RSA-53 and RSA-60 will be conducted in accordance with the guidelines presented in Appendix A (Generic Safety and Health Plan) of the Generic RI/FS Work Plan. In addition, for each potential exposure pathway, worst case air concentrations were calculated and compared with the permissible exposure limits. The potential for overexposure to one or a combination of similar acting chemicals during each phase of activity was evaluated. Air monitoring requirements were then established based on that evaluation.

6.1 AIR MONITORING AT RSA-53

6.1.a Evaluation of potential worst case air concentrations based on concentrations of contaminants detected in groundwater at RSA-53 indicate that the potential exists for exposure exceeding the permissible exposure limit. Also, both benzene and vinyl chloride (VC) have been detected in the groundwater at RSA-53. Therefore, in accordance with the requirements in the generic SHP, air monitoring will be conducted utilizing both OVA (FID) and colorimetric tubes during all activities involving contact with groundwater, including well installation, water level measurements, sampling groundwater, and conducting aquifer pump tests. Evaluation of concentrations detected in other media (soil and sediment) indicate that no potential exists for exceeding permissible exposure limits during the proposed activities. Therefore, no additional air monitoring is warranted at this site. However, care will be taken to avoid particulate (both water and soil) generation during mud rotary drilling.

6.2.b In addition, although concentrations of pesticides in sediments are sufficiently low that air monitoring for volatiles or dust is not warranted, because of the highly toxic and persistent nature of the pesticides, measures will be taken to ensure that the sediments remain damp, to avoid dust generation during their handling.

APPENDIX A.1
EXPOSURE POINT CONCENTRATIONS

Area	Medium	Chemical Name	List Code	Exposure Concentration	Units	EC is Only, Max, or UCL95	Phase from which EC Obtained
RSA-10	Groundwater	Acetone	ACET	4.39E-02	mg/L	UCL95	I
RSA-10	Groundwater	Arsenic	AS	5.68E-03	mg/L	UCL95	I
RSA-10	Groundwater	Barium	BA	9.02E-02	mg/L	UCL95	I
RSA-10	Groundwater	Benzene	C6H6	8.82E-03	mg/L	UCL95	I
RSA-10	Groundwater	Benzoic acid	BENZOA	6.00E-03	mg/L	Max	I
RSA-10	Groundwater	Bis(2-ethylhexyl) phthalate	B2EHP	2.04E-01	mg/L	UCL95	I
RSA-10	Groundwater	Cadmium (in aqueous matrix)	CD-A*	3.35E-03	mg/L	UCL95	I
RSA-10	Groundwater	Chlorobenzene	CLC6H5	4.08E-03	mg/L	UCL95	I
RSA-10	Groundwater	Chloroethane	C2H5CL	7.51E-03	mg/L	UCL95	I
RSA-10	Groundwater	Chloroform	CHCL3	3.75E-03	mg/L	UCL95	I
RSA-10	Groundwater	Chromium	CR	4.49E-02	mg/L	UCL95	I
RSA-10	Groundwater	Dichlorobenzene, p-	14DCLB	6.66E-03	mg/L	Max	I
RSA-10	Groundwater	Dichloroethane, 1,1-	11DCLE	1.90E-02	mg/L	UCL95	I
RSA-10	Groundwater	Dichloroethane, 1,2-	12DCLE	3.65E-03	mg/L	UCL95	I
RSA-10	Groundwater	Dichloroethene, 1,1-	11DCE	6.49E-03	mg/L	UCL95	I
RSA-10	Groundwater	Dichloroethenes, 1,2-, total	12DCE	2.48E-02	mg/L	UCL95	I
RSA-10	Groundwater	Dichloropropane, 1,2-	12DCLP	3.76E-03	mg/L	UCL95	I
RSA-10	Groundwater	Dichloropropane, 1,3-	13DCP	3.90E-03	mg/L	UCL95	I
RSA-10	Groundwater	Ethylbenzene	ETC6H5	7.97E-03	mg/L	UCL95	I
RSA-10	Groundwater	Fluorene	FLRENE	6.00E-03	mg/L	Max	I
RSA-10	Groundwater	Lead	PB	5.10E-03	mg/L	UCL95	I
RSA-10	Groundwater	Mercury	HG	6.50E-04	mg/L	UCL95	I
RSA-10	Groundwater	Methylene chloride	CH2CL2	1.31E-02	mg/L	UCL95	I
RSA-10	Groundwater	Methylnaphthalene, 2-	2MNAP	8.42E-03	mg/L	UCL95	I
RSA-10	Groundwater	Naphthalene	NAP	6.91E-03	mg/L	UCL95	I
RSA-10	Groundwater	Phenanthrene	PHANTR	5.00E-03	mg/L	Max	I
RSA-10	Groundwater	Selenium	SE	3.81E-03	mg/L	UCL95	I
RSA-10	Groundwater	Tetrachloroethane, 1,1,2,2-	TCLEA	4.79E-03	mg/L	UCL95	I
RSA-10	Groundwater	Tetrachloroethene	TCLEE	4.75E-03	mg/L	UCL95	I
RSA-10	Groundwater	Toluene	MEC6H5	1.84E-02	mg/L	UCL95	I
RSA-10	Groundwater	Trichloroethane, 1,1,1-	111TCE	7.45E-03	mg/L	UCL95	I
RSA-10	Groundwater	Trichloroethene	TRCLE	5.11E-02	mg/L	UCL95	I
RSA-10	Groundwater	Vinyl chloride	C2H3CL	6.73E-03	mg/L	UCL95	I
RSA-10	Groundwater	Xylenes, total	XYLEN	3.43E-02	mg/L	UCL95	I
RSA-10	Sediment	Acetone	ACET	2.08E-01	mg/kg	UCL95	I
RSA-10	Sediment	Aldrin	ALDRN	2.00E-02	mg/kg	Max	I
RSA-10	Sediment	Arsenic	AS	4.30E+00	mg/kg	Max	I
RSA-10	Sediment	Barium	BA	6.92E+01	mg/kg	Max	I
RSA-10	Sediment	Benzo(b)fluoranthene	BBFANT	1.10E-01	mg/kg	Max	I
RSA-10	Sediment	Benzo(ghi)perylene	BGHIPY	1.30E-01	mg/kg	Max	I
RSA-10	Sediment	Benzo(k)fluoranthene	BKFANT	1.20E-01	mg/kg	Max	I
RSA-10	Sediment	Bis(2-ethylhexyl) phthalate	B2EHP	1.20E-01	mg/kg	Max	I
RSA-10	Sediment	Chlordane, total	CLDAN	3.00E-02	mg/kg	Max	I
RSA-10	Sediment	Chromium	CR	8.85E+01	mg/kg	Max	I
RSA-10	Sediment	DDD, p,p'-	PPDDD	7.22E-01	mg/kg	UCL95	I
RSA-10	Sediment	DDE, p,p'-	PPDDE	4.02E-01	mg/kg	UCL95	I
RSA-10	Sediment	DDT, p,p'-	PPDDT	3.20E-01	mg/kg	Max	I
RSA-10	Sediment	Dibenz(ah)anthracene	DBAHA	1.10E-01	mg/kg	Max	I
RSA-10	Sediment	Dieldrin	DLDRN	5.00E-02	mg/kg	Max	I
RSA-10	Sediment	Diethyl phthalate	DEP	1.40E-01	mg/kg	Max	I
RSA-10	Sediment	Endrin	ENDRN	5.00E-02	mg/kg	Max	I
RSA-10	Sediment	Heptachlor	HPCL	2.00E-02	mg/kg	Max	I
RSA-10	Sediment	Indeno(1,2,3-cd)pyrene	ICDPYR	1.30E-01	mg/kg	Max	I
RSA-10	Sediment	Lead	PB	1.18E+01	mg/kg	UCL95	I
RSA-10	Sediment	Lindane	LIN	2.00E-02	mg/kg	Max	I
RSA-10	Sediment	Mercury	HG	2.10E-01	mg/kg	UCL95	I
RSA-10	Sediment	Methylene chloride	CH2CL2	8.79E-03	mg/kg	UCL95	I
RSA-10	Sediment	Selenium	SE	1.24E+00	mg/kg	UCL95	I
RSA-10	Shallow Soil	Acenaphthene	ANAPNE	1.30E+00	mg/kg	Max*	I
RSA-10	Shallow Soil	Acetone	ACET	7.20E+00	mg/kg	Max*	II
RSA-10	Shallow Soil	Benzene	C6H6	1.00E-02	mg/kg	Max*	II
RSA-10	Shallow Soil	Benzoic acid**	BENZOA	7.50E-01	mg/kg	Max*	I
RSA-10	Shallow Soil	Bis(2-ethylhexyl) phthalate**	B2EHP	4.90E-01	mg/kg	Max*	I

Area	Medium	Chemical Name	List Code	Exposure Concentration	Units	EC is Only, Max, or UCL95	Phase from which EC Obtained
RSA-10	Shallow Soil	Chloro-m-cresol, 4-	4CL3C	2.60E+00	mg/kg	Max*	I
RSA-10	Shallow Soil	Chlorophenol, o-	2CLP	2.60E+00	mg/kg	Max*	I
RSA-10	Shallow Soil	Dichlorobenzene, p-	14DCLB	1.30E+00	mg/kg	Max*	I
RSA-10	Shallow Soil	Dichloroethenes, 1,2-, total**	12DCE	5.00E-03	mg/kg	Max*	I
RSA-10	Shallow Soil	Dinitrotoluene, 2,4-	24DNT	1.60E+00	mg/kg	Max*	I
RSA-10	Shallow Soil	Methylene chloride**	CH2CL2	1.50E-02	mg/kg	Max*	I
RSA-10	Shallow Soil	Nitrophenol, 4-	4NP	2.00E+00	mg/kg	Max*	I
RSA-10	Shallow Soil	Nitrosodi-N-propylamine, N-	NNDNPA	1.60E+00	mg/kg	Max*	I
RSA-10	Shallow Soil	Pentachlorophenol	PCP	1.10E+00	mg/kg	Max*	I
RSA-10	Shallow Soil	Phenol	PHENOL	2.60E+00	mg/kg	Max*	I
RSA-10	Shallow Soil	Pyrene	PYR	1.40E+00	mg/kg	Max*	I
RSA-10	Shallow Soil	Tetrachloroethene**	TCLEE	2.90E-02	mg/kg	Max*	I
RSA-10	Shallow Soil	Toluene	MEC6H5	4.20E-01	mg/kg	Max*	II
RSA-10	Shallow Soil	Trichlorobenzene, 1,2,4-	124TCB	1.70E+00	mg/kg	Max*	I
RSA-10	Shallow Soil	Trichloroethene**	TRCLE	1.30E-01	mg/kg	Max*	I
RSA-10	Shallow Soil	Xylenes, total**	XYLEN	5.40E-02	mg/kg	Max*	I
RSA-10	Surface Water	Acetone	ACET	5.00E-02	mg/L	Max	I
RSA-10	Surface Water	Barium	BA	9.33E-02	mg/L	Max	I
RSA-10	Surface Water	Bis(2-ethylhexyl) phthalate	B2EHP	9.00E-03	mg/L	Max	I
RSA-10	Surface Water	Chromium	CR	6.20E-03	mg/L	Max	I
RSA-10	Surface Water	DDT, p,p'-	PPDDT	8.00E-05	mg/L	Max	I
RSA-10	Surface Water	Dieldrin	DLDRN	8.00E-05	mg/L	Max	I
RSA-10	Surface Water	Heptachlor	HPCL	2.00E-05	mg/L	Max	I
RSA-10	Surface Water	Methylene chloride	CH2CL2	1.60E-02	mg/L	Max	I
RSA-53	Groundwater	Acetone	ACET	8.89E-01	mg/L	UCL95	I/II
RSA-53	Groundwater	Aldrin	ALDRN	7.00E-04	mg/L	UCL95	I/II
RSA-53	Groundwater	Arsenic	AS	1.05E-02	mg/L	UCL95	I
RSA-53	Groundwater	BHC, alpha-	ABHC	3.60E-03	mg/L	UCL95	I/II
RSA-53	Groundwater	BHC, beta-	BBHC	7.80E-04	mg/L	Max	II
RSA-53	Groundwater	BHC, delta-	DBHC	1.60E-04	mg/L	Max	II
RSA-53	Groundwater	Barium	BA	3.19E-01	mg/L	UCL95	I
RSA-53	Groundwater	Benzene	C6H6	2.30E-02	mg/L	Max	I
RSA-53	Groundwater	Benzoic acid	BENZOA	4.40E-02	mg/L	UCL95	I
RSA-53	Groundwater	Bis(2-chloroethyl) ether	B2CLEE	3.00E-03	mg/L	Max	I
RSA-53	Groundwater	Bis(2-ethylhexyl) phthalate	B2EHP	1.90E-01	mg/L	UCL95	I
RSA-53	Groundwater	Cadmium (in aqueous matrix)	CD-A*	1.21E-02	mg/L	UCL95	I
RSA-53	Groundwater	Carbon tetrachloride	CCL4	1.82E-01	mg/L	UCL95	I/II
RSA-53	Groundwater	Chlordane, total	CLDAN	4.20E-03	mg/L	UCL95	I/II
RSA-53	Groundwater	Chlorobenzene	CLC6H5	1.54E+01	mg/L	UCL95	I/II
RSA-53	Groundwater	Chloroform	CHCL3	7.21E+00	mg/L	UCL95	I/II
RSA-53	Groundwater	Chlorophenol, o-	2CLP	7.60E-02	mg/L	UCL95	I
RSA-53	Groundwater	Chromium	CR	1.66E-01	mg/L	Max	I
RSA-53	Groundwater	Cresol, p-	4MP	4.00E-03	mg/L	Max	I
RSA-53	Groundwater	DDD, p,p'-	PPDDD	3.00E-02	mg/L	UCL95	I/II
RSA-53	Groundwater	DDE, p,p'-	PPDDE	2.49E-02	mg/L	UCL95	I/II
RSA-53	Groundwater	DDT, p,p'-	PPDDT	1.78E-01	mg/L	UCL95	I/II
RSA-53	Groundwater	Dichlorobenzene, o-	12DCLB	7.00E-03	mg/L	UCL95	I
RSA-53	Groundwater	Dichlorobenzene, p-	14DCLB	2.10E-02	mg/L	UCL95	I
RSA-53	Groundwater	Dichloroethane, 1,2-	12DCLE	1.82E-01	mg/L	UCL95	I/II
RSA-53	Groundwater	Dichloroethenes, 1,2-, total	12DCE	1.74E-01	mg/L	UCL95	I/II
RSA-53	Groundwater	Dichloropropene, cis-1,3-	C13DCP	4.10E-02	mg/L	Max	I
RSA-53	Groundwater	Dieldrin	DLDRN	6.00E-04	mg/L	UCL95	I/II
RSA-53	Groundwater	Diethyl phthalate	DEP	1.00E-02	mg/L	Max	I
RSA-53	Groundwater	Endrin	ENDRN	1.60E-04	mg/L	Max	I
RSA-53	Groundwater	Heptachlor epoxide	HPCLE	3.00E-05	mg/L	Max	II
RSA-53	Groundwater	Hexachloroethane	CL6ET	4.40E-02	mg/L	UCL95	I
RSA-53	Groundwater	Lead	PB	5.10E-02	mg/L	UCL95	I
RSA-53	Groundwater	Lindane	LIN	1.20E-03	mg/L	UCL95	I/II
RSA-53	Groundwater	Mercury	HG	4.10E-04	mg/L	Max	I
RSA-53	Groundwater	Methyl ethyl ketone	MEK	1.60E-02	mg/L	Max	II
RSA-53	Groundwater	Methyl n-butyl ketone	MNBK	2.76E-01	mg/L	UCL95	I/II
RSA-53	Groundwater	Methylene chloride	CH2CL2	1.15E+00	mg/L	UCL95	I/II
RSA-53	Groundwater	Phenol	PHENOL	1.30E-02	mg/L	UCL95	I

Area	Medium	Chemical Name	List Code	Exposure Concentration	Units	EC is Only, Max, or UCL95	Phase from which EC Obtained
RSA-53	Groundwater	Selenium	SE	2.85E-03	mg/L	UCL95	I
RSA-53	Groundwater	Tetrachloroethane, 1,1,2,2-	TCLEA	1.90E-02	mg/L	Max	I
RSA-53	Groundwater	Tetrachloroethene	TCLEE	5.00E-03	mg/L	Max	II
RSA-53	Groundwater	Toluene	MEC6H5	6.00E-03	mg/L	Max	II
RSA-53	Groundwater	Trichloroethane, 1,1,1-	111TCE	7.00E-03	mg/L	Max	I
RSA-53	Groundwater	Trichloroethene	TRCLE	1.50E-01	mg/L	Max	I
RSA-53	Groundwater	Vinyl chloride	C2H3CL	8.00E-03	mg/L	Max	I
RSA-53	Sediment	Acetone	ACET	2.80E-02	mg/kg	Only	I
RSA-53	Sediment	Arsenic	AS	2.50E+00	mg/kg	Only	I
RSA-53	Sediment	Barium	BA	3.80E+01	mg/kg	Only	I
RSA-53	Sediment	Chromium	CR	3.58E+01	mg/kg	Only	I
RSA-53	Sediment	DDD, p,p'-	PPDDD	4.00E-05	mg/kg	Only	I
RSA-53	Sediment	DDE, p,p'-	PPDDE	6.00E-05	mg/kg	Only	I
RSA-53	Sediment	Lead	PB	3.60E+00	mg/kg	Only	I
RSA-53	Sediment	Methylene chloride	CH2CL2	5.00E-03	mg/kg	Only	I
RSA-53	Shallow Soil	Acetone	ACET	2.18E-01	mg/kg	UCL95	I/II
RSA-53	Shallow Soil	Aldrin	ALDRN	4.00E-03	mg/kg	UCL95	I/II
RSA-53	Shallow Soil	Bis(2-ethylhexyl) phthalate	B2EHP	2.67E-01	mg/kg	UCL95	I
RSA-53	Shallow Soil	DDD, p,p'-	PPDDD	1.25E-01	mg/kg	UCL95	I/II
RSA-53	Shallow Soil	DDE, p,p'-	PPDDE	1.80E-02	mg/kg	UCL95	I/II
RSA-53	Shallow Soil	DDT, p,p'-	PPDDT	3.50E-02	mg/kg	UCL95	I/II
RSA-53	Shallow Soil	Diethyl phthalate	DEP	9.30E-02	mg/kg	Max	I
RSA-53	Shallow Soil	Endrin	ENDRN	1.70E-03	mg/kg	Max	I
RSA-53	Shallow Soil	Heptachlor	HPCL	1.10E-02	mg/kg	UCL95	I/II
RSA-53	Shallow Soil	Methylene chloride	CH2CL2	8.00E-03	mg/kg	UCL95	I/II
RSA-53	Shallow Soil	Trichloroethene	TRCLE	1.00E-02	mg/kg	UCL95	I/II
RSA-53	Surface Water	Barium	BA	3.99E-02	mg/L	Only	I
RSA-53	Surface Water	Methylene chloride	CH2CL2	5.00E-03	mg/L	Only	I
RSA-60	Groundwater	Acetone	ACET	8.80E-02	mg/L	UCL95	I/II
RSA-60	Groundwater	Aldrin	ALDRN	7.00E-05	mg/L	UCL95	I/II
RSA-60	Groundwater	Arsenic	AS	6.34E-03	mg/L	UCL95	I
RSA-60	Groundwater	BHC, beta-	BBHC	1.00E-05	mg/L	Max	II
RSA-60	Groundwater	Barium	BA	8.17E-01	mg/L	UCL95	I
RSA-60	Groundwater	Benzene	C6H6	6.09E-03	mg/L	UCL95	I/II
RSA-60	Groundwater	Bis(2-ethylhexyl) phthalate	B2EHP	2.00E-02	mg/L	UCL95	I
RSA-60	Groundwater	Cadmium (in aqueous matrix)	CD-A*	8.46E-03	mg/L	UCL95	I
RSA-60	Groundwater	Chlorobenzene	CLC6H5	3.71E-01	mg/L	UCL95	I/II
RSA-60	Groundwater	Chloroform	CHCL3	5.21E-03	mg/L	UCL95	I/II
RSA-60	Groundwater	Chlorophenol, o-	2CLP	2.00E-03	mg/L	Max	I
RSA-60	Groundwater	Chromium	CR	2.17E-01	mg/L	UCL95	I
RSA-60	Groundwater	DDD, p,p'-	PPDDD	1.30E-04	mg/L	UCL95	I/II
RSA-60	Groundwater	DDE, p,p'-	PPDDE	6.00E-05	mg/L	UCL95	I/II
RSA-60	Groundwater	DDT, p,p'-	PPDDT	2.20E-04	mg/L	UCL95	I/II
RSA-60	Groundwater	Dichlorobenzene, p-	14DCLB	3.00E-03	mg/L	Max	I
RSA-60	Groundwater	Dichloroethane, 1,1-	11DCLE	3.00E-03	mg/L	Max	I
RSA-60	Groundwater	Dichloroethenes, 1,2-, total	12DCE	3.00E-03	mg/L	Max	I
RSA-60	Groundwater	Dichloropropene, cis-1,3-	C13DCP	4.00E-03	mg/L	Max	I
RSA-60	Groundwater	Dichloropropene, trans-1,3-	T13DCP	5.11E-03	mg/L	UCL95	I/II
RSA-60	Groundwater	Ethylbenzene	ETC6H5	3.00E-03	mg/L	Max	I
RSA-60	Groundwater	Heptachlor	HPCL	9.00E-05	mg/L	UCL95	I/II
RSA-60	Groundwater	Lead	PB	5.00E-02	mg/L	UCL95	I
RSA-60	Groundwater	Lindane	LIN	7.00E-05	mg/L	UCL95	I/II
RSA-60	Groundwater	Methylene chloride	CH2CL2	1.18E-02	mg/L	UCL95	I/II
RSA-60	Groundwater	Selenium	SE	2.55E-03	mg/L	UCL95	I
RSA-60	Groundwater	Tetrachloroethane, 1,1,2,2-	TCLEA	3.41E-03	mg/L	UCL95	I/II
RSA-60	Groundwater	Toluene	MEC6H5	5.59E-03	mg/L	UCL95	I/II
RSA-60	Groundwater	Trichloroethene	TRCLE	7.40E-03	mg/L	UCL95	I/II
RSA-60	Groundwater	Xylenes, total	XYLEN	5.38E-03	mg/L	UCL95	I/II
RSA-60	Sediment	Acetone	ACET	1.74E-01	mg/kg	UCL95	I
RSA-60	Sediment	Aldrin	ALDRN	6.00E-02	mg/kg	Max	I

Area	Medium	Chemical Name	List Code	Exposure Concentration	Units	EC is Only, Max, or UCL95	Phase from which EC Obtained
RSA-60	Sediment	Arsenic	AS	1.84E+01	mg/kg	UCL95	I
RSA-60	Sediment	Barium	BA	3.17E+02	mg/kg	UCL95	I
RSA-60	Sediment	Bis(2-ethylhexyl) phthalate	B2EHP	1.90E-01	mg/kg	Max	I
RSA-60	Sediment	Chlorobenzene	CLC6H5	1.44E-02	mg/kg	UCL95	I
RSA-60	Sediment	Chromium	CR	3.86E+01	mg/kg	UCL95	I
RSA-60	Sediment	DDD, p,p'-	PPDDD	3.77E+00	mg/kg	UCL95	I
RSA-60	Sediment	DDE, p,p'-	PPDDE	2.98E+00	mg/kg	UCL95	I
RSA-60	Sediment	DDT, p,p'-	PPDDT	3.61E+00	mg/kg	UCL95	I
RSA-60	Sediment	Endrin	ENDRN	4.00E-02	mg/kg	Max	I
RSA-60	Sediment	Heptachlor	HPCL	2.00E-02	mg/kg	Max	I
RSA-60	Sediment	Lead	PB	2.85E+01	mg/kg	UCL95	I
RSA-60	Sediment	Lindane	LIN	2.00E-02	mg/kg	Max	I
RSA-60	Sediment	Mercury	HG	7.00E-01	mg/kg	UCL95	I
RSA-60	Sediment	Methylene chloride	CH2CL2	6.70E-02	mg/kg	Max	I
RSA-60	Sediment	Xylenes, total	XYLEN	8.49E-02	mg/kg	UCL95	I
RSA-60	Shallow Soil	Acetone	ACET	3.96E-01	mg/kg	UCL95	I
RSA-60	Shallow Soil	BHC, alpha-	ABHC	1.10E-03	mg/kg	Max	I
RSA-60	Shallow Soil	Bis(2-ethylhexyl) phthalate	B2EHP	4.23E+00	mg/kg	UCL95	I
RSA-60	Shallow Soil	Cadmium (in solid matrix)	CD-S*	1.60E+01	mg/kg	UCL95	I
RSA-60	Shallow Soil	Chlorobenzene	CLC6H5	1.50E-02	mg/kg	UCL95	I
RSA-60	Shallow Soil	DDD, p,p'-	PPDDD	1.83E-01	mg/kg	UCL95	I
RSA-60	Shallow Soil	DDE, p,p'-	PPDDE	3.04E-01	mg/kg	UCL95	I
RSA-60	Shallow Soil	DDT, p,p'-	PPDDT	1.11E-01	mg/kg	UCL95	I
RSA-60	Shallow Soil	Endrin	ENDRN	2.00E-03	mg/kg	Max	II
RSA-60	Shallow Soil	Lindane	LIN	1.00E-03	mg/kg	Max	I
RSA-60	Shallow Soil	Methylene chloride	CH2CL2	4.50E-02	mg/kg	UCL95	I
RSA-60	Shallow Soil	Xylenes, total	XYLEN	2.00E-02	mg/kg	UCL95	I
RSA-60	Surface Water	Acetone	ACET	5.10E-02	mg/L	Max	I
RSA-60	Surface Water	Aldrin	ALDRN	3.00E-04	mg/L	Max / UCL95	I
RSA-60	Surface Water	Barium	BA	1.29E-01	mg/L	Max	I
RSA-60	Surface Water	Chlordane, total	CLDAN	2.30E-04	mg/L	Max	I
RSA-60	Surface Water	Chromium	CR	1.16E-02	mg/L	Max	I
RSA-60	Surface Water	DDD, p,p'-	PPDDD	2.70E-03	mg/L	Max	I
RSA-60	Surface Water	DDE, p,p'-	PPDDE	2.00E-04	mg/L	UCL95	I
RSA-60	Surface Water	DDT, p,p'-	PPDDT	1.00E-03	mg/L	Max	I
RSA-60	Surface Water	Methylene chloride	CH2CL2	1.00E-02	mg/L	Max	I
RSA-60	Surface Water	Selenium	SE	2.05E-02	mg/L	Max	I
RSA-60	Surface Water	Tetrachloroethane, 1,1,2,2-	TCLEA	7.00E-03	mg/L	Max	I
RSA-60	Surface Water	Trichloroethene	TRCLE	6.00E-03	mg/L	Max	I

Notes:
EC = exposure concentration
mg/kg = milligram per kilogram
mg/L = milligram per liter
UCL95 = upper 95% confidence limit
Max = maximum detected concentration
Only = only one sample was taken, as a result EC is based on one sample
Max* = G&M (1992) calculated Shallow Soil UCL95s at RSA-10 exclusively for Waste Oil Pits. In addition, G&M (1992) included 4'-6' and 8'-10' samples in their Shallow Soil UCL95 calculations. Since this BRA is addressing RSA-10 as a whole and is looking at surface soil exposure (0' to 2'), Waste Oil Pit and non-Waste Oil Pit samples were included and soil depth samples of 4'-6' and 8'-10' were excluded.
** = The shallow soil exposure concentrations provided in the table are used for future workers at RSA-10, -53, and -60; current trespassers at RSA-53; and current visitors at RSA-60. However, current workers at RSA-10 are not exposed to shallow soil samples from the southern portion of RSA-10. As a result, exposure concentrations were modified as follows: benzoic acid from 7.50E-01 mg/kg to 4.88E-01 mg/kg, bis(2-ethylhexyl) phthalate from 4.90E-01 mg/kg to 3.00E-01 mg/kg, 1,2-dichloroethenes (total) from 5.00E-03 mg/kg to 1.50E-03 mg/kg, methylene chloride from 1.50E-02 mg/kg to 1.30E-02 mg/kg, tetrachloroethene from 2.90E-02 mg/kg to 6.00E-03 mg/kg, trichloroethene from 1.30E-01 mg/kg to 1.50E-03 mg/kg, and total xylenes from 5.40E-02 mg/kg to 1.50E-03 mg/kg. Benzoic acid; total 1,2-dichloroethenes; trichloroethene; and total xylenes exposure concentrations are half of the highest nondetect value as there were no detected values with the elimination of the southern shallow soil samples. Bis(2-ethylhexyl) phthalate, methylene chloride, and tetrachloroethene exposure concentrations are the maximum detected concentration of the northern shallow soil samples.

Source: ESE (1995)

APPENDIX A.2
PLAN ACCEPTANCE FORM

PLAN ACCEPTANCE FORM
PROJECT SAFETY AND HEALTH PLAN

I have read and agree to abide by the contents of the Safety and Health Plan for the following project:

Field Work Supporting RI/FS Activities at RSA-53 and RSA-60

Redstone Arsenal

Name (print)

Signature

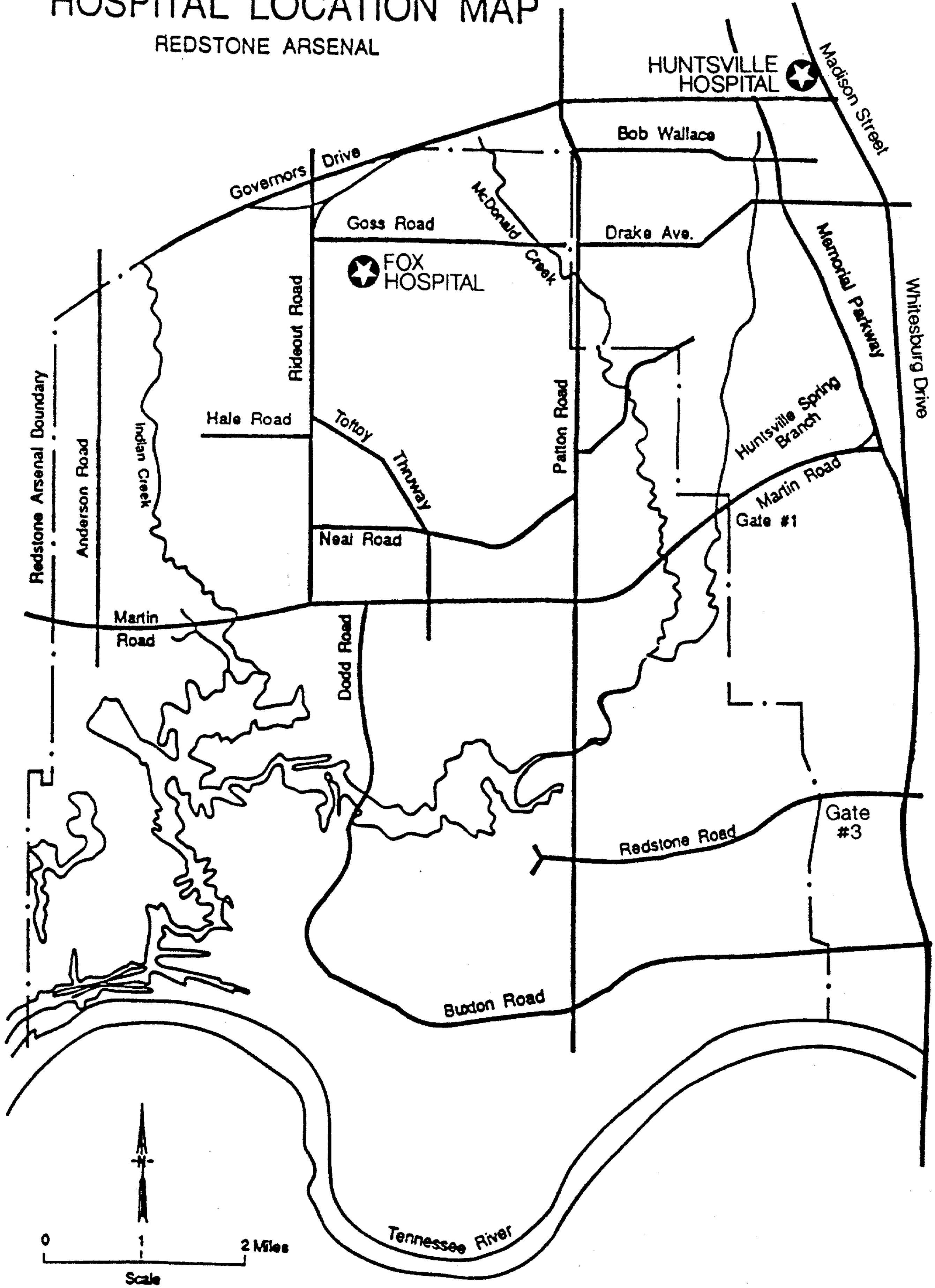
Date

Return to Onsite Safety and Health Officer before starting work at the site.

APPENDIX A.3
MAP TO NEAREST HOSPITAL

HOSPITAL LOCATION MAP

REDSTONE ARSENAL



APPENDIX A.4
ACCIDENT REPORT FORM

ACCIDENT REPORT FORM

Project: Redstone Arsenal RI/FS ______________________________

EMPLOYER

1. Name: ______________________________

2. Mail Address: ______________________________
(No. and Street) *(City or Town)* *(State)*

3. Location, if different from mail address: ______________________________

____

INJURED OR ILL EMPLOYEE

4. Name ______________________________ Social Security Number: ______________
(First) *(Middle)* *(Last)*

5. Home Address: ______________________________
(No. and Street) *(City or Town)* *(State)*

6. Age ________ 7. Sex: Male ____ Female ____ (Check one)

8. Occupation: ______________________________
(Specific job title, not the specific activity employee was performing at time of injury)

9. Department: ______________________________
(Enter name of department in which injured person is employed, even though they may have been temporarily working in another department at the time of injury)

THE ACCIDENT OR EXPOSURE TO OCCUPATIONAL ILLNESS

10. Place of accident or exposure: ______________________________
(No. and Street) *(City or Town)* *(State)*

11. Was place of accident or exposure on employer's premises? (Yes/No)

12. What was the employee doing when injured? ______________________________
(Be specific - Was employee using tools or

____
equipment or handling material?)

____

ACCIDENT REPORT FORM *(continued)*

13. How did the accident occur? ______________________________

____

____

(Describe fully the events which resulted in the injury or occupational illness. Tell what happened and how. Name objects and substances involved. Give details on all factors which led to accident. Use separate sheet for additional space.

14. Time of accident: ______________________________

15. Witnesses to accident:

____
(Name) *(Affiliation)* *(Phone No.)*

____
(Name) *(Affiliation)* *(Phone No.)*

____
(Name) *(Affiliation)* *(Phone No.)*

OCCUPATIONAL INJURY OR OCCUPATIONAL ILLNESS

16. Describe the injury or illness in detail and indicate the part of the body affected.

____

____

17. Name the object or substance which directly injured the employee. (For example, object which struck employee; the vapor or poison inhaled or swallowed; the chemical or radiation which irritated the skin; or in cases of strains, hernias, etc., the object the employee was lifting, pulling, etc.). ______________________________

____

____

18. Date of injury or initial diagnosis of occupational illness: ______________________________
(Date)

19. Did the accident result in employee fatality? ______________________________ (Yes or No)

OTHER

20. Name and address of physician: ______________________________

21. If hospitalized, name and address of hospital: ______________________________

____

Date of report __________ Prepared by ______________________________

Official position ____________________

APPENDIX B
FIELD SAMPLING PLAN

APPENDIX B
FIELD SAMPLING PLAN

B.0.a This Field Sampling Plan (FSP) presents the detailed sampling and testing methods for field activities to be conducted during the RI at Sites RSA-53 and RSA-60 (Group X4B). The FSP will be used as a guide for the collection of precise, accurate, and representative field data.

B.1 INTRODUCTION AND SCOPE

B.1.a Standard operating procedures will be followed to minimize errors which could result in the collection of invalid data or nonrepresentative samples. Non-standard situations encountered in the field will be resolved by the Parsons ES Project Manager in consultation with the CEHNC Project Manager. The Alabama Department of Environmental Management and USEPA will be notified of any changes or situations that may require approvals.

B.1.b The tasks described in this FSP will be conducted while following health and safety procedures defined in the Generic Safety and Health Plan (Generic RI/FS Work Plan Appendix A) and the Site Specific Safety Health and Plan (Appendix A). The following field activities will be conducted during the RI field effort at RSA-53 and RSA-60 (Group X4B):

- Groundwater level measurements from 68 existing monitoring wells;
- 10 soil borings, collection of two samples per boring for chemical analysis;
- 6 soil borings, collection of one undisturbed sample per boring for geotechnical testing;
- Installation of 5 deep overburden monitoring wells;
- Collection of 73 groundwater samples for chemical analysis;
- Collection of 14 surface water samples for chemical analysis;
- Collection of 14 sediment samples for chemical analysis; and
- Survey of horizontal locations and surface elevations of monitoring wells and horizontal locations of all other sampling points.

B.1.c This section is divided into five parts. Section B.2 identifies the equipment and materials to be used during the field investigations and provides calibration and maintenance requirements for the equipment. Section B.3 outlines requirements for documentation of field activities. Section B.4 provides the procedures for conducting the field activities listed above. Section B.5 provides the procedures for collection and handling of samples for off-site laboratory analyses. Installation of the groundwater monitoring wells is discussed in the Monitoring Well Installation Plan (Generic Work Plan Appendix D). Management of IDW is discussed in the Investigative Derived Waste Plan (Generic Work Plan Appendix E).

B.2 FIELD EQUIPMENT AND SUPPLIES

B.2.a This section identifies parameters to be measured in the field. Calibration and maintenance of instruments used for field measurements are described below. Decontamination procedures for sampling equipment are summarized in Section B.5.

B.2.1 Field Parameters

B.2.1.a The following parameters may be measured in the field with the specified instruments:

- Temperature: Thermometer or temperature probe
- pH: Portable pH meter
- Conductivity: Portable conductivity meter
- Organic Vapors: Organic vapor analyzer (OVA) or photoionization detector (PID)
- Water Level: Electronic water level indicator
- Distance: Surveyor's tape measure or surveyed location

B.2.2 Field Equipment Calibration

B.2.2.a Each instrument will be calibrated following the manufacturer's recommendations or the standard operating procedures presented in this document. The acceptance criteria and corrective actions for each piece of equipment are as specified in the manufacturer's recommendations. An equipment calibration log sheet is provided in Attachment B-1.

B.2.3 Field Equipment Maintenance

B.2.3.a Equipment maintenance and repair will be performed as required for each instrument. Preventive maintenance for all equipment includes inspection before use, cleaning as necessary during use, and thorough cleaning and inspection after use. During the performance of field activities, all downhole augers, rods, and samplers will be visually inspected. Rechargeable batteries will be checked before use and recharged after use. For equipment using disposable batteries, replacement batteries will be stocked. Maintenance and repairs on field equipment will occur when corrective action needs are identified. If the instrument cannot be repaired (or re-calibrated), the instrument will be replaced.

APPENDIX C
CHEMICAL DATA ACQUISITION PLAN

APPENDIX C
CHEMICAL DATA ACQUISITION PLAN FOR GROUP X4B SITES AT THE REDSTONE ARSENAL

C.1 CHEMICAL DATA ACQUISITION PLAN

C.1.a This appendix presents the Chemical Data Acquisition Plan (CDAP) for the Group X4B Sites at the RSA.

C.1.1 Purpose and Scope of the CDAP

C.1.1.a The purpose of the CDAP is to document the quality assurance requirements applicable to the investigations at the Group X4B Sites at the RSA. The scope of the CDAP includes the quality assurance and quality control criteria associated with the field sampling, field testing and laboratory analytical testing efforts of the investigations at the Group X4B Sites at the RSA. The CDAP as presented herein applies to work performed at the Group X4B RSA Sites or in any office or laboratory performing services for the investigations at Group X4B Sites.

C.1.2 Contents of the CDAP

C.1.2.a The contents of this CDAP is limited to those elements that are not presented in the Group X4B Sites Field Sampling Plan (FSP) and/or the General Work Plan. The following list the required elements of the CDAP and the document that contains the element.

Element	Location
Project Description	FSP, Section 3
Project Organization and Responsibilities	FSP, Section 6
Data Quality Objectives	FSP, Section 3
Data Quality Objectives for Measurement Data	CDAP, Section C.2
Field Activities	FSP, Section 4
Sample Custody Procedures	General Work Plan QAPP, App. B.3
Calibration Procedures and Frequency	CDAP, Section C.3
Analytical Procedures	CDAP, Section C.4
Data Reduction Validation and Reporting	General Work Plan, Section 4
Internal Quality Control Checks	CDAP, Section C.5
Performance and System Audits	General Work Plan QAPP, App. A.7

Preventative Maintenance	General Work Plan QAPP, App. A.8
Formulas for Calculating Data Quality Indicators	General Work Plan QAPP, App. A.9
Corrective Action	General Work Plan QAPP, App. A.10
Quality Assurance Reports to Management	General Work Plan QAPP, App. A.11

C.2 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

C.2.a The overall objective of investigations at the RSA is to provide an accurate, precise, and representative summary of data necessary to fill in data gaps. The collected samples and the data generated from these samples and other site-generated data are intended to provide the information necessary to meet the site-specific data needs as defined in the Sections 3.5 and 3.6 of the Group X4B Site Work Plan. . Definitions and descriptions of these PARCC parameters are contained in the General Plan QAPP. This section describes data quality objectives (DQO) in terms of the precision, accuracy, representativeness, comparability and completeness (PARCC) requirements for the field and laboratory analyses for investigations at Group X4B Sites at the RSA.

C.2.1 Field DQOs and PARCC Parameters

C.2.1.a All the field analyses are for screening data only. The requirements for the precision and accuracy are field duplicate samples, blanks and calibration of the equipment. Duplicates samples and blanks will be analyzed at a frequency of one for every ten samples or one per day, which ever is the most frequent. The calibration of the field equipment will be as specified by the instrument manufacture. The QC criteria for the field analyses is presented in Table C.1.

C.2.2 Laboratory DQOs and PARCC Parameters

C.2.2.a All the geochemical and chemical laboratory analyses are for definitive data. The geotechnical data will be generating using ASTM methods. The QC requirements are defined in these methods. Targeted acceptable precision and accuracy QC limits are dependent on the sample matrix and are defined in the CLP SOWs, SW846 Methods and summarized in Table 3.5 of the General Work Plan. Table C.2 presents the number and types of definitive investigative and quality control samples to be sampled and analyzed at the Group X4B Sites.

C.3 CALIBRATION PROCEDURES AND FREQUENCY

C.3.a The calibration procedures and frequencies for field equipment will be as specified by the instrument manufacture. The calibration procedures and frequencies for laboratory instruments shall be specified in CLP SOWs and other standard methodologies.

C.4 ANALYTICAL PROCEDURES

C.4.a The following discusses the field screening and laboratory definitive analysis of samples collected for chemical analysis during field sampling activities at the RSA .

C.4.1 Field Analyses

C.4.1.a Field screening analyses are listed in Section 3.5.

C.4.2 Field Measurement Procedures

C.4.2.a All field screening analyses shall be performed in accordance with written methods that contain clear procedures, appropriate QC, directions for corrective actions and reporting limits based on actual method performance.

C.4.3 Laboratory Analyses

C.4.3.a The laboratory chemical and geochemical analyses are listed in Section 3.5.

C.4.4 Laboratory Analytical Procedures

C.4.4.a Laboratory definitive chemical and geochemical analyses shall be performed according to the procedures contained in the CLP SOWs, SW846 and ASTM Methods.

C.5 INTERNAL QUALITY CONTROL CHECKS

C.5.a Internal QC checks are used to assess the quality of the field and laboratory analytical processes and provide a means to evaluate the need for corrective action. The internal QC checks for field analyses are:

- Field duplicate analyses;
- Field blanks; and
- Equipment calibrations.

C.5.b The USEPA CLP SOWs, SW846, and ASTM methodologies define the QA/QC procedures and analytical procedures to be used in the laboratory. These laboratory internal QC checks are method specific and include but are not limited to, the following:

- Initial and continuing calibration verifications;
- Method blanks;
- Internal standards, surrogates, matrix and blank spikes; and

- Replicate analyses.

TABLE C.1
QC CRITERIA FOR FIELD ANALYSES AT THE GROUP X4B SITES

Matrix	Parameter	Field Duplicates	Field Blanks
Groundwater	pH	± 0.1 s.u.	NR
	conductivity	5% RPD	NR
	temperature	± 1.0 °C	NR
	turbidity	no criteria (record results) - due to natural turbidity fluctuations, measurements may not agree	< Reporting Limit
Surface Water	pH	± 0.1 s.u.	NR
	hardness	5% RPD	< Reporting Limit
Sediment	pH	NA	NR
Soil	pH	NA	NR
	non-selective VOCs	NA	< Reporting Limit

NR = not required
NA = not applicable, measurements are intended for qualitative screening.

TABLE C.2
INVESTIGATIVE AND QC SAMPLES FOR THE GROUP X4B SITES

Matrix	Analysis	Investigative Samples	Trip Blanks (1)	Rinseate Blanks	Field Duplicates	MS/MSD (2)
Groundwater	VOCs	68	25	2	7	4
	Metals	68		2	7	4
Surface Water	VOCs	14	4		2	1
	SVOCs	14			2	1
	Metals	14			2	1
	Pesticides	14			2	1
	pH	14			2	
	Hardness	14			2	
Sediment	VOCs	14			2	1
	SVOCs	14			2	1
	Metals	14			2	1
	Pesticides	14			2	1
	pH	14			2	
	TOC	14			2	
	Bioassay					
Soil	VOCs	20			2	1
	SVOCs	20			2	1
	Metals	20			2	1
	Pesticides	20			2	1
	pH	20			2	
	TOC	20			2	

(1) One per cooler containing samples for VOC analyses.
(2) The value given is the number of MS/MSD pairs. The number of samples will be twice the value given.