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Remedial Investigation Sampling and Analysis Plan for J-Field, Aberdeen Proving Ground, Maryland

Volume 1: Field Sampling Plan

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CONTENTS

CONTENTS (Cont.)

CONTENTS (Cont.)

FIGURES

FIGURES (Cont.)

FIGURES (Cont.)

TABLES

TABLES (Cont.)

TABLES (Cont.)

FOREWORD

This document presents the Field Sampling Plan for the characterization field work to be conducted as part of a remedial investigation/feasibility study (RI/FS) to be carried out at J-Field, Aberdeen Proving Ground, Maryland, pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended. The RI/FS is to be conducted for the U.S. Army under the direction of the Directorate of Safety, Health, and Environment, Aberdeen Proving Ground. This report (Volume 1 of the *Remedial Investigation Sampling and Analysis Plan for J-Field, Aberdeen Proving Ground, Maryland*) is one in a series of documents being prepared to define the plans for RI/FS activities at J-Field. Other documents in this series include a Remedial Investigation Work Plan (Benioff et al. 1995); a Quality Assurance Project Plan (Prasad et al. 1995); and a Work Plan for the Focused Feasibility Study (FFS) of the Toxic Burning Pits Area (Biang et al. 1995). Two other documents — an Ecological Risk Assessment Work Plan and a Work Plan for the Feasibility Study — are in preparation.

NOTATION

ABBREVIATIONS AND ACRONYMS

AEC	U.S. Army Environmental Center
ANL	Argonne National Laboratory
AOC	area of concern
APG	Aberdeen Proving Ground
ASTM	American Society for Testing and Materials
CC	chain of custody
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (as amended)
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CLPAS	Contract Laboratory Program Analytical Suite
COC	chemicals of potential concern
COE	U.S. Army Corps of Engineers
CRDEC	Chemical Research, Development, and Engineering Center
CTF	Chemical Transfer Facility
CWA	chemical warfare agent
DANC	decontaminating agent, noncorrosive
DNAPL	dense, nonaqueous phase liquid
DQO	data quality objective
DSHE	Directorate of Safety, Health, and Environment
ECD	electron capture detector
EM	electromagnetic
EMD	Environmental Management Division (Aberdeen Proving Ground)
EMI	electromagnetic induction
EP	extraction procedure
EPA	U.S. Environmental Protection Agency
ERT	emergency response team
FFS	Focused Feasibility Study
FID	flame ionization detector
FS	Feasibility Study
FSP	Field Sampling Plan
GC	gas chromatography
GC/MS	gas chromatography/mass spectrometry
GPR	ground-penetrating radar
GPS	global positioning system
HASP	Health and Safety Plan
HE	high explosives

IRDMS	Installation Restoration Data Management System
IRP	Installation Restoration Program
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MDE	Maryland Department of the Environment
MRI	Midwest Research Institute
MS	mass spectrometer
MSL	mean sea level
NAPL	nonaqueous phase liquid
NCP	National Contingency Plan
ND	not detected
NPL	National Priorities List
OB	open burning
OD	open detonation
OSAS	on-site analytical suite
OVA	organic vapor analyzer
PAOC	potential area of concern
PB	Prototype Building
PID	photoionization detector
QA	quality assurance
QAPjP	Quality Assurance Project Plan
QAPP	Quality Assurance Program Plan
QC	quality control
RCP	Riot Control Burning Pit
RCRA	Resource Conservation and Recovery Act (as amended)
RFA	RCRA Facility Assessment
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RPDG	Robins Point Demolition Ground
RPTS	Robins Point Tower Site
SAP	Sampling and Analysis Plan
SBDG	South Beach Demolition Ground
SBT	South Beach Trench
SOP	standard operating procedure
SWMU	solid waste management unit
TAL	Target Analyte List
TBD	to be determined
TBP	Toxic Burning Pits
TCL	Target Compound List
TMDL	target method detection limit

USAEHA	U.S. Army Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USGS	U.S. Geological Survey
UXO	unexploded ordnance
WPP	White Phosphorus Burning Pits
XRF	X-ray fluorescence

ABBREVIATIONS FOR CHEMICALS

BNA	base neutral and acid extractable organic compounds
BTEX	benzene, toluene, ethylbenzene, and xylenes
C2H3CL	vinyl chloride
C6H6	benzene
CHCL3	chloroform
CK	cyanogen chloride
CN	chloroacetophenone
CS	o-chlorobenzylidene malononitrile/orthochlorobenzalmalononitrile
DANC	decontaminating agent, non-corrosive
DCE	dichloroethylene
11DCE	1,1-dichloroethylene
12DCE	1,2-dichloroethylene
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DM	adamsite
DNT	dinitrotoluene
24DNT	2,4-dinitrotoluene
26DNT	2,6-dinitrotoluene
FM	titanium tetrachloride
FS	sulfur trioxide/chlorosulfonic acid
HMX	cyclotetramethylene tetranitrate
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
PEH	petroleum hydrocarbon
PETN	penta-erythritol tetranitrate
PVC	polyvinyl chloride
PWP	plasticized white phosphorus
RDX	hexahydro-1,3,5-trinitro-1,3,4-triazine
Si(Li)	silicon-lithium

TCE	trichloroethane
111TCE	1,1,1-trichloroethane
112TCE	1,1,2-trichloroethane
TCLEA	1,1,2,2-tetrachloroethane
TCLEE	tetrachloroethylene
TDS	total dissolved solids
TEX	toluene, ethylbenzene, and xylenes
TKN	total Kjeldahl nitrogen
TNT	trinitrotoluene
246TNT	2,4,6-trinitrotoluene
TOC	total organic carbon
TOX	total organic halogens
trans-12DCE	trans-1,2-dichloroethylene
TRCLE	trichloroethylene
VOC	volatile organic compound
VX	methylphosphonothioic acid = o-ethyl S-(2-diisopropylaminoethyl methylphosphonothioate), a nerve agent
WP	white phosphorus

UNITS OF MEASURE

°C	degree(s) Celsius	in.	inch(es)
d	day(s)	L	liter(s)
°F	degree(s) Fahrenheit	lb	pound(s)
ft	foot (feet)	m	meter(s)
ft^2	square foot (feet)	mi	mile(s)
g	gram(s)	pCi	picocurie(s)
kg	kilogram(s)	ppb	part(s) per billion
µg	microgram(s)	ppm	part(s) per million
mg	milligram(s)	yd	yard(s)
gal	gallon(s)		

1 INTRODUCTION

1.1 BACKGROUND

The Environmental Management Division (EMD) of Aberdeen Proving Ground (APG), Maryland, is conducting a remedial investigation and feasibility study (RI/FS) of the J-Field area at APG pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended. J-Field is within the Edgewood Area of APG in Harford County, Maryland (Figure 1.1). Since World War II, activities in the Edgewood Area have included the development, manufacture, testing, and destruction of chemical agents and munitions. These materials were destroyed at J-Field by open burning[1] and open detonation (OB/OD).

Considerable archival information about J-Field exists as a result of efforts by APG staff to characterize the hazards associated with the site. Contamination of J-Field was first detected during an environmental survey of the Edgewood Area conducted in 1977 and 1978 by the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA) (predecessor to the U.S. Army Environmental Center [AEC]). As part of a subsequent USATHAMA environmental survey, 11 wells were installed and sampled at J-Field. Contamination at J-Field was also detected during a munitions disposal survey conducted by Princeton Aqua Science in 1983. The Princeton Aqua Science investigation involved the installation and sampling of nine wells and the collection and analysis of surficial and deep composite soil samples. In 1986, a Resource Conservation and Recovery Act (RCRA) permit (MD3-21-002-1355) requiring a basewide RCRA Facility Assessment (RFA) and a hydrogeologic assessment of J-Field was issued by the U.S. Environmental Protection Agency (EPA). In 1987, the U.S. Geological Survey (USGS) began a two-phased hydrogeologic assessment in which data were collected to model groundwater flow at J-Field. Soil gas investigations were conducted, several well clusters were installed, a groundwater flow model was developed, and groundwater and surface water monitoring programs were established that continue today.

While APG was pursuing the investigation of J-Field under RCRA corrective action, the Edgewood Area was added to the National Priorities List (NPL) on February 21, 1990. Because of that listing, an RI/FS is required for the entire Edgewood Area pursuant to Modification 2 of the RCRA Permit and a March 1990 Federal Facility Agreement between EPA Region III and the Department of the Army. The corrective action requirements of RCRA have been preempted, and J-Field is being evaluated under CERCLA.

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[1] Pursuant to Title 40, Code of Federal Regulations (40 CFR), Part 260.10, "open burning" means the combustion of any material without the following characteristics:
(1) Control of combustion air to maintain adequate temperature for efficient combustion,
(2) Containment of the combustion-reaction in an enclosed device to provide sufficient residence time and mixing for complete combustion, and
(3) Control of emission of the gaseous combustion products.

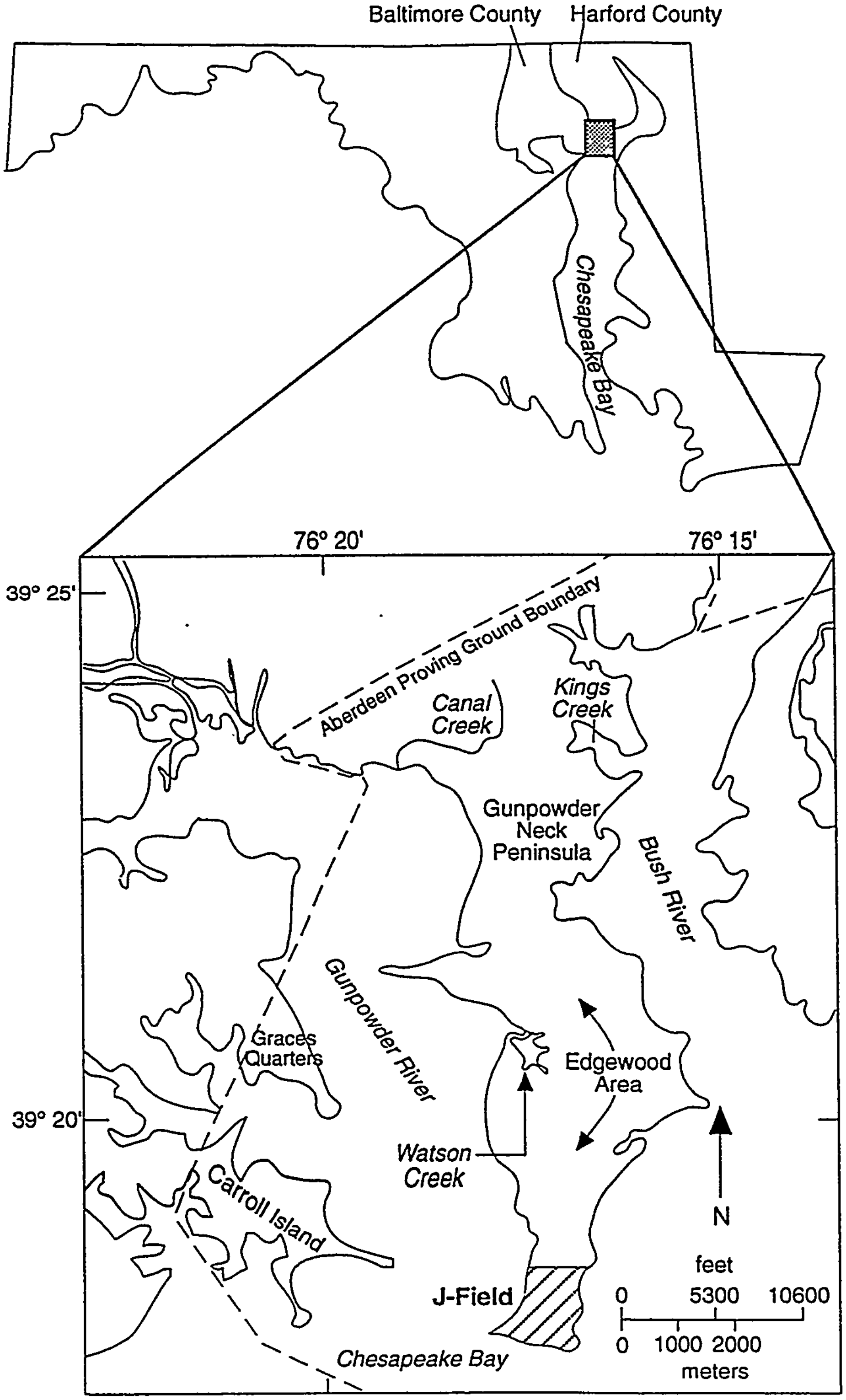


FIGURE 1.1 Location of J-Field in the Edgewood Area at APG (Source: Adapted from Hughes 1993)

J-Field is almost flat and is covered by open fields, woods, and nontidal marshes. It encompasses about 460 acres at the southern end of the Gunpowder Neck Peninsula (Figure 1.2). The peninsula is surrounded by tidal estuaries on three sides — Gunpowder River to the west, Chesapeake Bay to the south, and Bush River to the east. For the purposes of the RI/FS, J-Field has been divided into eight geographic areas or features that are designated in this report as areas of concern (AOCs): the Toxic Burning Pits (TBP), the White Phosphorus Burning Pits (WPP), the Riot Control Burning Pit (RCP), the Robins Point Demolition Ground (RPDG), the Robins Point Tower Site (RPTS), the South Beach Demolition Ground (SBDG), the South Beach Trench (SBT), and the Prototype Building (PB) (Figure 1.3). These AOCs correspond to the eight solid waste management units (SWMUs) identified in the *RCRA Facility Assessment, Edgewood Area, Aberdeen Proving Ground, MD* (Nemeth 1989). Several subareas within these AOCs could represent discrete sources of contamination. The AOCs and their associated subareas are as follows:

- Toxic Burning Pits (TBP) AOC
    - Main Burning Pits (consisting of a northern burning pit and a southern burning pit)
    - Methylphosphonothioic Acid (VX) Burning Pit
    - Mustard Burning Pit
    - Pushout Area
    - Liquid Smoke Disposal Pit
    - Demolition Area
    - Storage/Unloading Area
    - Square Pit
- White Phosphorus Burning Pits (WPP) AOC
    - Principal Burning Pits (consisting of a northern burning pit, a southern burning pit, and an associated bermed depression that received runoff from the northern burning pit)
    - Pushout Area
    - Mounded Areas
    - Historic White Phosphorus Disposal Area (located south to southeast of the existing principal burning pits)
- Riot Control Burning Pit (RCP) AOC
    - Burning Pit
    - Pushout Area
- Robins Point Demolition Ground (RPDG) AOC
    - Active Area
    - Inactive Area
- Robins Point Tower Site (RPTS) AOC

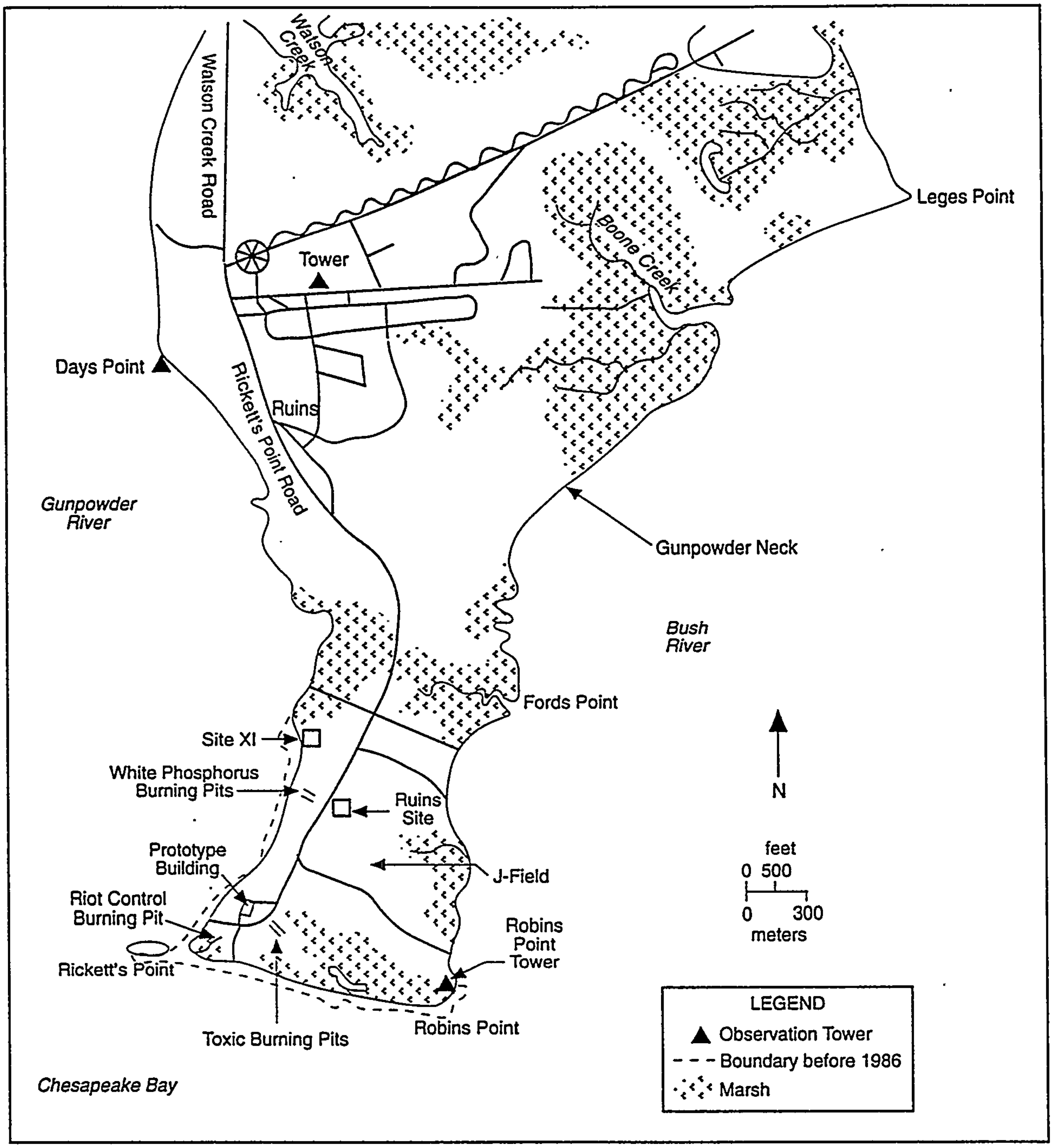


FIGURE 1.2 Location of J-Field and Major Associated Features on the Gunpowder Neck Peninsula (Source: Adapted from Hughes 1993)

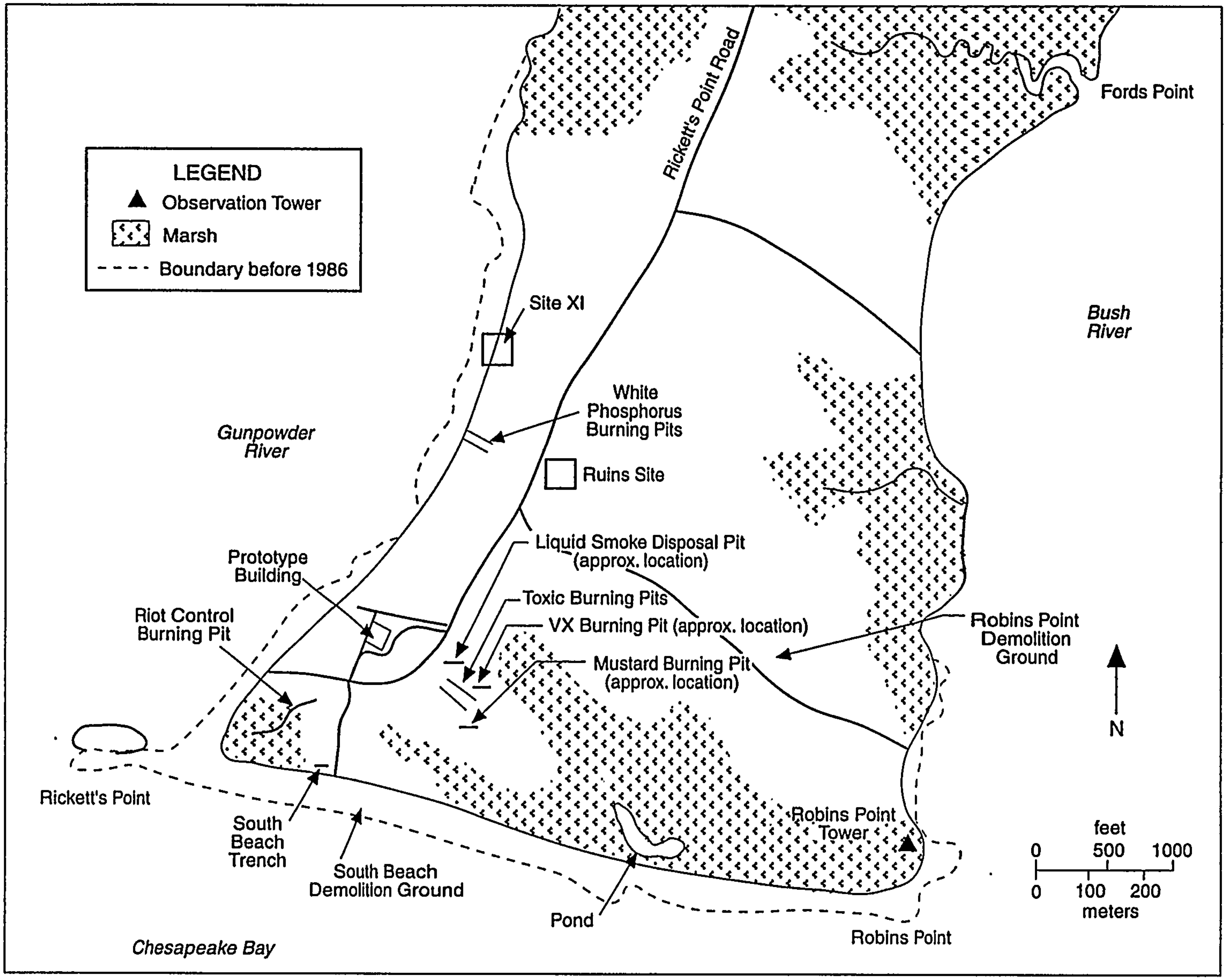


FIGURE 1.3 Locations of Areas of Concern and Principal Site Features at J-Field (Source: Adapted from Hughes 1993)

- South Beach Trench (SBT) AOC
- South Beach Demolition Ground (SBDG) AOC
- Prototype Building (PB) AOC

Although most of the AOCs are no longer used for OB/OD, a portion of the RPDG is currently active and is operating with interim status under RCRA. A RCRA Part B permit application was submitted in November 1988. An amended permit application is being prepared to update the November 1988 submittal. An open burning pan located 50 m west of the PB and an open detonation area at the WPP AOC are also being used for emergency disposal operations.

1.2 SITE HISTORY

The extent of activities at J-Field before World War II is unknown; however, a terrain map from the 1920s-1930s era indicates that some areas of J-Field were cleared at that time. These cleared areas may have been used for test activities (Nemeth 1989; U.S. Army Corps of Engineers [COE] 1923). During World War II, J-Field was used to test high explosives (HE) and chemical munitions. In addition, chemical agents, chemical wastes, and HE were burned or detonated in open pits or buried under several feet of soil. The depths of the pits were maintained by pushing burned soil and ash out toward the nearby marshes. In the case of the TBP AOC, this procedure moved the edge of the adjacent marsh eastward more than 100 ft (Sonntag 1991). Also during World War II, steel-reinforced structures (such as bunkers, buildings, and slab walls) were built at J-Field to use as targets for conventional munitions.

Available information indicates that chemicals disposed of at J-Field have included nerve agents (such as VX), blister agents, riot control agents, white phosphorus, chlorinated solvents, and drummed chemical wastes generated by research laboratories, process laboratories, pilot plants, and machine and maintenance shops. Between 1946 and 1971, limited testing of lethal chemical agents continued at J-Field (Nemeth 1989). Open-air testing of lethal chemical agents stopped in 1969 (Nemeth 1989). Disposal activities at various J-Field locations are summarized in Table 1.1.

Procedures for open burning in J-Field pits involved placing 3-4 ft of wood dunnage in a pit, placing the materials to be burned on top of the dunnage, adding fuel oil, and igniting it. Scrap metal items were removed and reburned in the same manner in a reburn pit. Large metal items were recovered and disposed of as scrap.

Decontamination procedures included the use of a chlorinating agent known as "decontaminating agent, noncorrosive" (DANC). DANC is an organic *N*-chloroamide compound in solution with 1,1,2,2-tetrachloroethane (TCLEA) that was used to decontaminate mustard, Lewisite, and VX. It typically contained 90-95% (by weight) TCLEA. If recovered

TABLE 1.1 Summary of Disposal Activities at J-Field

Site Name	Period of Use	Activity
Toxic Burning Pits (originally 5 separate pits; only 2 remain)	1940-1980	OB/OD of HE in southeastern portion. Disposal of HE-filled munitions, nerve agents, mustard, liquid smoke, chlorinated solvents, and radioactive chemicals.
White Phosphorus Burning Pits	Late 1940s-1980; occasional emergency disposal of white phosphorus	OB/OD of white phosphorus, PWP,[a] other chemicals. Potential for disposal of CN[b] and trichloroethylene.
Riot Control Burning Pit Area	Late 1940s to early 1970s; riot control agent disposal, 1960s to early 1970s	OB of chemicals, chemical-filled munitions, riot control agents (CS,[c] CN).
Robins Point Demolition Ground	Late 1970s-present	OD of explosive materials, sensitive and unstable chemicals.
South Beach Demolition Ground	Late 1950s-1970s	OD of HE.
Prototype Building Area	During World War II	Stored wastes and HE munitions. Possible storage of solid wastes in building or nearby. Building used to test bombing effects. Periodically used for storage since World War II.
Robins Point Tower Site	Late 1950s-1960s	Potential test burn of radioactively contaminated wood.
South Beach Trench	Late 1950s	Unknown.

[a] Plasticized white phosphorus.

[b] Chloroacetophenone.

[c] o-Chlorobenzylidene malononitrile.

Sources: Adapted from Nemeth (1989); EPA and U.S. Department of the Army (1990).

scrap materials were decontaminated with DANC in the pit before being removed, the oxidizing agent would degrade. The most significant impact from this procedure would have been the introduction of TCLEA into the environment. Available information indicates that the use of DANC at J-Field was widespread and common (Nemeth 1989).

Disposal of radioactive waste is known to have occurred at J-Field. The TBP area was used for disposal of small amounts of radioactively labeled chemicals. In addition, test burns of contaminated wood wastes, including wood contaminated with radium and strontium-90, may have been conducted at the RPTS (Nemeth 1989).

J-Field has had only limited use since 1980. However, the Robins Point Demolition Ground and the WPP AOCs are still occasionally used for the destruction of explosives-related materials (Nemeth 1989).

1.3 PURPOSE AND SCOPE OF THE SAMPLING AND ANALYSIS PLAN

The purpose of the investigation described in the Sampling and Analysis Plan (SAP) is collection of data of sufficient quantity and quality to identify and delineate sources of contamination and to conduct human health and ecological risk assessments. This process includes determination of an applicable conceptual site model for J-Field that identifies significant pathways of contaminant migration to human and environmental receptors.

The purpose of this Field Sampling Plan (FSP) (Volume 1 of the SAP) is to provide guidance for all fieldwork to be conducted at J-Field. All field methods, sampling procedures, and data management procedures to be implemented during the RI are outlined in this report. All aspects of the quality assurance and quality control protocols, project organization, and standard operating procedures (SOPs) are detailed in the QAPjP (Volume 2 of the SAP).

The RI Work Plan presents an initial evaluation of the eight AOCs and lists data needs specific to each area. In general, additional data needed to adequately characterize the AOCs include information on the environmental setting of J-Field, the operational history of each AOC, the nature and extent of contamination in environmental media, potential migration pathways, and potential human and environmental receptors.

1.4 REPORT ORGANIZATION

Section 1 of this FSP presents background information and summarizes the purpose and scope of the SAP. Section 2 summarizes the site background, environmental setting, and previous and ongoing investigations conducted at J-Field. Also included is an overview of available information about the nature and extent of contamination at each AOC, the types of wastes present, and the potential pathways of contaminant migration. The environmental setting includes site topography, geology, soils, surface water, groundwater, climate, and ecology.

Section 3 discusses the conceptual site model for J-Field and describes the plans for environmental sampling and analysis to be conducted at J-Field for the RI field activities. Topics include the sampling locations, environmental matrices to be sampled, contaminants to be analyzed for, analytical methods, and the rationale for the sampling needs. A brief description of the sampling protocol is also included. The sampling protocol is complicated by the possible presence of unexploded ordnance (UXO) and chemical warfare agents (CWAs), which are chemical agents adopted or considered for military use. The CWAs include nerve agents such as VX and blister agents such as mustard.

Section 4 describes (1) the format of and the information needed in sample records and (2) the data numbering systems to be used. Section 5 describes sampling procedures and equipment to be used for each type of sampling. Some of the procedures described are tentative because it is not clear which method will work best in the field and satisfy the protocol requirements.

Section 6 discusses the protocol to be followed in managing project records, including technical data. All references cited in this report are listed in Section 7, and a list of preparers is provided in Section 8. Appendix A lists J-Field-related documents prepared to date that have been reviewed for the preparation of this FSP. Appendix B presents a sampling plan for the potential areas of concern (PAOCs) at J-Field.

Volume 2 of the SAP contains the QAPjP. An outline of the QAPjP is provided in Table 1.2.

TABLE 1.2 Outline of the Quality Assurance Project Plan

Section	Topic
1	Introduction
2	Project Description
3	Project Organization and Responsibilities
4	Data Quality Objectives
5	Sampling
6	Sample Custody
7	Calibration Procedures
8	Analytical Procedures
9	Data Validation, Reduction, and Reporting
10	Quality Control Checks
11	Performance and System Audits
12	Preventive Maintenance
13	Record Keeping
14	Data Assessment Procedures
15	Corrective Action
16	Quality Assurance Reports to Management

2 ENVIRONMENTAL CONDITIONS AT J-FIELD

2.1 ENVIRONMENTAL SETTING

2.1.1 Surface Features

J-Field is nearly flat, with a maximum relief of about 10 ft. The ground surface slopes gently toward marshy areas or toward Chesapeake Bay and on-site surface water. In some places, wave erosion has formed short, steep cliffs (2-10 ft high) along the shore (Hughes 1993).

Surface water occurs in demolition craters, in marsh areas, and in a few open ponds within the marshes. Between December and May water collects in wooded areas where drainage is poor because the low-permeability soils slow the rate of infiltration. Figure 2.1 shows the overall topography of the site.

2.1.2 Climate

The climate in the area of APG is temperate and moderately humid and is moderated by the presence of Chesapeake Bay. The average annual precipitation of 45 in. is distributed relatively uniformly during the year. The average annual temperature is about 54°F (Nemeth 1989; Hughes 1993).

2.1.3 Geology and Soils

The stratigraphy of J-Field consists of Quaternary (Talbot) sediments underlain by Cretaceous (Potomac Group) sediments. The Quaternary sediments constitute a fluvial, estuarine, and marginal marine unit of sand, gravel, and silty clay. The Cretaceous sediments are a sand and clay unit of fluvial origin.

The Quaternary sediments can be divided into three units. The surface unit consists of interbedded sand and clay about 30-40 ft thick; the middle unit is silty, sandy clay and organic matter about 36-107 ft thick; and the base unit is gravelly sand and clay about 13-50 ft thick. The Cretaceous sediments consist of interbedded layers of fine-grained sand and massive clay. The top of this layer is at a depth of 110-160 ft. Metamorphic bedrock underlies the sediments at depths ranging from 200 to 900 ft.

2.1.4 Surface Water

The southern and eastern shores of J-Field are covered by an extensive marsh system (Figure 2.2). The marshes may be flooded during storms and very high tides but are

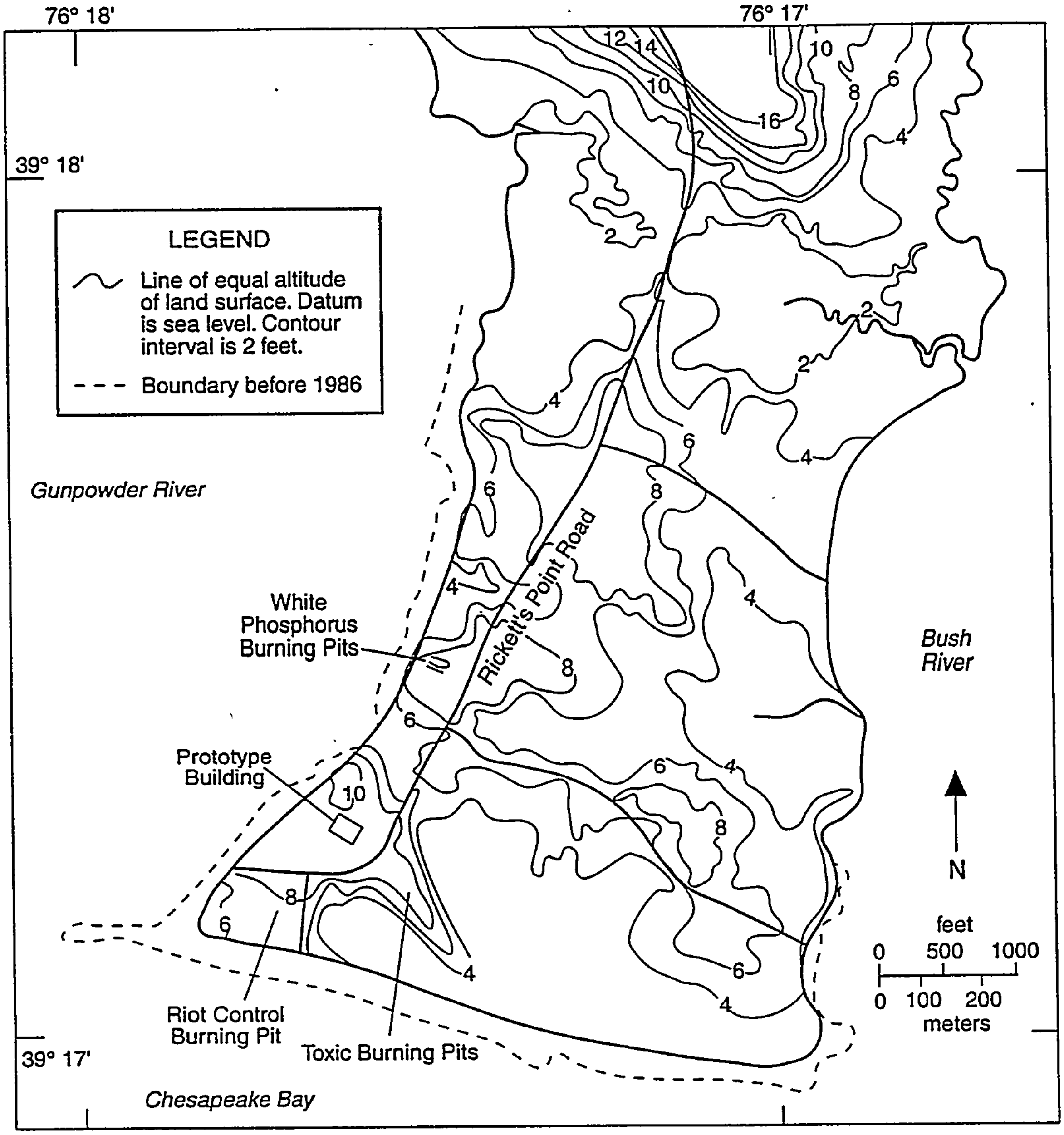


FIGURE 2.1 Topography of the J-Field Area (Source: Adapted from Hughes 1993)

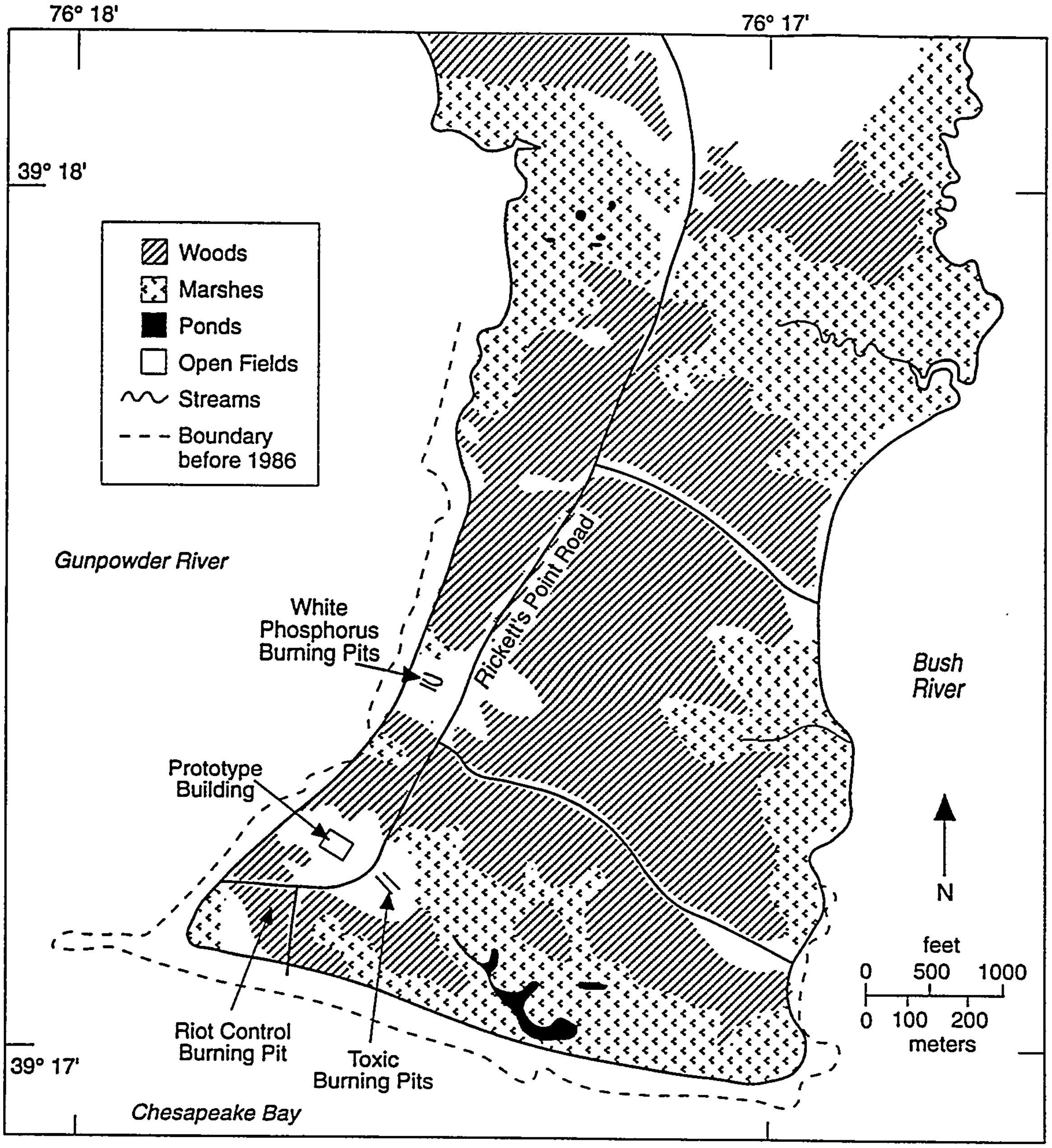


FIGURE 2.2 Locations of Woods, Marshes, Ponds, Open Fields, and Streams at J-Field (Source: Adapted from Hughes 1993)

not affected by normal tides of 1-2 ft. The water level in the marshes is generally about 2 ft above high tide in Chesapeake Bay. The disposal pits at J-Field originally drained into these marshes or into the Gunpowder and Bush rivers. During the 1970s, drainage from the disposal pits was blocked. Currently, surface water can be 1-2 ft deep in the TBP and the WPP during the wet season, generally March to June (Hughes 1993). Several ponds and streams are located within the marshy areas of J-Field (Figure 2.2). The largest pond, which is about 5 ft deep, is southeast of the TBP. Two streams on the eastern side of J-Field are the only on-site streams and do not carry much runoff except during storms.

2.1.5 Groundwater

Four major hydrologic units have been identified beneath J-Field — the surficial aquifer (in the overlying Talbot layer), the leaky confining unit (in the middle layer), the confined aquifer (in the bottom Talbot unit), and the Potomac Group aquifer. Groundwater flow in these units is described below on the basis of current knowledge of the aquifers. Groundwater is currently being modeled in these units. The model results are not yet available, but will be presented in the RI report with other results of the RI field investigation.

2.1.5.1 Surficial Aquifer

The surficial aquifer consists of interbedded sand and clay and corresponds to the surface unit of the Quaternary (Talbot) sediment; it ranges from 25 to 40 ft thick, with elevations following the surface topography. The steepest hydraulic gradients were found near the TBP and WPP. Because the closest pumping of this aquifer is about 4 mi to the west, the major influences on the flow system are recharge, evapotranspiration, and tidal fluctuations. Recharge is mainly through rainfall, and the system discharges into the marshes and Chesapeake Bay. Some recharge from Chesapeake Bay may occur during droughts (Hughes 1993). Figure 2.3 shows the direction of groundwater flow in the surficial aquifer.

A general downward gradient that occurs between the water table and the leaky confining layer indicates that the leaky confining unit is recharged primarily by the surficial aquifer. During the summer, the direction of vertical flow is reversed at some locations. Groundwater under the marsh and the rivers, which are discharge areas, probably leaks upward from the leaky confining aquifer into the surficial aquifer.

2.1.5.2 Leaky Confining Unit

The leaky confining unit consists of silty, sandy clay and organic matter and corresponds to the middle unit of the Quaternary (Talbot) sediments. Vertical leakage from

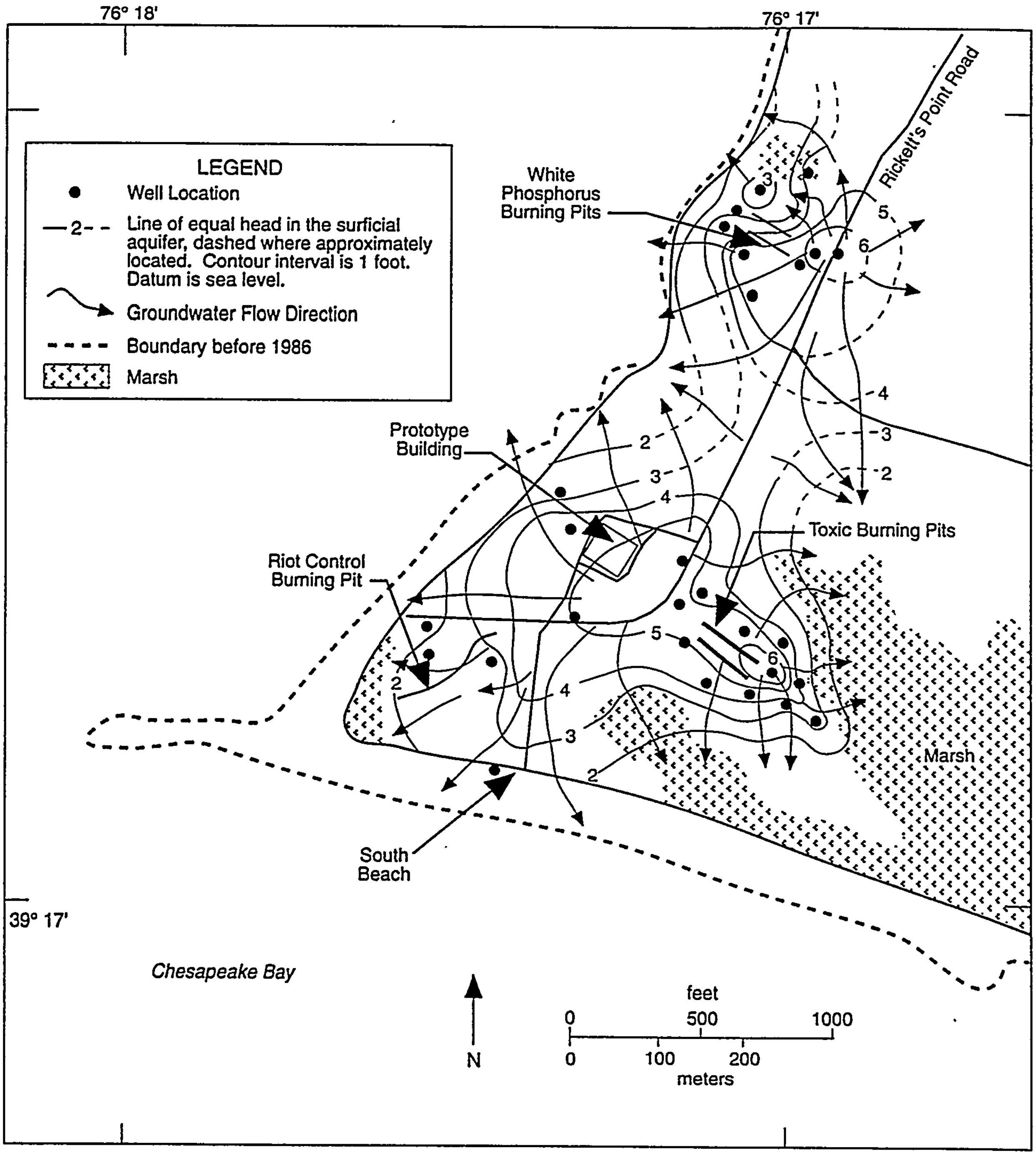


FIGURE 2.3 Groundwater Flow in the Surficial Aquifer, November 1989 (Source: Adapted from Hughes 1993)

the leaky confining unit to the underlying confined aquifer occurs at all sites beneath J-Field but is probably quite limited offshore. The direction of vertical flow may be reversed in some offshore areas (Hughes 1993).

Lateral flow in the leaky confining unit is generally the same as that of the surficial aquifer. In the western part of the site, the unit is 40 ft thick, with a surface elevation 25 ft below mean sea level (MSL). In the eastern portion of the site, the unit is 107 ft thick and has a surface elevation of 35 ft below MSL. Hydraulic conductivities range from less than 0.01 to 0.20 ft/d, with a median value of 0.05 ft/d (Hughes 1993).

2.1.5.3 Confined Aquifer

The confined aquifer consists of gravelly sand and clay and corresponds to the base unit of the Quaternary (Talbot) sediments. In the western part of J-Field, the top of the confined aquifer is 60 ft below MSL, and the unit is 50 ft thick. In the southeast, this aquifer dips to a surface elevation of 142 ft below MSL and thins to 15 ft thick. Lateral flow directions are similar to those in the water table; however, the hydraulic head and lateral gradients are very small. Groundwater flows away from the TBP toward the marshes and Chesapeake Bay, and wells show evidence of a tidal influence. Seasonal variations in the flow direction of the confined aquifer occur for short periods during the summer (Hughes 1993).

2.1.5.4 Potomac Group Aquifer

The Potomac Group aquifer consists of interbedded, fine-grained sand and massive clay. This aquifer corresponds to the Cretaceous (Potomac Group) sediments of fluvial origin. Surface elevations of the Potomac Group aquifer range from 105 ft below MSL in the eastern part of J-Field to 157 ft below MSL in the western part. The thickness of the aquifer is, in general, uncertain but may be up to 800 ft. The sediments are underlain by metamorphic bedrock. Insufficient data are available to determine lateral or vertical flow directions or the effects of the seasons and tides on the Potomac Group aquifer (Hughes 1993).

2.1.6 Ecology

Gunpowder Neck Peninsula consists primarily of open fields (mowed and unmowed grass), bare ground, and second-growth woods (dominated by maple, oaks, and sweetgum). J-Field supports extensive areas of these second-growth woods and freshwater wetlands (dominated by common reed). A large wetland at the southern end of J-Field (Figure 2.2) supports extensive areas of reed and includes a large area of open water. All wetlands at J-Field are separated from the Chesapeake Bay by beach ridges and thus are not directly influenced by tidal fluctuations except through changes in groundwater levels. A few areas of bare ground are located on the western and eastern sides of J-Field, particularly in the vicinity of disposal pits. Additional freshwater tidal and nontidal wetlands occur along the periphery of the Gunpowder Neck Peninsula, outside of J-Field. The peninsula is surrounded by freshwater tidal estuaries — Chesapeake Bay to the south, Gunpowder River to the west, and Bush River to the east.

Both the TBP and the WPP AOCs are in open areas cleared of natural vegetation. The area immediately around each pit consists of mowed grass with weeds typical of disturbed habitats and old fields. The TBP are west of a large wetland at the southern end of J-Field. Some of the burned material from these pits has, over time, been pushed into the wetland. The WPP are very close to the Gunpowder River. In 1986, a berm was constructed to prevent waste material from these pits from entering the river. Such material is now diverted into a wetland approximately 100 m north of the pits. The RCP has not been used since the early 1970s; therefore, it is presently overgrown with shrubs and reeds. It is likely that runoff from the pit enters an adjacent wetland and the Gunpowder River.

The biota at J-Field have not been surveyed in detail; however, common species are likely to include those typical of other areas of the APG. Mammals likely to be common at J-Field include the muskrat, raccoon, white-tailed deer, short-tailed shrew, and white-footed mouse. Common birds could include great blue heron and spotted sandpiper. Because of its status as a federal endangered species, the bald eagle (known to occur at J-Field) is of ecological and regulatory interest. Composition of the fish communities in the J-Field wetlands has not been determined. Common species in the surrounding estuary include alewife, American shad, Atlantic menhaden, channel catfish, and white perch.

2.2 BACKGROUND OF J-FIELD AREAS OF CONCERN

The following sections summarize the past disposal operations conducted at each AOC at J-Field. General descriptions of the hydrology and soils in the vicinity of J-Field are also included. PAOCs are addressed in Appendix B.

2.2.1 Toxic Burning Pits AOC

The TBP AOC is located on about 9 acres in the southern portion of J-Field (Figure 1.3). Disposal operations at the TBP area began in the 1940s and have continued until the present. The pits were used most extensively between the late 1940s and the 1960s. Items disposed of included chemical agents, bulk chemical wastes, drummed chemical wastes, HE (by OB/OD), nerve agents, incapacitating agents (also known as riot control agents), chlorinated solvents, and blister agents (Nemeth 1989).

Information from interviews, sampling, and magnetic surveys indicates that five disposal pits were used at the TBP area. The two existing (or main) burning pits (each covering about 4,500 ft^2) were the pits most actively used for the disposal of various chemical agents and explosives. Three other burning pits, now covered, were used to dispose of VX, dichlorodiethyl sulfide (mustard), and the primary components of liquid smoke — titanium tetrachloride (FM) and sulfur trioxide/chlorosulfonic acid (FS).

The VX pit and mustard pit are about 100 and 150 ft long, respectively. The liquid smoke disposal pit is fairly small, covering an area of about 24 ft^2. Liquid smoke was probably disposed of by placing it on the ground and allowing it to vaporize into the atmosphere. HE munitions were also disposed of by detonation in an area along the southeastern edge of the TBP area (Nemeth 1989).

Storage and handling areas have been identified (in aerial photographs) at the upper end of both the VX burning pit and the mustard burning pit. In addition, a square pit approximately 4 ft by 4 ft and 3 ft deep has been identified at the current tree line south of the main burning pits. These storage and handling areas and the pit could be additional sources of contamination in the TBP AOC.

The TBP area is bounded to the northeast by marsh and to the south and southeast by woods and marsh (Nemeth 1989). Because the elevation of the ground surface is highest in the northwestern portion of the TBP area, surface water probably drains toward the south-southeast into the marsh area. The direction of groundwater flow in the surficial aquifer is probably also toward the marsh. Soils are brownish-yellow silty fine sand at the surface, grading to bluish-gray silty fine sand below a depth of 14 ft (Princeton Aqua Science 1984).

2.2.2 White Phosphorus Burning Pits AOC

The WPP AOC is located near the Gunpowder River in the western portion of J-Field (Figure 1.3). The area contains two pits that were used for disposal (by detonation and burning) of white phosphorus (WP), plasticized white phosphorus (PWP), munitions filled with WP, and materials contaminated with WP. After materials were burned and reburned in the pits, debris and soil were pushed out. Some of the materials disposed of at this site probably contained other types of waste in addition to WP. The types and quantities of these other wastes are unknown, although personal interviews indicate that riot control agents may have been disposed of here (Nemeth 1989).

The WPP area has been used as a disposal site since the late 1940s or early 1950s. Aerial photographs show that in 1951, disposal operations were conducted in the southeastern portion of what is currently the open disposal area. The two existing pits were constructed sometime between 1951 and 1957 (Nemeth 1989).

During the late 1950s, the pits were extended to the Gunpowder River. Pushout from the pits was pushed into the river. In 1986, a ditch was excavated to drain water from the pits. The ditch from the northern pit extends north toward a bermed depression that was constructed to hold the water. The ditch associated with the southern pit ends at what is assumed to be a pushout area. During wet weather, water collects in the pits and the bermed depression, even though surface runoff does not enter the pits (Nemeth 1989; Sonntag 1991). As previously noted, the WPP is considered an active emergency disposal facility. As a result, the existing pits and areas potentially affected by emergency disposal operations have been excluded from this FSP and are deferred pending the relocation of emergency disposal operations. However, aerial photograph interpretation indicates that two suspect burning areas may have existed northwest and southwest of the WPP and that a storage area may have existed southeast of the WPP. These areas could represent sources of contamination and are not likely affected by current operations. As a result, these areas will be addressed in this FSP.

Surface water drainage from the WPP area flowed west into Gunpowder River. The direction of groundwater flow in the surficial aquifer is also probably toward Gunpowder River to the west (Nemeth 1989). Soils are brownish-yellow silty fine sand at the surface, grading to bluish-grey silty fine sand below a depth of 14 ft (Princeton Aqua Science 1984).

2.2.3 Riot Control Burning Pit AOC

The RCP AOC is located in a heavily wooded area in the southwestern portion of J-Field (Figure 1.3). Except for a small area in the northeastern part of the site, the area is overgrown with vegetation. About 30 ft of an access road has been eroded, and the presence of several fallen trees about 10 ft offshore indicates that this area is rapidly being eroded by wave action.

Disposal operations in the pit began in the late 1940s and continued until operations at the site ceased in the early 1970s. The area immediately east of the access road to the South Beach was probably part of the site and may have been used for burning operations during the 1950s. A trench was excavated in the area sometime between 1957 and 1960 and was later extended southwest to the Gunpowder River to provide drainage from the pit. Between 1960 and the early 1970s, the trench was used for burning riot control agents, munitions filled with riot control agents, and material contaminated with these agents (Nemeth 1989). The main agent disposed of was the tear agent o-chlorobenzylidene malononitrile (CS); some chloroacetophenone (CN) was also disposed of there (Sonntag 1991).

Surface water drainage from the RCP area flows toward the southwest into a small marsh area and the Gunpowder River. The direction of groundwater flow in the surficial aquifer is probably toward the marsh and Gunpowder River to the west-southwest. Shallow soils are predominantly clayey sandy silt (Nemeth 1989).

2.2.4 Prototype Building AOC

The PB AOC is located in the southwestern portion of J-Field, northwest of the TBP area and north of the RCP area (Figure 1.3). The building, constructed during World War II, is an open-sided, three-level reinforced concrete structure.. It was originally used for testing the effectiveness of bombs. Since World War II, the PB and the areas to the west and north have been intermittently used for temporary storage of solid waste (Nemeth 1989). Two suspect burning areas have also been identified — one northeast and one west of the PB — on the basis of a review of archival information.

The area around the PB is fairly flat; surface water drains primarily west toward a marsh area (Nemeth 1989) but may also flow north-northwest toward the Gunpowder River. The direction of groundwater flow in the surficial aquifer is probably toward Chesapeake Bay. The shallow soils are predominantly silty, clayey sand with greater amounts of clay and silt near the surface (Nemeth 1989).

2.2.5 South Beach Demolition Ground AOC

The SBDG AOC was located along the southern beach of J-Field (Figure 1.3). The area was used as a demolition site for HE munitions during the 1960s and 1970s, and possibly during the 1950s (Nemeth 1989). Munitions were detonated either on the surface or under several feet of soil. It is reported that remnants of munitions detonated in this area are currently visible about 100 ft offshore during low tide. At high tide, most of the demolition ground area is 1-2 ft below water. A few demolition craters, which are assumedly remnants of the SBDG operations, are visible just inland from the shoreline and east of the end of Rickett's Point Road.

Surface water from the remnants of the SBDG most likely drains south toward Chesapeake Bay. The direction of groundwater flow in the surficial aquifer is probably toward the bay as well. The nature of the shallow soils in the SBDG is undocumented; however, they are most likely composed of clayey sandy silt, similar to the SBT area.

2.2.6 South Beach Trench AOC

The SBT AOC is located near the southern beach of J-Field, southeast of the RCP area (Figure 1.3). The trench, about 75 ft long and 12 ft wide, was excavated between 1957 and 1960. It may have been a borrow pit for nearby demolition activities. Aerial photographs from the 1960s reveal a road leading into and out of the SBT. No information has been found regarding past chemical or hazardous material disposal in this area; however, chemical analyses of soil samples collected from the trench during the RFA showed low levels of chlordane and naphthalene (Nemeth 1989).

Surface water drainage from the SBT is primarily west toward a marsh area (Nemeth 1989), but surface water may also flow south toward Chesapeake Bay. Groundwater in the surficial aquifer probably flows toward Chesapeake Bay. Shallow soils are predominantly clayey sandy silt (Nemeth 1989).

2.2.7 Robins Point Demolition Ground AOC

The RPDG AOC is in the eastern portion of J-Field close to the Bush River (Figure 1.3). The site was first used during the late 1970s for the destruction of HE and HE-filled munitions. The site was also reportedly used during the 1980s for destruction of small amounts of sensitive and unstable chemicals by detonation with explosives (Nemeth 1989).

The original site, now inactive and considered an AOC for the purposes of the RI/FS activities, was a small clearing near the edge of the adjacent marsh. In 1985, the clearing was enlarged, and a berm was built on the western edge of the clearing. Later demolition activities occurred in an area west of the berm; the berm prevented surface runoff from entering the marsh (Nemeth 1989). The area west of the berm has remained active and continues to be used for disposal operations.

Before 1985, surface water drainage from the RPDG flowed directly into the adjacent marsh to the east. The berm constructed in 1985 now prevents runoff from directly entering the marsh. However, water that ponds west of the berm seeps through the berm to the inactive portion of the RPDG. Groundwater in the surficial aquifer probably flows to the east toward the marsh. Shallow soils in the RPDG consist predominantly of clayey silt (Nemeth 1989).

2.2.8 Robins Point Tower Site AOC

The RPTS is located near Robins Point at the southeastern tip of the Gunpowder Peninsula (Figure 1.3). The wooden observation tower was built between 1957 and 1960. The road connecting Robins Point with Rickett's Point Road has existed since about 1917, when APG became an army installation. However, aerial photographs suggest that the area was not used until the 1950s. The Robins Point area was used for launching and observing rockets (Nemeth 1989).

Around 1959, the Robins Point area may have been used for at least one test burn of wood contaminated with radioactive material (including radium and strontium). According to Nemeth (1989), the test burn was to be conducted in a trench (20 ft long, 5 ft wide, and 5 ft deep), with not more than 500 lb of material to be burned in small increments. A 1959 U.S. Army Environmental Hygiene Agency (USAEHA) report recommended that the routine burning of radioactively contaminated materials be conducted in a closed incinerator; correspondence in the USAEHA project file indicates that this recommendation was accepted (Nemeth 1989). The possibility remains, however, that a test burn of radioactively contaminated wood did occur at either the RPDG or the RPTS. Records do not indicate which site was used. However, it is likely that the RPTS was used because the site of the demolition ground was wooded and not yet in use in 1959. In addition, aerial photographs from the 1960s show no roads or open areas at the site of the RPDG.

Surface water from the RPTS probably flows east toward Bush River and south toward the adjacent marsh. Groundwater in the surficial aquifer probably also flows toward Bush River and the marsh. The shallow soils are predominantly sand, with sandy clayey silt near the surface (Nemeth 1989).

2.2.9 Other J-Field Sites

Pursuant to the requests of the Maryland Department of the Environment (MDE), investigative activities have been expanded beyond the eight specified AOCs to include all of J-Field. As a result, a protocol was developed to identify other suspect areas, referred to as PAOCs, on the basis of a review of archival information and walkover surveys. The process used to identify the PAOCs and the sampling activities proposed for the PAOCs are described in Appendix B.

2.3 PRELIMINARY EVALUATION OF J-FIELD AREAS OF CONCERN

Several investigations have been conducted at J-Field to characterize contamination from past operations, install monitoring wells, and characterize the estuarine sediments around the peninsula. Table 2.1 provides a chronological summary of these studies. An overview of the results of these studies is presented in the following sections. These sections present data for J-Field that were collected through January 1993. All data corrected during the RI will be presented in technical updates and the RI report.

2.3.1 Toxic Burning Pits

2.3.1.1 Types of Waste Present

The TBP were used to dispose of HE-filled munitions, nerve agents, mustard agents, CWAs, decontaminating agents, liquid smoke, chlorinated solvents, and radioactive chemicals. In addition, fuel was used to ignite materials placed in the pits.

2.3.1.2 Types of Contaminants Present

A hydrological assessment of J-Field was carried out in two phases by the USGS. Phase I was conducted from 1987 to 1992 to select locations for establishing monitoring wells at the TBP and WPP areas. It was assumed that the pits and the open burning grounds around them were the primary sources of contamination in the area. The goal of Phase II, conducted in 1992, was to determine the extent of contamination in the area of the TBP, sample the RCP area, and determine if contaminated groundwater was moving into Chesapeake Bay (Hughes 1993). The following subsections discuss the findings relative to the nature and extent of contamination in the TBP area.

Soil Gas

During Phase I of the hydrological assessment, the USGS sampled 37 locations around the TBP for soil-gas concentrations of trichloroethylene (TRCLE), tetrachloroethylene (TCLEE), alkanes, combined hydrocarbons, and simple aromatics. The relative contours for

TABLE 2.1 **Summary of Previous Investigations at J-Field**

Field Investigation	Investigator	Date	Objective/Activity
Environmental Contamination Survey	USATHAMA	1977-1978	Conducted to determine if contamination from past operations was migrating off-post. Eleven monitoring wells (TH1-11) were installed in the surficial aquifer — 10 near the TBP and WPP and 1 near the Robins Point Tower. Groundwater samples were collected and analyzed.
Munitions Disposal Study	Princeton Aqua Science	1983	Installed nine monitoring wells (P1-9) in the surficial aquifer — five near the TBP and four near the WPP. Composite soil samples were collected during drilling of wells. Soil samples were also collected from the pits in the TBP and WPP areas.
RCRA Facility Investigation	USAEHA	1986	Sampled groundwater from TH and P series wells. Soil samples also collected in and around the pits in the TBP, WPP, and RCP areas and near the Prototype Building. A field radiation survey was also performed.
Hydrological Assessment, Phase I	USGS	1987-1992	Drilled exploratory boreholes, collected soil samples, and ran geophysical logs. Installed 12 well clusters (JF1-12), each consisting of 3 wells screened in the upper portions of the confined aquifer, the confining unit, and surficial aquifer. Wells were sampled on a monthly (1987) and quarterly basis (1989-1992); water-level measurements also taken. Conducted slug tests. Currently using MODFLOW model to simulate contaminant pathways in groundwater. A total of 21 surface samples also collected from Gunpowder River and Chesapeake Bay. Soil and soil-gas samples collected in TBP and WPP areas.

TABLE 2.1 (Cont.)

Field Investigation	Investigator	Date	Objective/Activity
Characterization and Interim Remediation	Roy F. Weston, Inc.	1992	Activities included topographic survey of J-Field area; survey of UXO in each burning pit and along shoreline of WPP and RCP; construction of access roads; placement of riprap and gabion structures along WPP and RCP shoreline; removal and staging of surface material and debris from burning pit areas; sampling and staging drums from the Prototype Building; sampling and analysis of soil from the pits and pushout areas; installation of flood control berms in the pit areas, where needed; and collection of surface and subsurface soil samples.
Hydrological Assessment-Phase II	USGS	1992	Continued sampling of groundwater, measuring water levels in all monitoring wells, and slug testing. Four new wells installed. Collected surface water samples from marsh areas and estuaries surrounding J-Field, based on thermal imagery studies conducted by the USGS.
Sediment Sampling Study	EPA	1992	Conducted a study to characterize the estuarine sediments around the Gunpowder Neck Peninsula.

all contaminants except the alkanes show a broad band of contamination that extends across the eastern end of the pits from the marsh on the north to the marsh on the south (Figure 2.4). The alkanes appear to be limited to the area south of the TBP, and the data suggest a plume of contamination moving into the marsh at the southern edge (Figure 2.5) (Hughes 1993).

Additional soil-gas samples were collected during Phase II from wooded and marshy areas north and south of the TBP and from 15 locations along Chesapeake Bay. Samples were analyzed for combined dichloroethylenes (DCEs) and trichloroethanes (TCEs), combined TRCLEs and TCLEEs, phthalates, and heavy aromatic hydrocarbons (Hughes 1993).

Relative values and contours for concentrations of combined DCE and TCE and of combined TRCLE and TCLEE show a similar distribution, with elevated contamination to the southeast of the TBP. Figure 2.6 shows contours for combined TRCLE and TCLEE. The DCE plus TCE contamination south of the pits is somewhat more extensive, with elevated values extending to the shore of Chesapeake Bay. The concentration contours, when combined with contours from Phase I analyses, suggest that plumes of contaminated groundwater are moving downgradient under the marshes both on the northern and southern sides of the TBP. This hypothesis is supported by the relative contours for heavy aromatics (Figure 2.7), which show locations with more extensive contamination, including along the shore. The data also suggest that contaminated groundwater may be moving beneath, and possibly discharging into, the bay, or that contaminated surface water from the marshes may be moving into shore sediments (Hughes 1993).

Soil

In 1983, soil samples were collected during the installation of monitoring wells at the TBP. Four composite samples were collected at depth intervals of 5 ft. The samples were analyzed for metals, cyanide, phenols, total phosphorus, volatile organic compounds (VOCs), pesticides, polychlorinated biphenyls (PCBs), and herbicides. Some of the results are listed in Table 2.2. The data showed elevated concentrations of lead, zinc, nitrate, and petroleum hydrocarbons in each of the samples. It should be noted that the background samples also contained somewhat elevated concentrations of petroleum hydrocarbons.

During the 1986 RFA (Nemeth 1989), surface soil samples were collected from 20 locations in the TBP and the debris pushout area (Figure 2.8). All of the samples were analyzed for metals, extractable metals, and explosives-related compounds. The results, as summarized in Table 2.3, show that the surface soil in and around the TBP contain elevated levels of metals, especially lead (up to 2.6% in the pushout area [location 12]); mercury (up to 10.8 mg/kg in one of the pits [location 8]); and cadmium (16.6 mg/kg at location 20). Samples from locations 7 and 12 exceeded the RCRA extraction procedure (EP) limit of 5.0 mg/L for lead (40 CFR 261).

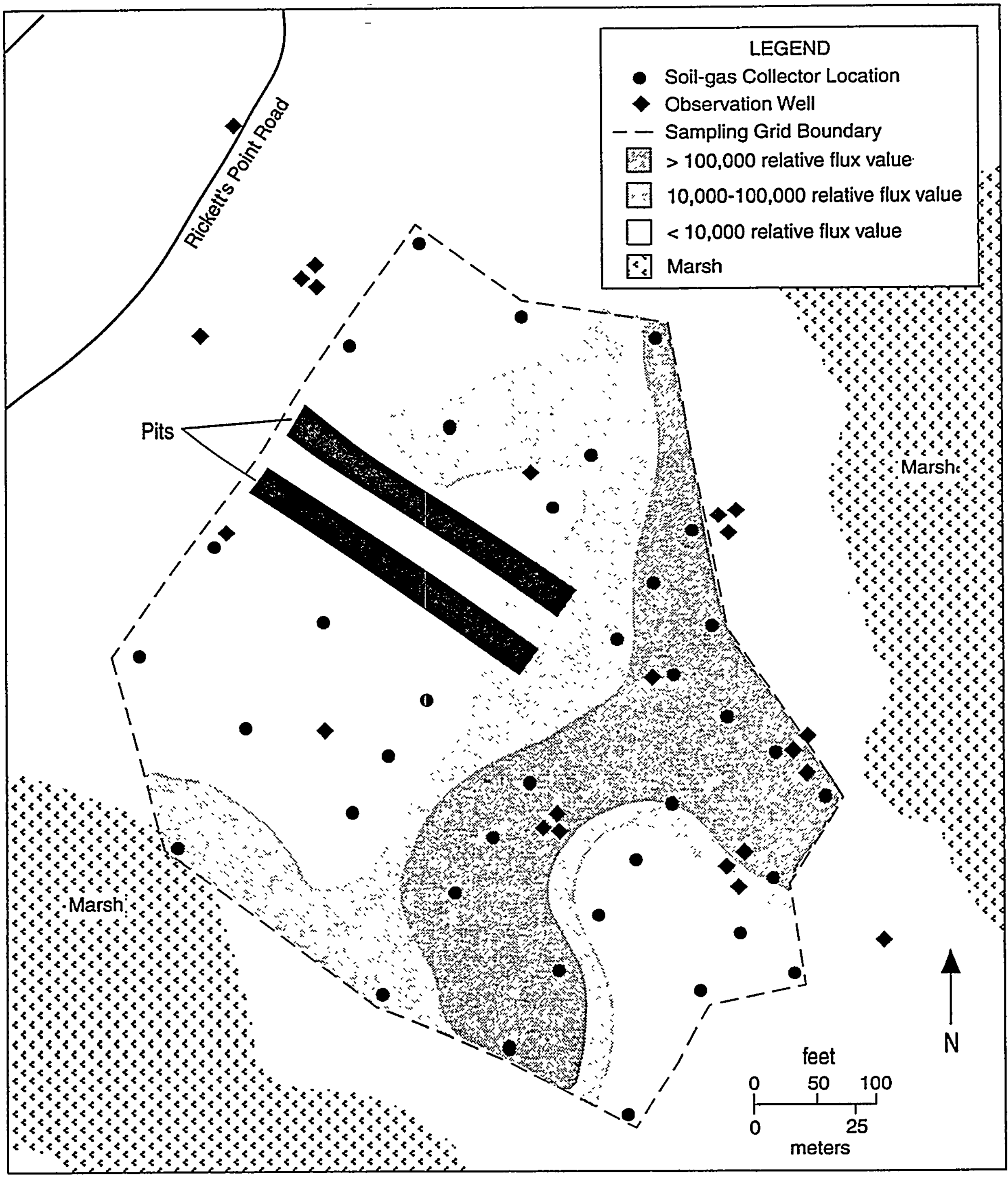


FIGURE 2.4 Relative Contours for all Soil-Gas Parameters (except alkanes) at the Toxic Burning Pits Area (Source: Adapted from Hughes 1993)

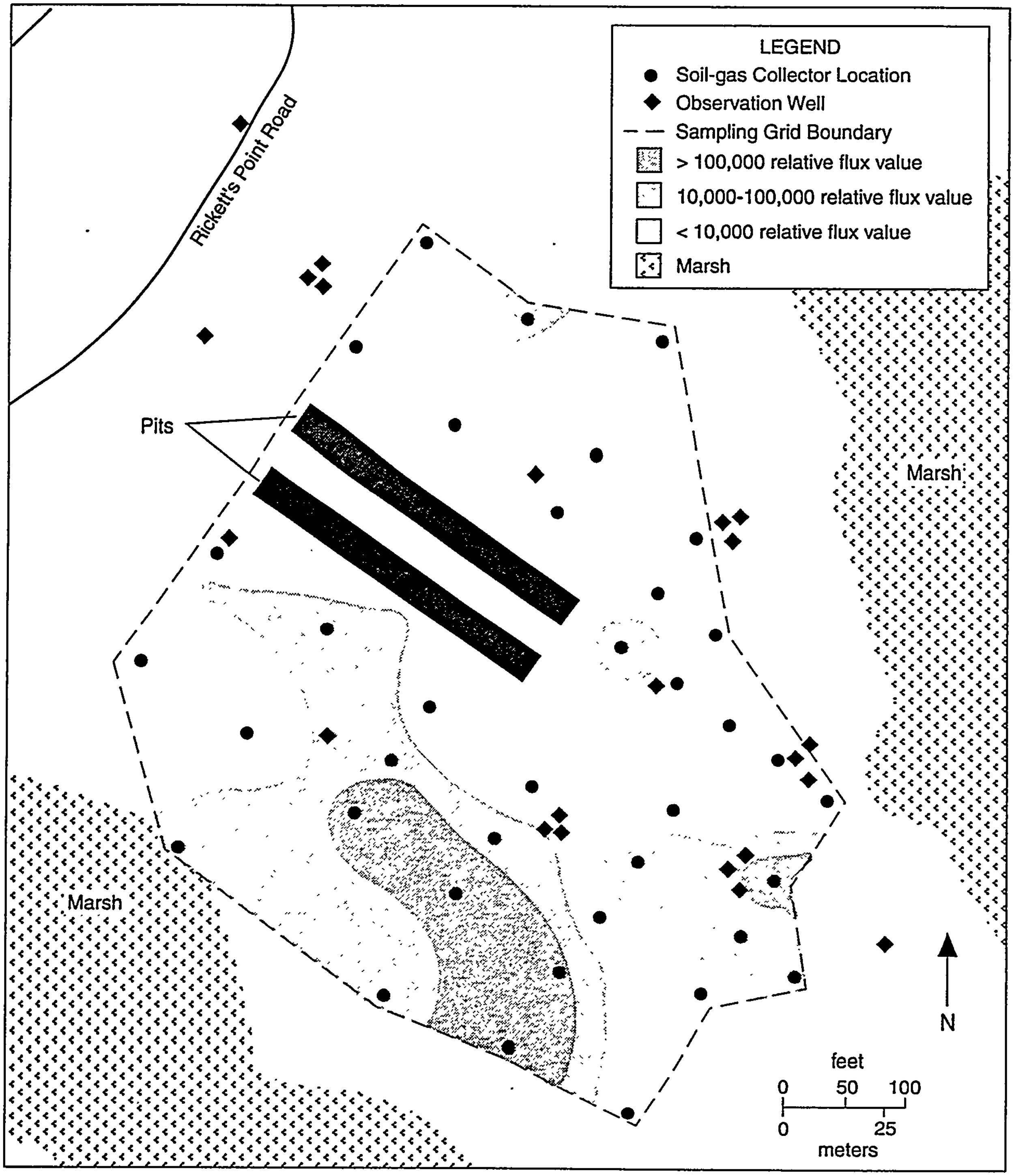


FIGURE 2.5 Relative Contours for Alkanes in Soil Gas from the Toxic Burning Pits Area (Source: Adapted from Hughes 1993)

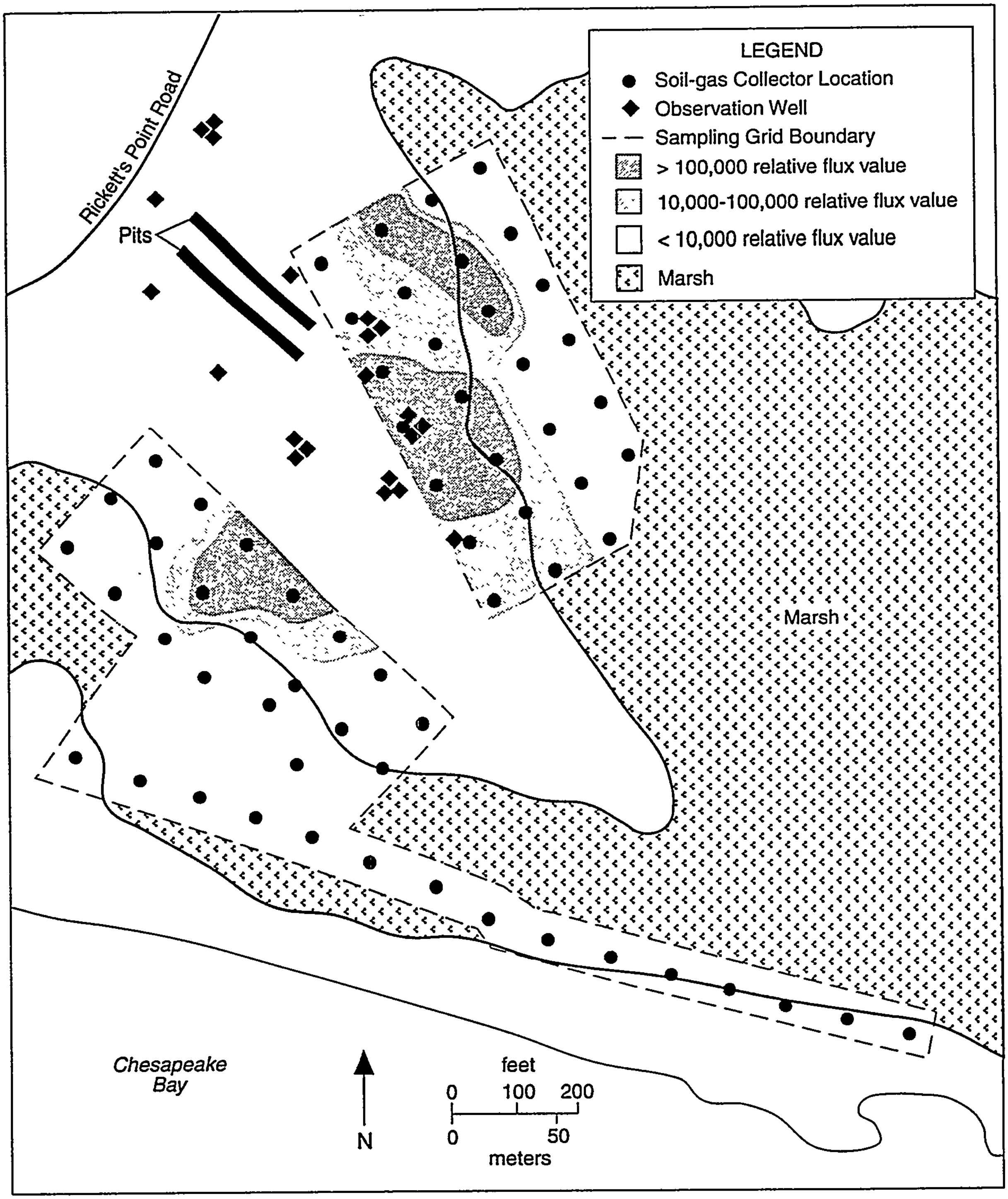


FIGURE 2.6 Relative Contours for Combined TRCLE and TCLEE at the Toxic Burning Pits Area (Source: Adapted from Hughes 1993)

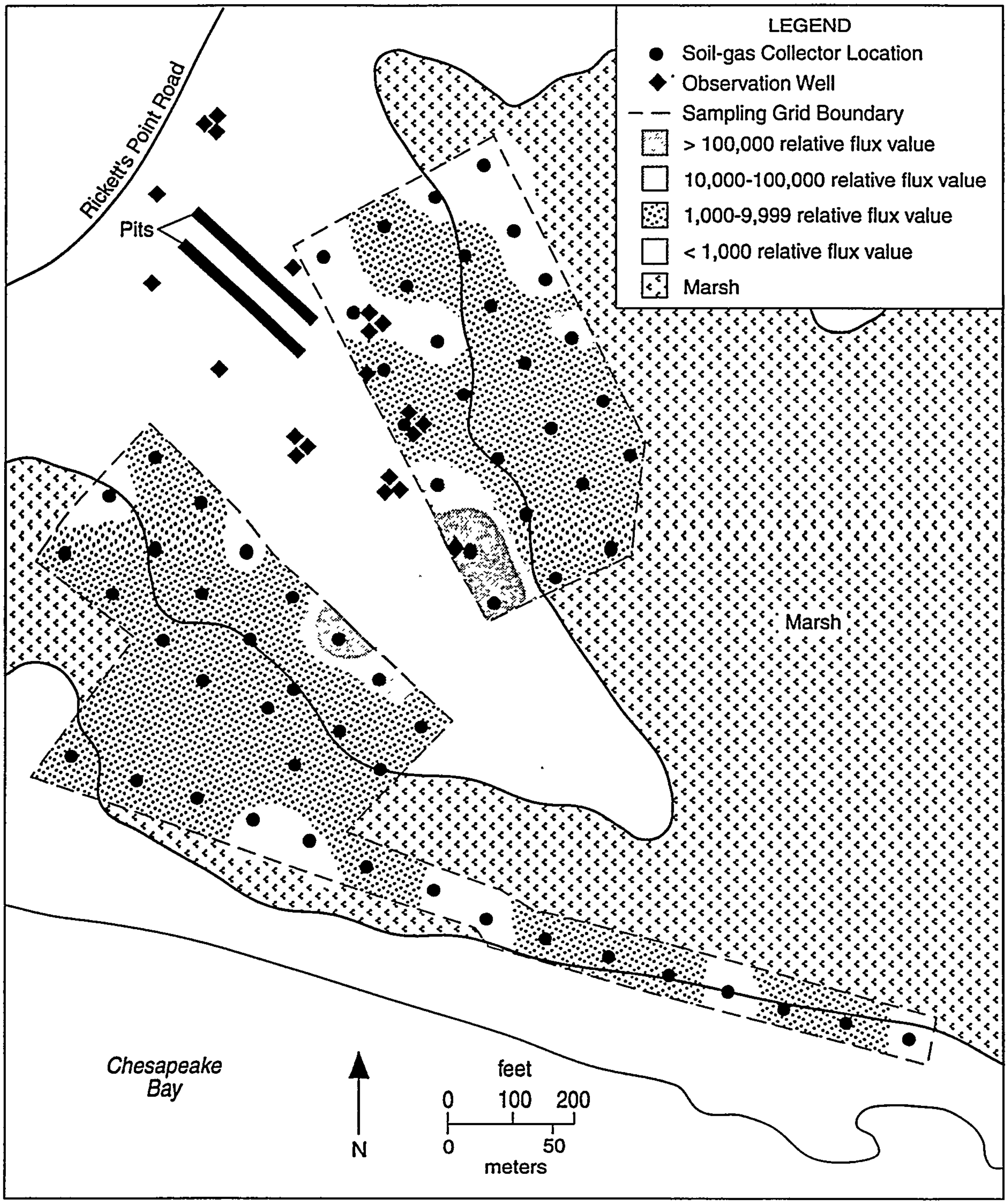


FIGURE 2.7 Relative Contours for Heavy Aromatics in Soil Gas from the Toxic Burning Pits Area (Source: Adapted from Hughes 1993)

TABLE 2.2 Analytical Results for Analysis of Soil Samples from the Toxic Burning Pits AOC Main Burning Pits, January 1983

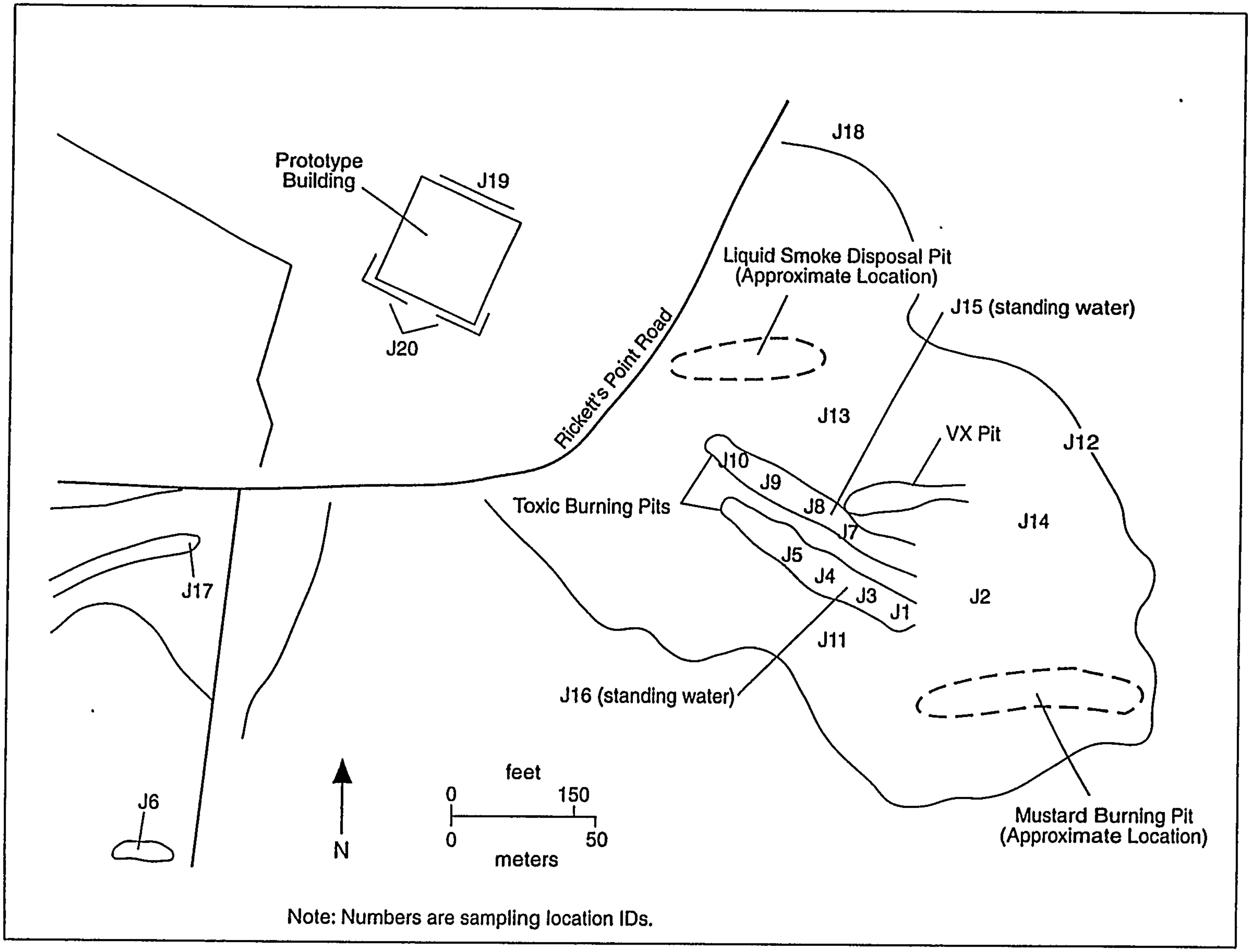
	Parameter Concentrations (mg/kg except as noted)		
Parameter[a]	Background[b]	Pit 1[c]	Pit 2[c]
Arsenic	<0.481	3.56	<0.53
Barium	110	247	257
Cadmium	0.84	4.46	2.19
Chromium	74.70	413	192
Iron	6,000	18,900	17,000
Lead	76.90	717	281
Manganese	153	169	206
Mercury	0.034	0.080	0.008
Potassium	857	1,450	1,650
Zinc	250	1,510	810
pH (standard units)	6.30	8.50	8.80
Nitrate	295	316	249
Total phosphorus	9.00	<0.50	<0.25
Cyanide	<0.50	<0.50	<0.50
Petroleum hydrocarbons	113	800	850
Phenols	0.37	<0.13	0.31
Toluene (μg/kg)	<20.00	32.00	28.00
Ethylbenzene (μg/kg)	20.00	<20.00	<20.00

[a] Table lists all parameters detected at least once.

[b] Locations of background samples not given.

[c] Based on available information, it is inferred that Pit 1 is the northern main burning pit and Pit 2 is the southern main burning pit.

Source: Adapted from Princeton Aqua Science (1984).



Note: Numbers are sampling location IDs.

FIGURE 2.8 Locations in the Toxic Burning Pits Area where Surface Soil and Surface Water Samples Were Collected during the 1986 RCRA Facility Assessment (Source: Adapted from Nemeth 1989)

TABLE 2.3 Analytical Results for Analysis of Soil Samples J1-J20 from the Toxic Burning Pits, 1986

Parameter[a]	J1	J2[b]	J3	J4	J5	J6	J7	J8	J9
Total Metals (mg/kg)									
Arsenic	54.8	25.2	21.5	40.5	18.5	9.7	47.3	25.7	43.9
Barium	592	277	313	90.5	134	<60	488	172	296
Cadmium	8.13	4.57	2.52	4.88	1.58	2.20	17.3	8.64	6.10
Chromium	75.5	54.4	45.9	95.9	70.8	10.7	73.3	76.0	53.3
Lead	472	548	378	85.3	60.3	38.5	2,998	720	1,369
Mercury	0.78	0.87	0.46	0.15	0.22	0.17	2.16	10.8	7.29
Silver	14.0	<5.0	<5.0	12.1	<5.0	<5.00	15.2	7.01	<5.0
Extractable Metals (mg/L)									
Cadmium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.228	<0.10	<0.10
Lead	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	5.23	<0.50	<0.50
Silver	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50

	J10	J11	J12	J13	J14	J17	J18	J19	J20
Total Metals (mg/kg)									
Arsenic	32.2	12.6	24.1	8.26	28.7	15.9	6.5	9.74	12.3
Barium	208	101	855	107	256	<60	81.4	<60	<60
Cadmium	4.75	0.27	3.57	1.01	1.47	5.02	<0.20	5.38	16.6
Chromium	58.0	12.1	80.1	19.2	30.4	63.9	6.65	15.4	13.5
Lead	4,101	15.8	26,040	41.8	1,522	203	12.1	140	1,622
Mercury	6.10	0.11	0.77	0.11	0.59	0.20	<0.10	0.28	3.40
Silver	<5.0	<5.0	<5.0	<5.0	<5.0	8.64	<5.0	<5.0	<5.0
Extractable Metals (mg/L)									
Cadmium	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.112
Lead	<0.50	<0.50	31.2	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Silver	<0.50	<0.50	<0.50	<0.50	0.154	<0.50	<0.50	<0.50	<0.50

[a] Includes parameters that were detected in at least one soil sample.

[b] VOCs were measured in sample J2 only; 1,000 µg/kg TRCLE and traces of other VOCs were found.

Source: Nemeth (1989).

Composite samples from locations 1 and 2 contained 13,000 µg/kg heptachlor epoxide and lower concentrations of other pesticides. Aroclor 1248 (a PCB) was detected at a concentration of 230,000 µg/kg. Composites from locations 3 through 5, 7 through 10, 19, and 20 (near the PB) also contained pesticides — 1,000 µg/kg each dichlorodiphenyldichloroethane (DDD), dichlorodiphenyldichloroethylene (DDE), and dichlorodiphenyltrichloroethane (DDT) (in locations 19 and 20 only); and 3,700 µg/kg PCBs (locations 3 through 5 only). Hughes (1993) states that detection of pesticides in samples containing PCBs may represent false positives. PCBs reportedly were used as heat-transfer fluids at the Edgewood Area and disposed of at J-Field (Nemeth 1989). Trace concentrations of organic compounds were also detected in samples: TRCLE (at 1,000 µg/kg) and traces of other VOCs in the sample from location 2, the only sample analyzed for VOCs.

Soil samples were collected by the USGS from depths of approximately 1 ft below land surface at 36 sites in J-Field, including the TBP area (Figure 2.9). The samples were analyzed for indicator parameters, metals, VOCs, semivolatile compounds, and explosives (Hughes 1992). The results of these analyses, except for explosives, are presented in Table 2.4. Soil samples showed some metals contamination, especially at locations 39 and 30, north of the Mustard Pit. Traces of organic compounds were also detected in some samples.

Soil samples were also collected in the TBP area by Weston in October 1992 (Figure 2.10). The samples were collected at depths of 2, 4, and 6 ft in the pits; and at depths of 3 in. and 1 ft in the marshes and pushout areas. Tables 2.5 and 2.6 summarize the analytic results for parameters detected in some of these samples.

The highest concentrations of organic compounds were found in the area of the Mustard Pit: TCLEA, up to 3,270,000 µg/kg at 6 ft; 1,1,2-trichloroethane (112TCE), up to 8,500 µg/kg at 6 ft; TCLEE, up to 25,700 µg/kg at 6 ft; and trichloroethene, up to 263,000 µg/kg at 6 ft. Organic compounds, including TCLEA, 112TCE, acetone methylene chloride, and TRCLE, were detected in the main burning pits (see Table 2.6). High levels of PCBs were detected in the southern main pit (up to 143,000 µg/kg at 2 ft), the mustard pit (up to 178 µg/kg at 6 ft), the southern marsh (up to 3,200 µg/kg at 1 ft), and the pushout area northwest of the main pits (up to 3,800 µg/kg at 1 ft). The highest concentrations of lead were found in the southern main pit (340 mg/kg at 2 ft), the mustard pit (121 mg/kg at 6 ft), the southern marsh — (542 mg/kg at 1 ft), the marsh east of the main pits (79,800 mg/kg at 3 in.), and the pushout area northwest of the main pits (1,180 mg/kg at 3 in.).

Surface Water

Surface water samples (J15 and J16) were collected from the TBP area as part of the 1986 RFA (Nemeth 1989). Sampling locations are shown in Figure 2.8. Samples were analyzed for metals, explosives-related compounds, inorganic compounds, gross alpha, gross beta, radium-226, radium-228, VOCs, semivolatile compounds, and PCBs. The results are summarized in Table 2.7 for locations J15 and J16.

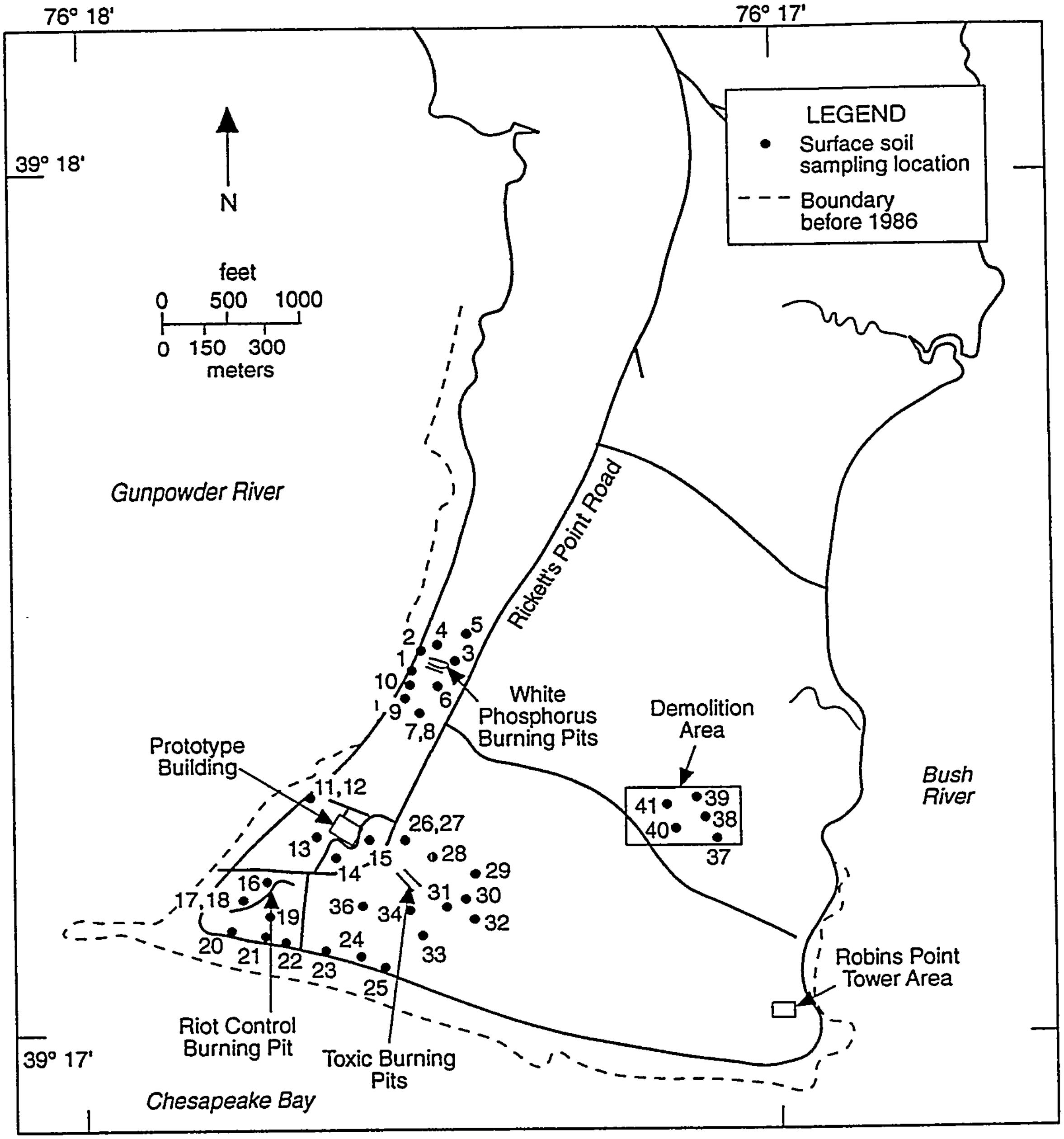


FIGURE 2.9 Locations where Soil Samples Were Collected by the USGS in 1991 (Source: Adapted from Hughes 1992)

TABLE 2.4 Analytical Results for Analysis of Soil Samples from the Toxic Burning Pits Area, April 1991[a]

Parameter	Concentration by Soil Sample Location[b]												
	23	24	25	26	27	28	29	30	31	32	33	34	36
Metals (mg/kg)													
Arsenic	3.7	3.2	ND	4.5	4.2	7.8	49	21	2.6	3.3	3.5	6.6	3.2
Cadmium	ND	ND	ND	ND	ND	2.4	16	ND	ND	ND	ND	ND	ND
Chromium	14	11	6.6	16	15	37	121	46	12	13	13	17	17
Copper	21	50	10	22	19	233	786	48	4.2	11	15	40	17
Lead	17	40	14	41	38	662	87,100	952	15	17	29	42	19
Antimony	ND	ND	ND	ND	ND	ND	1,120	ND	ND	ND	ND	ND	ND
Zinc	ND	ND	20	96	157	ND	7,960	ND	25	ND	ND	ND	ND
Volatile Organic Compounds (µg/kg)													
Acetone	5.89	13.9	6.73	15.8	6.75	9.80	15.7	4.88	2.24	ND	21.0	ND	ND
cis-1,2-Dichloroethylene	NA	NA	NA	NA	NA	2.4	NA	2.40	NA	NA	NA	NA	NA
Trichloroethylene	ND	ND	ND	ND	ND	1.12	ND	ND	ND	ND	ND	ND	ND
Semivolatile Organic Compounds (µg/kg)													
Butylbenzl phthalate	ND	598	ND	ND	720	ND	580	ND	ND	ND	ND	ND	ND
Benzoic acid	353	7,000	1,500	ND	ND	ND	420	420	ND	ND	2,100	ND	ND
Other (mg/kg)													
Total Kjeldahl nitrogen	1,040	2,340	695	249	247	637	605	488	627	1,030	1,730	639	552
Total organic carbon	958	2,590	1,630	1,190	1,720	1,590	1,630	1,190	1,390	871	1,810	752	1,010
Total organic halogen	ND	ND	157	20	48	37	34	ND	ND	ND	ND	ND	ND

[a] ND = not detected; NA = not analyzed.

[b] Locations are shown in Figure 2.9.

Source: Hughes (1992).

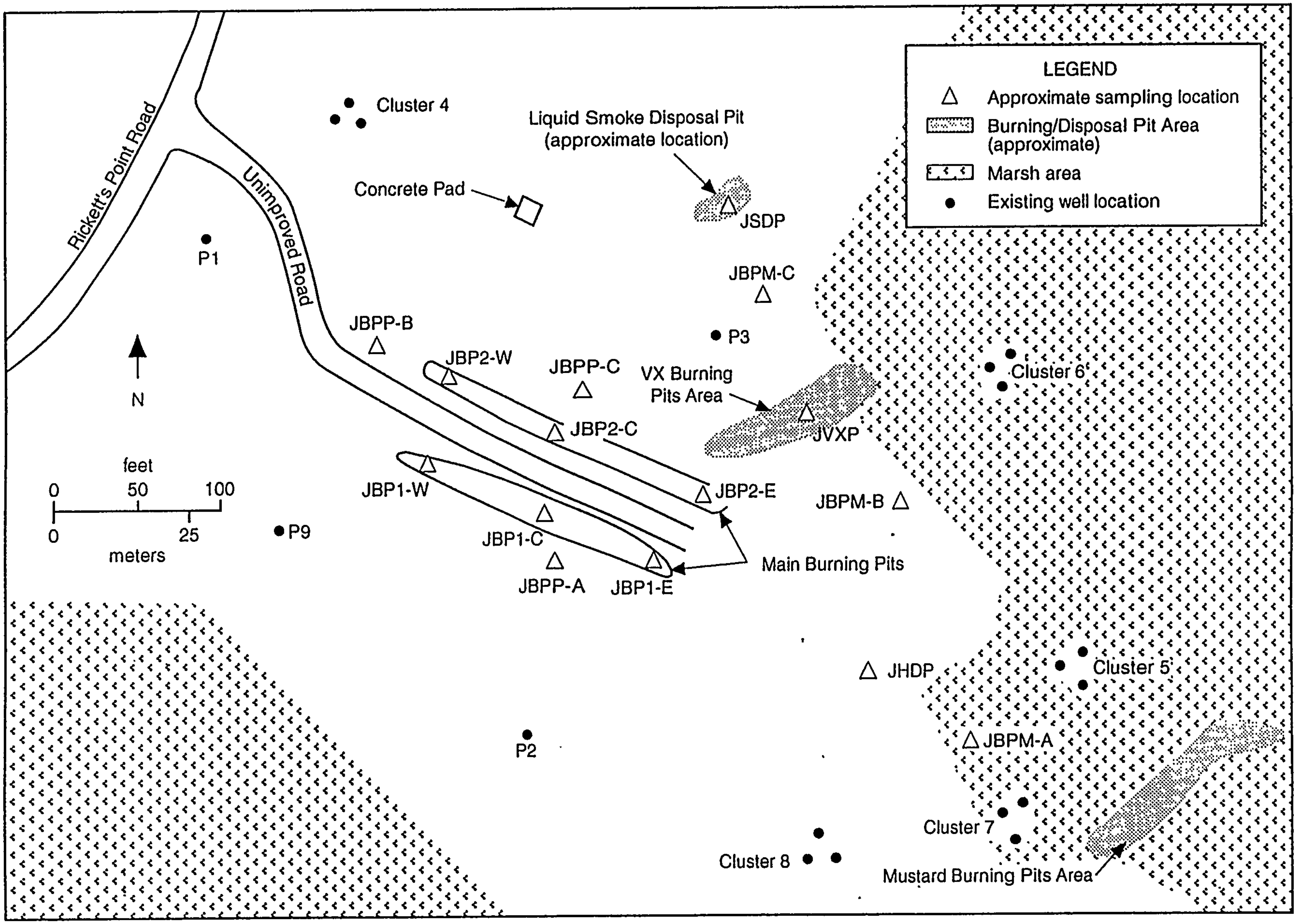


FIGURE 2.10 Locations of Soil Sampling Conducted by Weston in 1992 in the Toxic Burning Pits AOC (Source: Adapted from Mazelon 1993)

TABLE 2.5 Analytical Results for Target Compound List Analytes in Selected Soil Samples from the Toxic Burning Pits, 1992[a]

	Concentrations (μg/kg) by Soil Sample Location							
TCL[b] Analyte	JBP1-E(2′)[c]	JBP1-E(4′)	JBP2-E(2′)	JBP2-E(4′)	JVXP(4′)	JVXP(6′)	JSDP(4′)	JSDP(6′)
Volatile Organic Compounds								
1,1,2,2-Tetrachloroethane	6.74	ND[d]	ND	ND	167	39	15,200	25.6
1,1,2-Trichloroethane	ND	ND	ND	ND	ND	ND	80.5	ND
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND
1,1-Dichloroethylene	ND	ND	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND	ND	ND
Acetone	16.4	33	44.7	116	ND	ND	344	ND
Benzene	ND	ND	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	ND	ND	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	ND	6.23	ND	6.30	7.03	8.25	44.0	12.4
Tetrachloroethylene	ND	ND	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethylene	ND	ND	ND	ND	ND	ND	78.0	ND
Trichloroethylene	28.1	ND	ND	ND	ND	15.8	345	ND
Vinyl chloride	ND	ND	ND	ND	ND	ND	ND	ND
Xylenes	12.4	ND	ND	ND	ND	ND	ND	ND
Semivolatile Organic Compounds								
2-Methylnaphthalene	471	ND	ND	ND	ND	ND	ND	ND
Hexachloroethane	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	580	ND	ND	ND	ND	ND	ND	ND
PCBs								
Aroclor 1248	143,000	1,180	ND	ND	ND	ND	ND	ND
Aroclor 1254	ND	ND	224	ND	ND	ND	ND	ND

TABLE 2.5 (Cont.)

TCL Analyte	Concentration (µg/kg) by Soil Sample Location					
	JHDP(4′)	JHDP(6′)	JBPM-A(3″)	JBPM-A(1′)	JBPM-B(3″)	JBPM-B(1′)
Volatile Organic Compounds						
1,1,2,2-Tetrachloroethane	289,000	3,270,000	123	1,460	13,200	15,200
1,1,2-Trichloroethane	2,100	8,540	61.0	ND	80.2	ND
1,1-Dichloroethane	ND	8.99	ND	ND	ND	ND
1,1-Dichloroethylene	31.3	77.6	ND	ND	ND	ND
1,2-Dichloroethane	40.1	62.4	ND	ND	ND	ND
Acetone	177	113	275	ND	324	ND
Benzene	19.1	83.1	ND	ND	ND	ND
Carbon tetrachloride	17.1	172	ND	ND	ND	ND
Chloroform	142	445	ND	ND	ND	ND
Methylene chloride	44.9	41.2	36.1	ND	36.2	ND
Tetrachloroethylene	ND	25,700	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	ND	ND
trans-1,2-Dichloroethylene	3,860	3,220	ND	ND	50.4	ND
Trichloroethylene	6,780	263,000	843	26,000	517	ND
Vinyl chloride	315	302	ND	ND	ND	ND
Xylenes	ND	ND	ND	ND	ND	ND
Semivolatile Organic Compounds						
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND
Hexachloroethane	ND	628	ND	498	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND
PCBs						
Aroclor 1248	ND	178	ND	ND	ND	ND
Aroclor 1254	ND	ND	1,700	3,160	ND	ND

[a] Only detected analytes are reported; for samples with duplicate analyses, the higher value is reported.

[b] TCL = Target Compound List.

[c] Sample depth shown in parentheses.

[d] ND = not detected.

TABLE 2.6 Analytical Results for Target Analyte List Analytes in Selected Soil Samples from the Toxic Burning Pits, 1992[a]

	Concentration (mg/kg) by Soil Sample Location						
TAL[b] Analyte	JBP1-E(2′)[c]	JBP1-E(4′)	JBP2-E(2′)	JBP2-E(4′)	JVXP(4′)	JVXP(6′)	JSDP(4′)
Antimony	5.08	ND[d]	ND	ND	ND	ND	ND
Arsenic	5.02	4.18	3.50	2.33	1.19	ND	1.38
Beryllium	0.309	0.453	0.228	0.380	ND	ND	ND
Cadmium	3.21	ND	ND	ND	ND	ND	ND
Chromium	36.6	18.2	14.2	12.7	5.33	3.15	4.09
Cobalt	5.64	ND	ND	ND	ND	ND	ND
Copper	248	10.1	6.85	10.1	ND	ND	ND
Lead	340	10.5	15.9	96.3	10.5	2.6	3.37
Zinc	1,220	123	94.4	76.5	33.8	13.1	13.5

	Concentration (mg/kg) by Soil Sample Location						
TAL Analyte	JSDP(6′)	JHDP(4′)	JHDP(6′)	JBPM-A(3″)	JBPM-A(1′)	JBPM-B(3″)	JBPM-B(1′)
Antimony	ND	ND	ND	ND	ND	13.7	ND
Arsenic	ND	3.94	6.29	4.80	22.5	7.49	3.58
Beryllium	ND	0.457	0.408	0.434	0.263	0.339	0.398
Cadmium	ND	ND	7.23	2.95	6.05	5.94	ND
Chromium	5.54	11.9	44.1	37.8	67.9	53.4	15.6
Cobalt	ND	ND	ND	ND	ND	6.41	ND
Copper	ND	ND	123	305	392	521	4.77
Lead	8.22	10.5	121	145	542	79,800	11.2
Zinc	12.8	25.1	296	690	678	1,000	46.9

[a] Only detected analytes are reported; for samples with duplicate analyses, the higher value is reported.

[b] TAL = Target Analyte List.

[c] Sample depth shown in parentheses.

[d] ND = not detected.

Source: Mazelon (1993).

TABLE 2.7 Analytical Results for Surface Water Samples from the Toxic Burning Pits Area, 1986

Parameter[a]	Location J15	 J16
Dissolved Metals (μg/L)		
Cadmium	<1.0	2.0
Lead	40	104
Mercury	0.60	<0.20
Inorganic Compounds (μg/L)		
Nitrate and nitrite as N	<30	60
Sulfate	12,000	16,000
Chloride	3,000	4,000
Total dissolved solids	NA[b]	34,000
Radioactivity (pCi/L)		
Gross alpha	<0.8	7.0
Gross beta	5.7	15
Radium-226	NA	0.50
Radium-228	NA	1.4

[a] Includes parameters that were detected in one or more samples. No detection limits given for VOCs, semivolatile compounds, and PCBs.

[b] NA = Not analyzed.

Source: Nemeth (1989).

The surface water contained some lead contamination. The lead concentration at location 16 was above the primary drinking water standard (50 μg/L). The gross alpha radionuclide was also slightly elevated at location 16. The radioactivity measurements were consistent with results from a field radiation survey of the TBP for materials emitting beta and gamma radioactivity. No radiation above background levels was detected (Nemeth 1989).

The USGS collected nearshore surface water samples from the Gunpowder River (9 locations) and the Chesapeake Bay (11 locations) at low tide. One sample was collected onshore in a drainage ditch. Sampling locations are shown in Figure 2.11. Filtered and unfiltered samples were analyzed for water quality parameters, metals, and a few organic compounds. Nitrate concentrations in samples from locations 3, 7, and 13 ranged from 280 to 400 μg/L. The metals data showed the presence of lead (from not detected [ND][1] to

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[1] The detection limits for analyses were not reported.

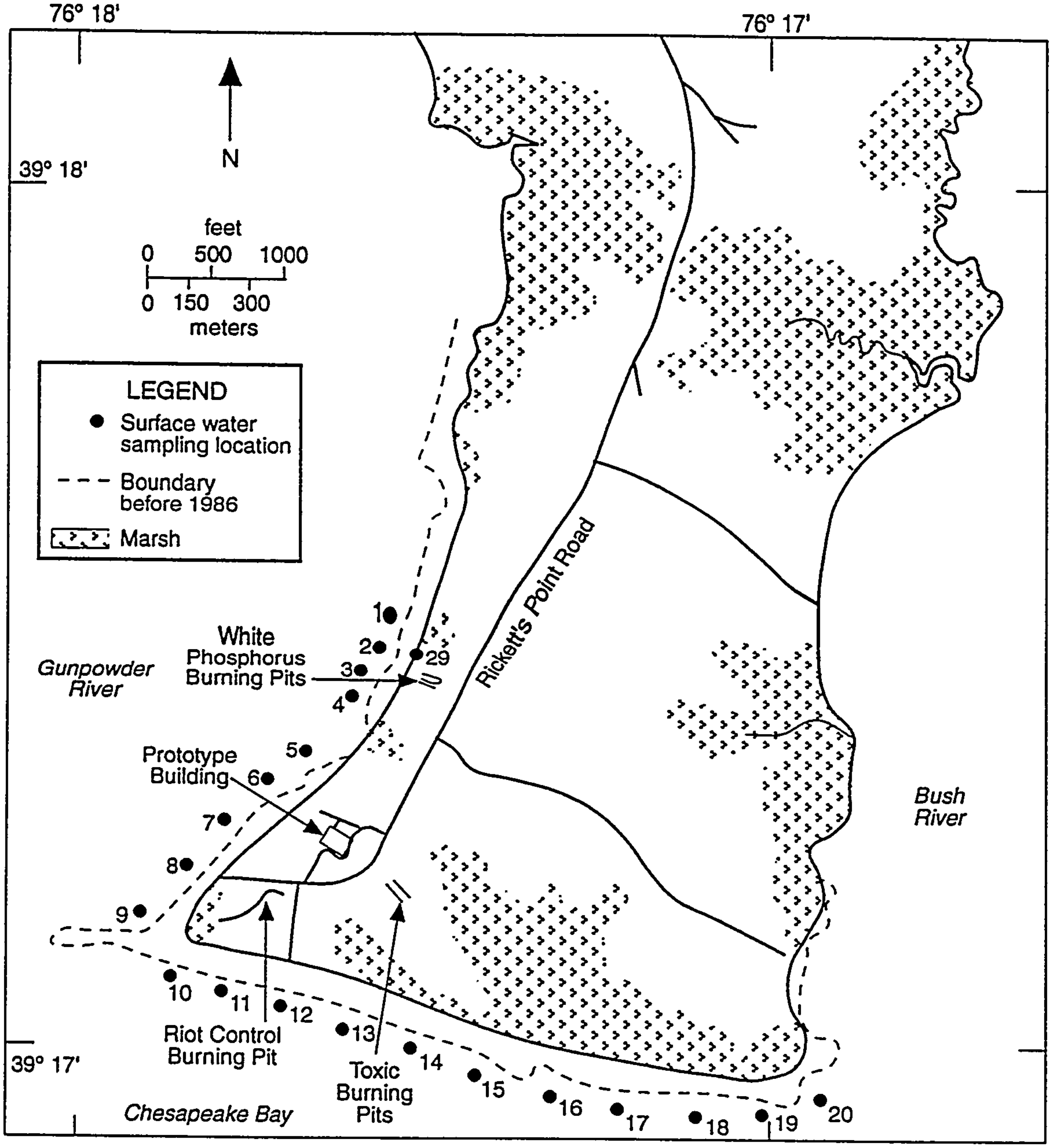


FIGURE 2.11 Locations of Surface Water Samples Collected at J-Field in 1988 (Source: Adapted from USGS 1991)

28 µg/L) and zinc (50-133 µg/L) at locations 1 through 4. Lead and zinc concentrations at the other locations ranged from ND to 2.68 and 48 µg/L, respectively. Mercury and nickel concentrations were slightly elevated at location 1 (0.54 and 33.7 µg/L, respectively). No evidence was found of elevated concentrations of arsenic, barium, or chromium. Comparison of results from filtered and unfiltered samples showed that the elevated metals concentrations may be associated with the suspended solids in the samples (Hughes 1993).

Acetone, toluene, phenol, total organic carbon (TOC), and total organic halogen (TOX) were analyzed in the filtered and unfiltered samples from nine locations. Phenol (ND to 51.9 µg/L), TOC (4,000-7,000 µg/L), and TOX (21.6-30.4 µg/L) were detected in the unfiltered samples only. The presence of acetone in some of the samples may represent laboratory contamination. Toluene (3.05 µg/L) was found at location 1 (Hughes 1993).

The data for the nearshore surface water have shown essentially no contamination. Contaminants appear to be associated with the suspended solids, suggesting that the nearshore sediments may be contaminated.

In August 1992, the EPA emergency response team (ERT) collected nearshore surface water and sediment samples at 17 locations around the peninsula — in the Gunpowder and Bush rivers and in Chesapeake Bay (Figure 2.12). Filtered surface water samples were analyzed for VOCs, base neutral and acid extractable organic compounds (BNA), Target Analyte List (TAL) metals, pesticides, PCBs, and inorganic parameters (sulfate, total Kjeldahl nitrogen [TKN], total phosphorus, and cyanide). The data showed that beryllium, lead, and mercury were below their respective detection limits of 6,000, 6,000, and 200 µg/L. Zinc concentrations ranged from 11,000 µg/L at locations 3, 4, and 16 to 96,000 µg/L at location 6. Nickel concentrations ranged from 28,000 µg/L at most locations to 38,000 µg/L at location 9. No cyanide, VOCs, pesticides, or PCBs were detected.

Sediment samples, collected at the same locations as the surface water, were analyzed for CWAs and CWA degradation products, explosives, VOCs, BNA, TAL metals, pesticides, PCBs, and other parameters (TOC, sulfate, total phosphorus, TKN, and percent solids). The results indicate that there is essentially no contamination in sediments at these locations, although lead was detected at concentrations ranging from 2 mg/L at location 11 to 22 mg/L at location 17. Arsenic and cadmium were also detected: arsenic at concentrations ranging from 1 to 6 mg/L (at location 6) and cadmium at concentrations ranging from <0.5 to 3 mg/L (at location 8). The detection limit for beryllium was fairly high, ranging from 0.5 to 2.6 mg/L. The only VOC detected was acetone, up to 101 µg/kg at location 7.

Groundwater

Eleven groundwater monitoring wells (TH series) were installed in J-Field during the 1977 environmental survey. Locations of these wells are shown in Figure 2.13. Only one well (TH4) was installed in the area of the TBP. Well depths ranged from 20 to 25 ft. The

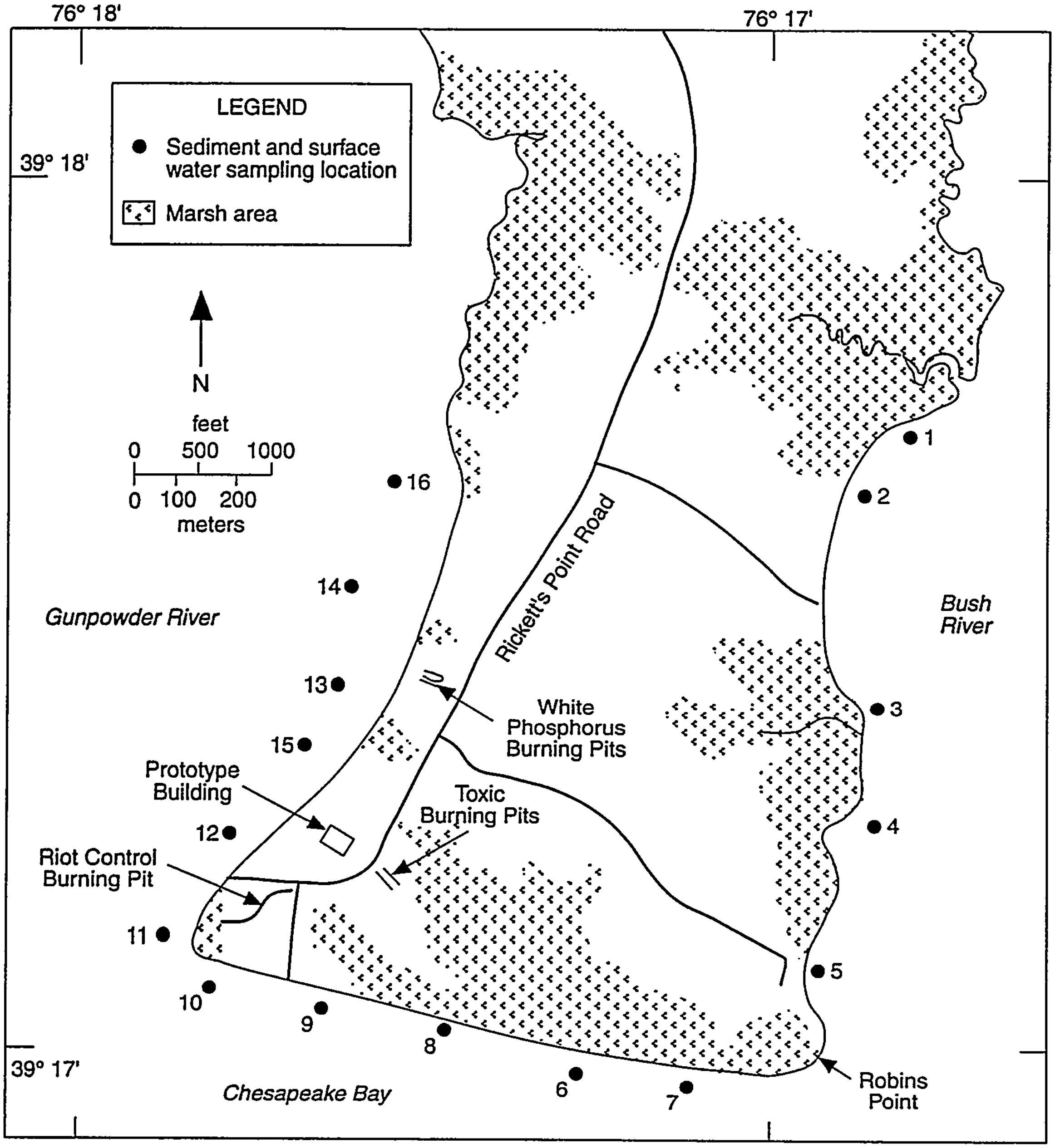


FIGURE 2.12 Locations of Surface Water and Sediment Samples Collected at J-Field in 1992 (Source: EPA 1992)

wells were screened in the surficial aquifer with 25-ft-long screens (Sonntag 1991). Samples collected from the wells in 1977 were analyzed for metals, inorganic chemicals, white phosphorus, mustard degradation products, cholinesterase inhibitors, semivolatile compounds, and VOCs. Organic contaminants (up to 200,000 µg/L) were found in all of the wells (no data were given for TH7).

Five additional wells were installed around the TBP as part of a munitions disposal study (Figure 2.13, P series) (Princeton Aqua Science 1984). The wells were screened in the surficial aquifer from depths of 17-20 ft with 15-ft-long screens (Sonntag 1991). Water samples collected from the wells in 1983 were analyzed for metals, nitrate, TOX, TOC, radioactivity, pesticides, herbicides, and secondary drinking water parameters. Two of the five wells (P4 and P5) contained elevated concentrations of the gross beta radionuclide (140 and 12 pCi/L, respectively). Two wells (P3 and P4) contained TOX (6.6 and 7.1 mg/L, respectively). Two wells (P2 and P5) contained elevated concentrations of nitrates (12 and 10 mg/L, respectively).

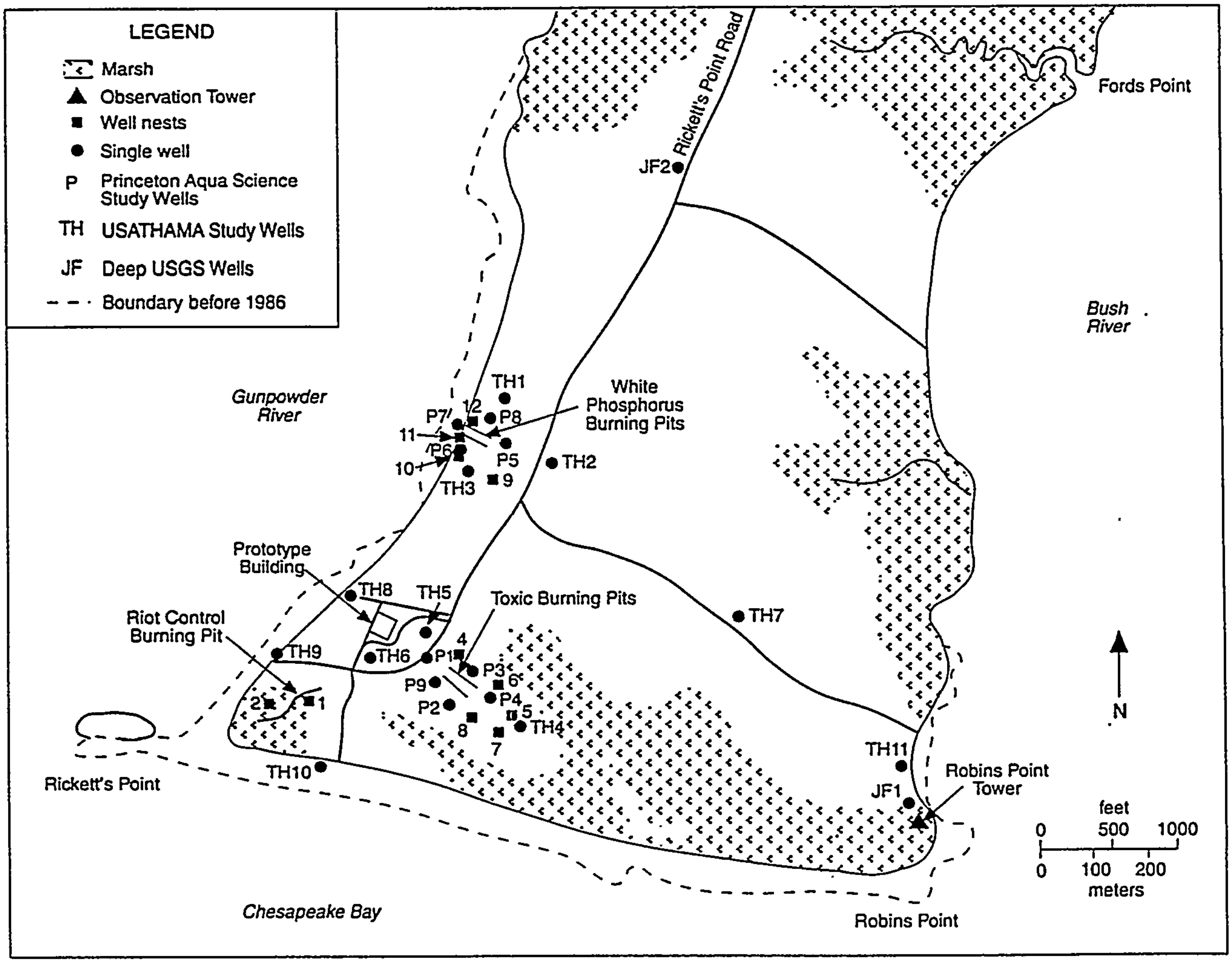


FIGURE 2.13 Locations of All Wells Installed at J-Field (Source: Adapted from Hughes 1993)

The P-series wells were sampled again in 1986 as part of the Edgewood Area RFA (Nemeth 1989). The samples were analyzed for metals, explosives-related compounds, inorganic compounds, radioactivity, thiodiglycol, VOCs, semivolatile compounds, and PCBs. The results are summarized in Table 2.8. Elevated concentrations of VOCs were found in only two wells (P3 and P4), near the area exhibiting soil-gas contamination. The compounds found include trans-1,2-dichloroethylene (trans-12DCE), up to 8,500 µ/L in well P4; TRCLE, up to 6,700 µg/L in well P4; vinyl chloride, up to 550 µg/L in well P3; and TCLEE, up to 420 µg/L in well P3. The data also indicate that the elevated gross beta activity detected in well P3 was due to naturally occurring potassium-40; however, it is not clear why potassium concentrations were so much higher in this well than in the others.

Thirty-eight additional monitoring wells were installed by the USGS in 1988 and 1989 (Sonntag 1991; Hughes 1993). Two of these wells, JF1 and JF2, were installed and screened in the Potomac Group. The 36 other wells were placed in nests of 3 at 12 different locations (Figure 2.13). Well nests JF3-JF8 were placed in the TBP area. The nested wells were screened in the confined aquifer, the leaky confining unit, and the surficial aquifer. The naming convention for the well nests involves a combination of letters and numbers. The letters with numbers (i.e., JF1-JF12) indicate the location. This location indicator code is then coupled with the numbers 1, 2, or 3 to indicate the strata being monitored. The confined aquifer is designated by the number 1, the leaky confining unit by the number 2, and the surficial aquifer by the number 3.

During 1990, samples from 55 of the 58 existing wells at J-Field were analyzed for metals, inorganic compounds, VOCs, and semivolatile organic compounds. Several of the wells were also analyzed for organosulfur, explosives, and radioactive contaminants. Wells were selected for specific contaminant analyses on the basis of the nature of disposal activities that had occurred nearby (USGS 1991).

Table 2.9 summarizes the analytical results indicating the presence of metals and other inorganic compounds. Concentrations of lead (124 µg/L) in well P9 and arsenic (60 µg/L) in well JF83 exceed maximum contaminant levels (MCLs). Both of these wells are downgradient from the TBP. Potassium concentrations ranged from not detected to 140 µg/L. Except for one measurement at well P3, the elevated concentrations of potassium (above 50 µg/L) occurred in the leaky confining unit or the confined aquifer. Movement of sea water into the groundwater may not be a source of potassium because wells with elevated potassium do not have elevated chloride concentrations.

The analytical results (summarized in Table 2.10) show that the TBP are contaminated with VOCs, and a contaminant plume in the groundwater extends downgradient to the southeast. This condition is reflected in the elevated concentrations of 112TCE, 1,2-dichloroethylene (12DCE), TCLEA, TCLEE, and TRCLE in well nests JF5, JF7, and JF8. The concentrations are highest in the surficial aquifer — up to 7,150 µg/L 12DCE in wells JF73 and JF83. The data also show that some contamination extends down into the leaky confining unit and the confined aquifer (1,400 µg/L TRCLE in the leaky confining unit [JF82]

TABLE 2.8 Analytical Results for Groundwater from the P-Series Monitoring Wells, 1986

Parameter[a]	Concentration by Well				
	P1	P2	P3	P4	P9
Dissolved Metals (μg/L)					
Arsenic	<10	<10	24	<10	<10
Cadmium	<1	<1	<1	3	<1
Lead	<5	<5	<5	90	<5
Selenium	<5	9	54	26	<5
Potassium	1,040	733	113,000	1,380	782
Inorganic Compounds (μg/L)					
Nitrate/nitrite as N	490	12,000	<50	<50	8,000
Sulfate	54,000	105,000	362,000	93,000	94,000
Chloride	4,800	23,000	304,000	866,000	24,000
Total phosphate as P	NA[b]	NA	NA	NA	NA
Total dissolved solids	125,000	328,000	1,403,000	1,087,000	262,000
Radioactivity (pCi/L)					
Gross beta	1.3	2.5	100	<4.8	1.4
Potassium-40	NA	NA	120	NA	NA
Radium-226	NA	NA	0.43	NA	NA
Volatile Organic Compounds (μg/L)					
Benzene	ND[c]	ND	6.0	ND	ND
Chlorobenzene	ND	ND	980	ND	ND
Ethyl benzene	ND	ND	3.0	ND	ND
Toluene	ND	ND	5.0	ND	ND
Chloroform	ND	ND	7.0	3.0	ND
Carbon tetrachloride	ND	5.0	ND	ND	ND
112TCE	ND	ND	7.0	130	ND
TCLEA	ND	ND	ND	200	5.0
Vinyl chloride	ND	ND	550	48	ND
trans-12DCE	ND	ND	2,220	8,500	ND
TRCLE	ND	ND	980	6,700	5.0
TCLEE	ND	ND	420	ND	ND

[a] Includes all parameters that were detected at least once. Metals analyzed but not detected: barium (<300 μg/L), chromium (<10 μg/L), mercury (<0.2 μg/L), and silver (<25 μg/L).

[b] NA = not analyzed.

[c] ND = not detected.

Source: Nemeth (1989).

TABLE 2.9 Analytical Results for Selected Inorganic Compounds, TOC, and Metals in Groundwater from the Toxic Burning Pits, 1990

Well	Chloride (mg/L)	Potassium (mg/L)	TOC (mg/L)	Arsenic (µg/L)	Cyanide (µg/L)	Lead (µg/L)	Nickel (µg/L)	Selenium (µg/L)	Zinc (µg/L)
P2	<100	<50	<10	ND[a]	ND	ND	ND	3.8	ND
P3	<100	61.8	25	30.2	ND	ND	61.9	ND	ND
P4	390	<50	<10	ND	ND	ND	ND	ND	292
P9	<100	<50	<10	ND	ND	124	ND	ND	ND
TH4	<100	<50	<10	ND	ND	ND	ND	2.35	ND
JF51	<100	140	<10	ND	13.9	ND	ND	ND	ND
JF52	<100	<50	<10	ND	ND	ND	ND	ND	ND
JF53	<100	<50	<10	ND	ND	ND	440	ND	ND
JF61	<100	98	160	8.03	ND	ND	ND	ND	ND
JF62	<100	<50	10	ND	ND	ND	ND	ND	ND
JF63	180	<50	50	4.11	ND	ND	ND	ND	ND
JF71	<100	79	<10	3.32	ND	ND	ND	ND	ND
JF72	<100	<50	180	ND	ND	ND	ND	3.21	ND
JF73	<100	<50	<10	5.52	ND	ND	ND	ND	ND
JF81	130	<50	<10	ND	ND	ND	ND	ND	ND
JF82	<100	74.7	100	20.4	88	ND	ND	ND	ND
JF83	120	<50	<10	60	ND	ND	ND	6.18	ND

[a] ND = not detected.

Source: USGS (1991).

TABLE 2.10 Analytical Results for Selected VOCs in Groundwater from the Toxic Burning Pits Area, 1990

	VOC[b] Concentrations (µg/L)								
Well[a]	112TCE	11DCE	12DCE	C2H3CL	C6H6	CHCL3	TCLEA	TCLEE	TRCLE
P2	4.02	ND[c]	10.2	ND	ND	ND	101	ND	440
TH4	ND	ND	ND	ND	ND	ND	3.73	ND	ND
JF53	110	8.04	850	132	ND	ND	3,500	ND	820
JF52	10	ND	420	ND	ND	2.2	34.3	ND	52
JF51	ND	3.79	430	ND	ND	ND	ND	ND	520
JF63	ND	ND	7.33	ND	ND	7.6	ND	17.6	600
JF62	ND	ND	ND	ND	ND	ND	ND	ND	2.7
JF61	ND	ND	ND	ND	ND	ND	ND	ND	1.8
JF73	67.3	6.81	7,150	ND	ND	2.9	340	ND	1,800
JF72	ND	ND	32.6	ND	ND	1.9	ND	ND	4.5
JF71	ND	ND	ND	ND	ND	24	ND	ND	7.3
JF83	7,100	19	7,150	56.3	4.88	50	250	1,000	4,900
JF82	ND	30.1	210	ND	ND	5.6	ND	47.2	1,400
JF81	7,100	ND	34.6	ND	ND	ND	290	ND	230

[a] TBP wells not listed contained no VOCs, or traces of 111TCE, C2H5CL, CCL4, CH3CL, and C6H5CL. No data for wells P1, P3, P4, JF43, JF41.

[b] Installation Restoration Data Management System (IRDMS) acronyms are used for VOCs: 112TCE = 1,1,2-trichloroethane; 11DCE = 1,1-dichloroethylene; 12DCE = 1,2-dichloroethylene; C2H3CL = vinyl chloride; C6H6 = benzene; CHCL3 = chloroform; TCLEA = 1,1,2,2-tetrachloroethane; TCLEE = tetrachloroethylene; and TRCLE = trichloroethylene.

[c] ND = not detected.

Source: USGS (1991).

and 7,100 µg/L 112TCE in the confined aquifer [JF81]). Because the well screens monitoring the confined aquifer are at depths of 70 ft or more (well JF81 is screened at a depth of 120-123 ft), WOC contamination extends more than 100 ft deep.

Because TRCLE was detected most often, the TRCLE data were used to create a contour map of contamination in the surficial aquifer (Figure 2.14). Those contours show that a plume of contaminated groundwater extends south of the TBP area to the shore and, possibly, into the bay. Additional data on VOC concentrations in the groundwater at locations farther south and closer to the shore are needed to determine if the plume in the surficial aquifer extends into the bay.

Data for the single wells screened in the Potomac Group sediments (JF1 and JF2) indicate low concentrations of VOC contamination in the deeper strata. Well JF1 contained

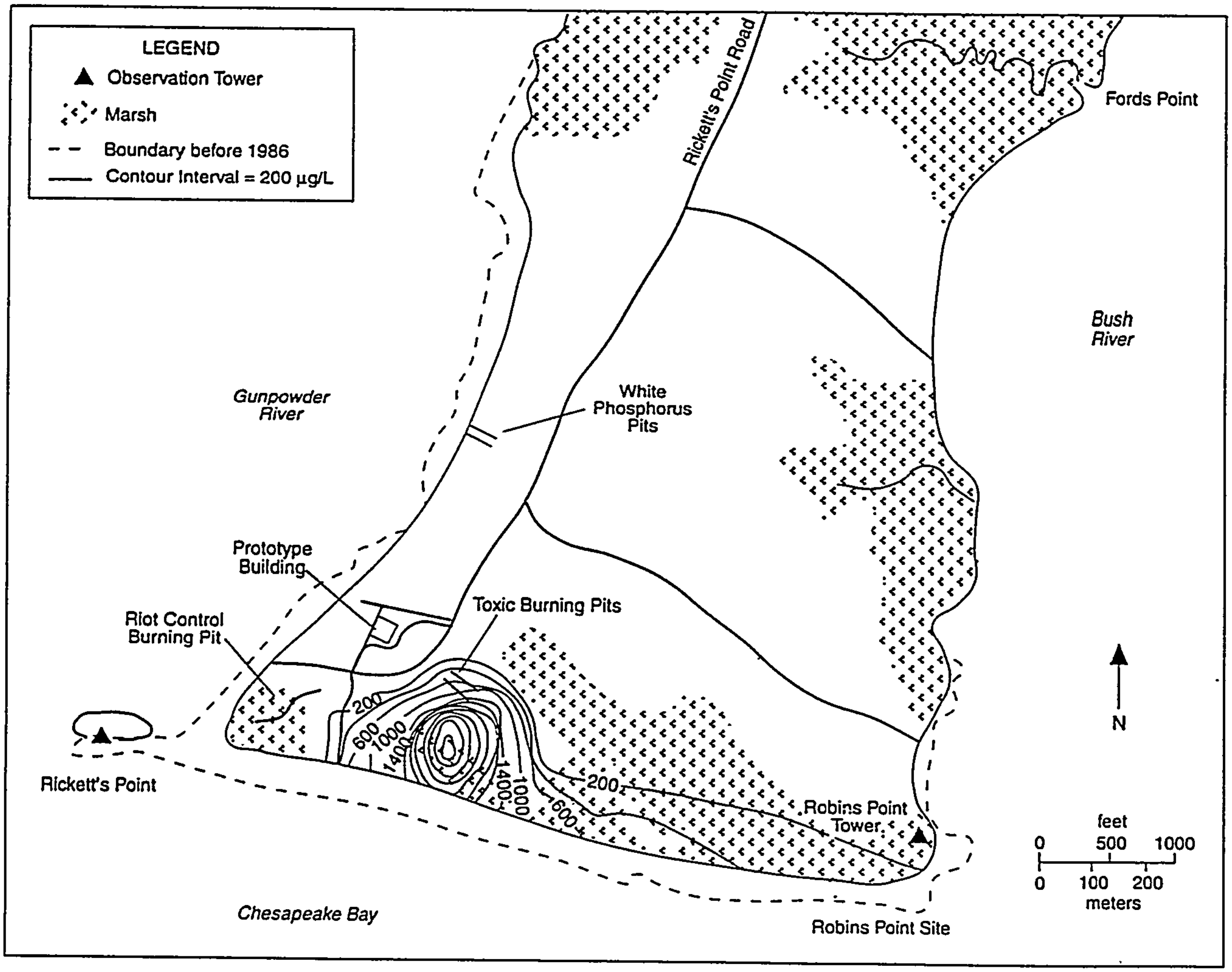


FIGURE 2.14 Contours of TRCLE Concentrations (µg/L) in the Surficial Aquifer (contour interval = 200 µg/L) (Source: Adapted from Hughes 1993)

2.25 μg/L 1,1,1-trichloroethane (111TCE) at a depth of 185-190 ft; well JF2 contained 6.7 μg/L TRCLE at 208-213 ft. These values are questionable because one of the two blanks associated with the sampling event contained detectable concentrations of TCLEA, TCLEE, and TRCLE.

Groundwater samples from a few wells were analyzed for explosives and organosulfur compounds. Results are summarized in Table 2.11. The data indicate some contamination with organosulfur compounds (including degradation products of mustard) in the surficial aquifer downgradient from the TBP. The maximum concentration was 140 μg/L 1,4-dithiane in well P3 just north of the western end of the TBP. No organosulfur contamination was found in the middle or lower aquifers. Explosives-related compounds were

TABLE 2.11 Analytical Results for Organosulfur and Explosives-Related Compounds in Groundwater from the Toxic Burning Pits Area, 1990

	Concentrations of Organosulfur Compounds (μg/L)				
Well	4-Chlorophenyl-methsulfoxide	4-Chlorophenyl-sulfone	1,4-Dithiane	1,4-Oxithiane	Thiodiglycol
P3	ND[a]	ND	140	ND	NA[b]
P4	ND	ND	8.28	ND	NA
JF53	ND	ND	2.11	ND	ND
JF63	ND	ND	8.21	8.24	21
JF83	ND	20.5	ND	ND	NA

	Concentrations of Explosives-Related Compounds (μg/L)				
	DNT[c]	Nitro-benzene	Nitro-cellulose	PETN[d]	RDX[e]
P9	ND	ND	226	ND	0.496
JF43	ND	ND	21.3	ND	ND
JF51	ND	0.0889	ND	ND	ND
JF63	ND	ND	ND	15.9	ND
JF73	ND	ND	ND	ND	1.18

[a] ND = not detected.

[b] NA = no data available.

[c] DNT = dinitrotoluene.

[d] PETN = penta-erythritol tetranitrate.

[e] RDX = hexahydro-1,3,5-trinitro-1,3,4-triazine.

Source: USGS (1991).

also found in low concentrations (up to 226 µg/L nitrocellulose) in the water table and the lower aquifer. Because nitrocellulose is not soluble in water, this value is either lab error or due to suspended solids in the groundwater sample.

Concentrations of the radioactive species uranium, thorium-230, cesium-137, and strontium-90 were measured in monitoring wells P1, P3, P4, JF53, JF52, JF51, JF63, and JF73. Elevated concentrations of cesium-137 (up to 172 pCi/L) and strontium-90 (up to 128 pCi/L), measured as beta radiation, were found in wells P3, JF51, and JF73 (USGS 1991). If these values are confirmed by additional measurements, they would indicate the presence of radioactive contaminants.

In 1992, the USGS analyzed groundwater collected from wells in the TBP area (Figure 2.13) for VOCs (Table 2.12). The data indicate that VOCs are present in the three aquifers underlying J-Field (surficial unit, confining unit, and confined unit); that concentrations of TRCLE, TCLEE, TCLEA, chloroform (CHCL3), 12DCE, and 112TCE have increased significantly since 1990 (see also Table 2.10); and that concentrations of 1,1-dichloroethylene (11DCE) have not been detected.

TABLE 2.12 Analytical Results for Selected VOCs in Groundwater Samples from the Toxic Burning Pits Area, 1992

	VOC Concentrations (µg/L)					
Well[a]	112TCE	12DCE	C2H3CL[b]	TCLEA	TCLEE	TRCLE
P3	ND[c]	980	600	ND	3,400	570
P4	65	3,300	ND	ND	ND	3,600
P9	ND	ND	10	ND	ND	ND
JF53	290	10,000	95	4,900	ND	4,200
JF52	1	140	ND	1	ND	3
JF51	ND	210	ND	ND	ND	97
JF63	ND	120	ND	75	130	4,400
JF62	ND	4	ND	ND	ND	13
JF61	ND	2	ND	ND	2	10
JF73	90	920	ND	9,000	280	5,100
JF71	ND	ND	ND	2	ND	3
JF83	2,000	12,000	ND	260,000	3,600	41,000
JF82	ND	190	ND	ND	ND	1,800
JF81	ND	22	ND	5	3	220

[a] TBP wells not listed contained no VOCs. No data were obtained for wells P1, P2, JF43, 42, 41, and JF72.

[b] C2H3CL = vinyl chloride.

[c] ND = not detected.

Source: USGS (1992).

The highest VOC concentrations were found in well clusters JF5, 6, 7, and 8 in all three aquifers. The greatest increases in concentrations were found in JF83, which monitors the surficial aquifer south of the main burning pits — TRCLE increased from 4,900 µg/L in 1990 to 41,000 µg/L in 1992, TCLEE increased from 1,000 µg/L to 3,600 µg/L, TCLEA increased from 250 µg/L to 260,000 µg/L, and 12DCE increased from 7,150 µg/L to 12,000 µg/L. Concentrations of 112TCE decreased from 7,100 µg/L in 1990 to 2,000 µg/L in 1992 (USGS 1992).

2.3.1.3 Potential Pathways of Contaminant Migration

Existing data indicate that the main pathway of contaminant migration at the TBP AOC is movement through the vadose zone down into the groundwater and then transport by groundwater.

Contaminants are apparently moving from their source, down into the groundwater, and then downgradient into the marshes by surficial aquifer discharge or into the estuaries by groundwater upwelling, or to locations even farther downgradient.

The direction of groundwater movement in the Talbot aquifers appears to be away from the TBP AOC toward the low-lying marshes and under the Gunpowder and Bush rivers. However, the lateral gradients in the lower aquifers are quite small (USGS 1991). The vertical movement of groundwater appears to be down through the aquifers; however, offshore there may be upward flow from each of the three Talbot aquifers into the Gunpowder and Bush rivers. Movement in the surficial and confined aquifers is affected by the tides (USGS 1991).

Surface water and associated sediment transport may play some role in contaminant migration in that surface runoff, particularly after intense storms, may carry dissolved and suspended contaminants from the contaminated areas into the marshes and estuaries. Surface water percolating through and leaching contaminated soils may be a major pathway by which contaminants move down into the groundwater, especially for metals and VOCs. Any contaminants that may have been present in the past in sufficient quantities to exist as free liquid in the soil would be expected to migrate down, independent of the presence of water.

Because of the generally humid conditions in the J-Field study area, wind transport of contaminated soil in areas with a good vegetative cover is expected to be minor. Diffusion of contaminated soil gas into the atmosphere and direct volatilization of contaminants from the soil are also expected to be minor release mechanisms. However, because portions of the TBP AOC are unvegetated or are sparsely covered with stressed vegetation, the air pathway may be significant and will be investigated.

2.3.2 White Phosphorus Burning Pits

2.3.2.1 Types of Waste Present

The WPP area was used for the disposal of WP, PWP, and other related chemicals. It is also possible that riot control agents such as CN and TRCLE were disposed of in the WPP (Nemeth 1989).

2.3.2.2 Types of Contaminants Present

The first phase of the USGS hydrological assessment was conducted to select locations for monitoring wells at the TBP and WPP. It was assumed that the pits and the open burning grounds around them are the primary sources of contamination. The following subsections discuss the findings relative to the nature and extent of contamination in the WPP area.

Soil Gas

During Phase I of the hydrological assessment, the USGS sampled 35 locations around the WPP for soil-gas concentrations of TRCLE, TCLEE, combined hydrocarbons, and simple aromatics. The highest relative flux values of contamination were found north of the pits and to the west along the shore of Gunpowder River. Isolated areas of contamination were found to the south. The relative flux contours for TCLEE, shown in Figure 2.15, are similar to those for the other measured contaminants. However, the simple aromatics contamination north of the pits is more extensive than is shown in Figure 2.15 (Hughes 1993).

Soil

In 1983, soil samples were collected from each of the four monitor well boreholes at the WPP (Figure 2.16). For each borehole, one sample was obtained as a composite of samples collected over 5-ft intervals. The samples were analyzed for metals, cyanide, phenols, total phosphorus, VOCs, pesticides, PCBs, and herbicides.

The only significant contamination found was lead, at 1,360 mg/kg in the sample from borehole JBP-4. Arsenic (10 mg/kg), barium (208 mg/kg), and possibly cadmium (1.33 mg/kg) were found in the same sample. No VOCs were found in any of the samples at a detection limit of 5 µg/kg. Cyanide was not found at a detection limit of 20 µg/kg. Samples from the other boreholes showed essentially no contamination (Princeton Aqua Science 1984). One composite sample was collected from each of the two main pits in the WPP AOC. The samples from the pits, along with background samples, were analyzed for several chemical parameters (Table 2.13). The results show significant levels of lead (up to 2,960 mg/kg) and

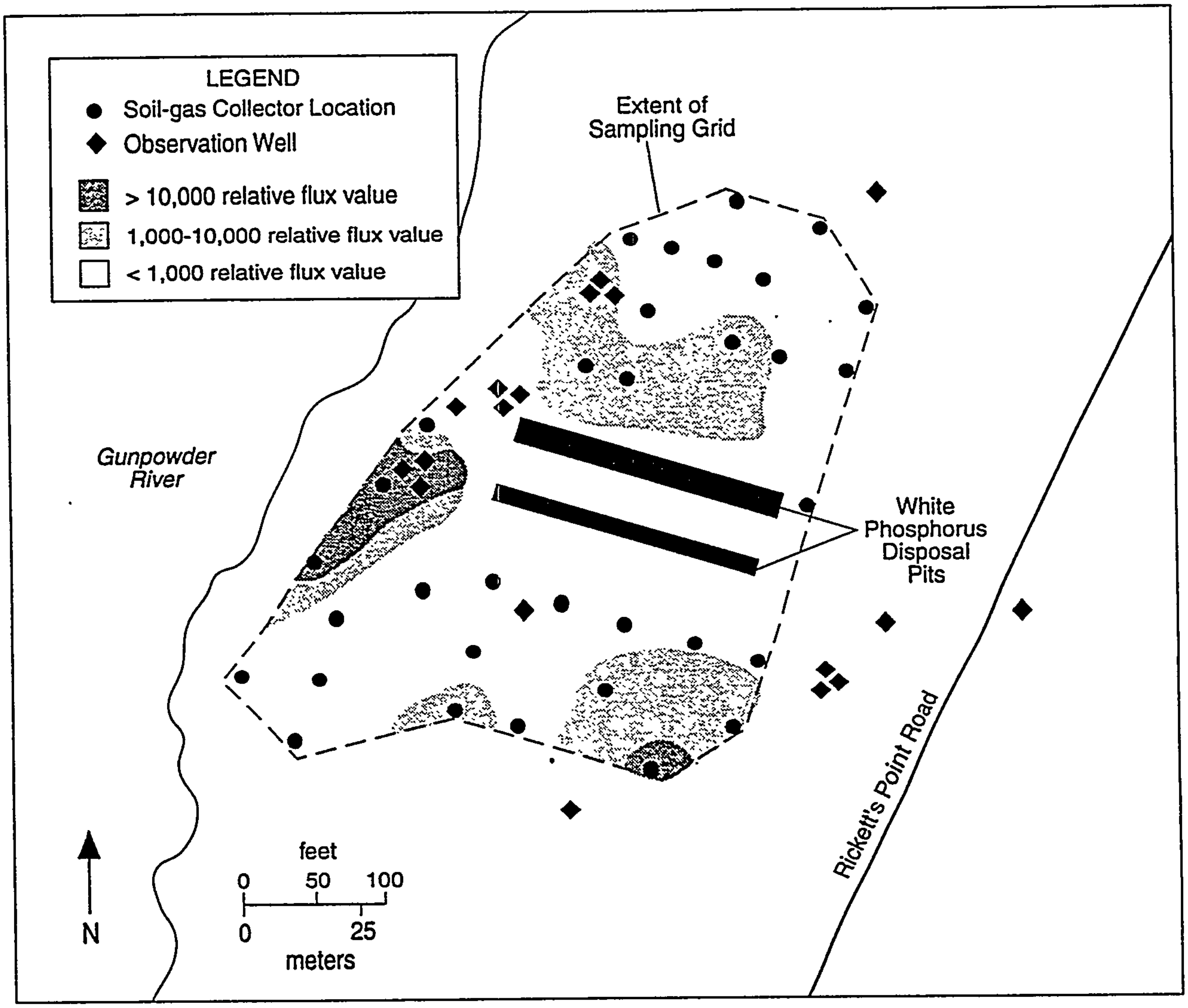


FIGURE 2.15 Relative Flux Contours for TCLEE at the White Phosphorus Pits (Source: Adapted from Hughes 1993)

zinc (up to 2,720 mg/kg) in each sample. High concentrations of petroleum hydrocarbons (up to 5,800 mg/kg) were also detected. The elevated levels of petroleum hydrocarbons in the background samples (62 mg/kg) indicate that these samples were collected at contaminated locations. Elevated levels of phosphorus (up to 1,573 mg/kg) were also detected in the WPP samples.

As part of the 1986 RFA (Nemeth 1989), surface soil samples were collected at two locations (J31 and J32) in and around the WPP. Figure 2.17 shows the sampling locations. The samples were analyzed for metals, extractable metals, and explosives-related compounds. The results, as summarized in Table 2.14, show that the surface soil in and around the WPP contained elevated levels of metals, especially lead (up to 255 mg/kg), chromium (up to 28.9 mg/kg), cadmium (up to 2.40 mg/kg), and barium (up to 149 mg/kg). Neither of the two samples exceeded the RCRA EP limits for metals.

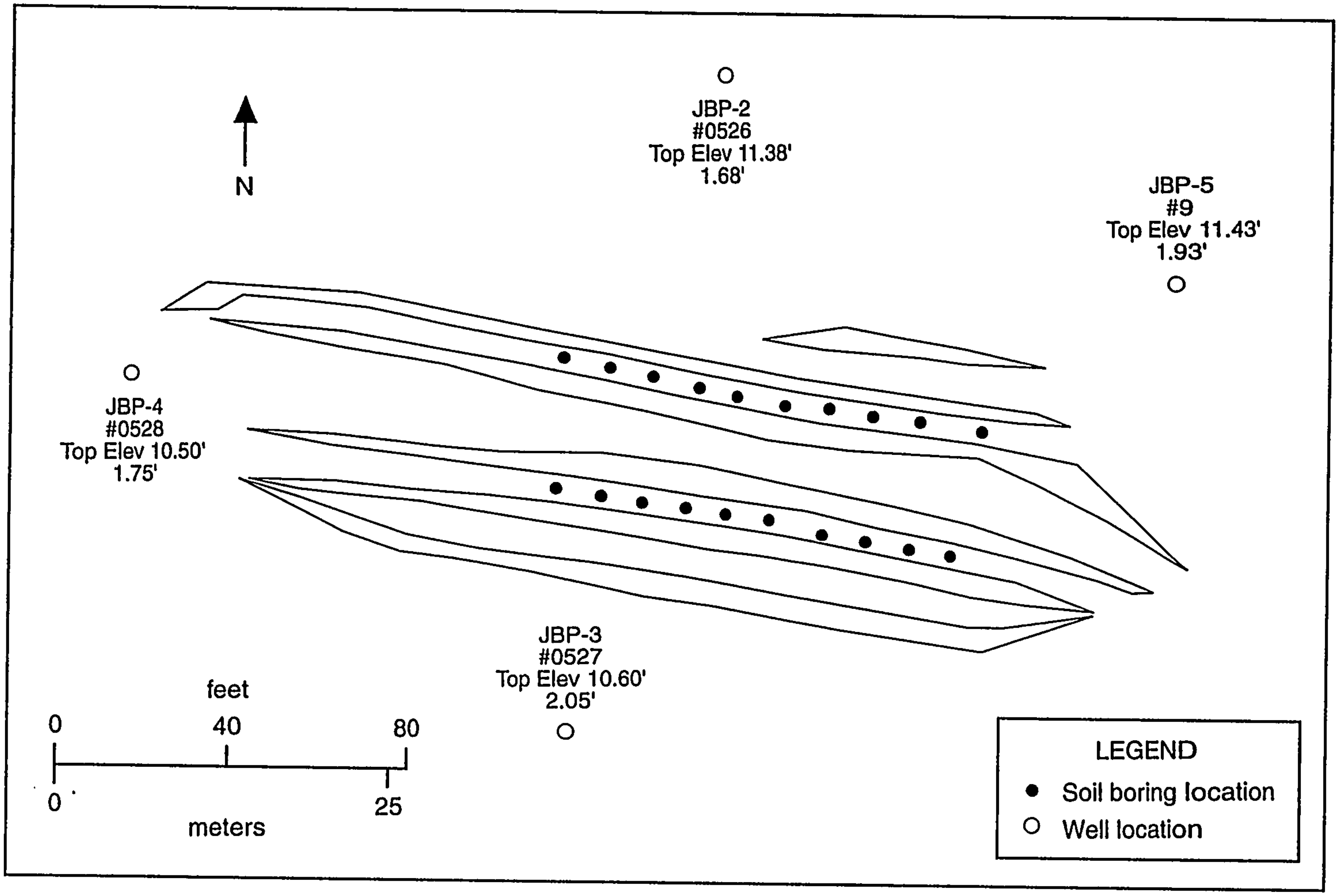


FIGURE 2.16 Locations of Soil Borings at the White Phosphorus Pits (Source: Adapted from Princeton Aqua Science 1984)

TABLE 2.13 Concentrations of Chemical Parameters in Soil from the White Phosphorus Pits at J-Field

Parameter[a]	Concentration[b] (mg/kg, unless noted)		
	Background[c]	Pit 1[d]	Pit 2[d]
Arsenic	1.46	2.93	0.915
Barium	247	939	525
Cadmium	0.519	6.70	2.74
Chromium	34.3	203	183
Iron	14,800	18,100	17,900
Lead	889	2,960	1,310
Manganese	267	260	197
Mercury	0.042	0.037	0.065
Potassium	2,420	2,260	2,520
Zinc	45.4	2,530	2,720
pH (standard units)	6.9	7.7	6.8
Nitrate	202	498	136
Total phosphorus	26	220	1,573
Cyanide	<0.5	<0.5	0.77
Petroleum hydrocarbons	62	2,260	5,800
Phenols	<0.130	<0.134	0.636
Aromatics			
Toluene (µg/kg)	45.8	75.6	27.4
Ethylbenzene (µg/kg)	<20	<20	51.6

[a] Table lists parameters detected in at least one sample. Parameters measured but not detected are other aromatics (<20 µg/kg), VOCs (<10 µg/kg), herbicides (<10 µg/kg), pesticides (<20 µg/kg), and PCBs (<10,000 µg/kg).

[b] Results are based on composite soil samples taken in January 1983.

[c] Locations of background samples not given.

[d] Based on available information, it is inferred that Pit 1 is the northern pit and Pit 2 is the southern pit.

Source: Adapted from Princeton Aqua Science (1984).

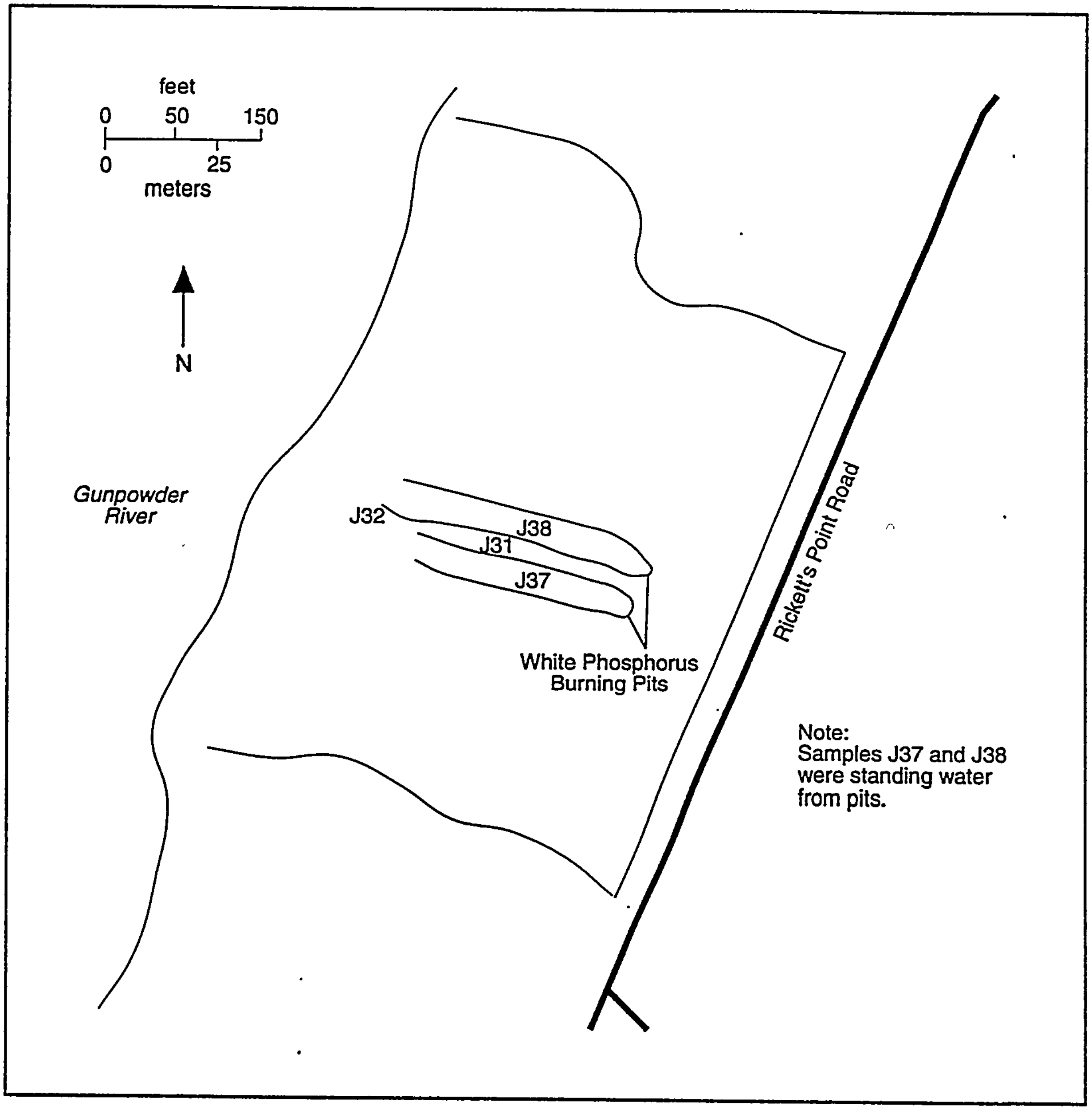


FIGURE 2.17 Locations of Surface Soil (J31 and J32) and Surface Water Samples (J37 and J38) in the White Phosphorus Pits Area (Source: Adapted from Hughes 1993)

The USGS collected soil samples (at approximately 1-ft depths) from 36 sites in J-Field, including the WPP area (Figure 2.15). The samples were analyzed for indicator parameters, metals, VOCs, semivolatile compounds, and explosives (Hughes 1992). The results are presented in Table 2.15. Levels of metals were fairly low, except that at location 1 (just east of the pits) the concentration of zinc was 942 mg/kg. No VOCs were detected.

Soil samples were also collected in the WPP area by Weston in October 1992. Samples were collected at depths of 2 and 4 ft in the pits and at depths of 3 in. and 1 ft in the marshes and pushout areas. Table 2.16 summarizes the analytic results for parameters detected in some of these samples.

TABLE 2.14 Analytical Results for Soil Samples J31 and J32 from the White Phosphorus Pits, 1986

Parameter[a]	J31	J32
Total Metals (mg/kg)		
Arsenic	14.1	12.3
Barium	141	149
Cadmium	2.46	2.40
Chromium	28.9	18.1
Lead	255	184
Mercury	<0.10	0.14
Silver	<1.00	<5.00
Extractable Metals (mg/L)		
Barium	<10.0	<10.0
Cadmium	<0.10	<0.10
Chromium	<0.50	<0.50
Lead	<0.50	<0.50

Source: Nemeth (1989)

Surface Water

Surface water samples (J37 and J38) were collected from the WPP area as part of the 1986 RFA (Nemeth 1989). Sampling locations are shown in Figure 2.11. Samples were analyzed for metals, explosives-related compounds, inorganic compounds, gross alpha and beta, VOCs, BNAs, pesticides, and PCBs. The results are summarized in Table 2.17 for locations J37 and J38.

The surface water contained some lead contamination. Sulfate and total dissolved solids (TDS) were slightly elevated in the WPP surface water, and gross alpha was also slightly elevated. None of the values for the other radioactive parameters was indicative of contamination.

Surface water samples were collected by the USGS at low tide close to the J-Field shore in the Gunpowder River (four locations near the WPP). One sample was collected onshore in a drainage ditch. Locations are shown in Figure 2.11. Filtered and unfiltered samples were analyzed for water quality parameters, metals, and a few organic compounds. A sample taken at location 3 had nitrate concentrations of 380 µg/L. The metals data showed low concentrations of lead (ND to 28 µg/L) and zinc (50 to 133 µg/L) at locations 1 to 4. Mercury and nickel concentrations were slightly elevated at location 1 (0.54 and 33.7 µg/L, respectively). No evidence was found of arsenic, barium, or chromium contamination. Comparison of data for filtered and unfiltered samples indicates that the slightly elevated metals concentrations may be associated with the suspended solids in the samples. This conclusion is based on the lower concentrations of metals in filtered samples for the few locations where both filtered and unfiltered data were obtained (Hughes 1993).

A few organic constituents (acetone, toluene, phenol, TOC, and TOX) were measured in samples from two locations. TOC and TOX were detected in the unfiltered samples only (4,000 and 21.6 µg/L, respectively). Toluene was found only at location 1 (3.05 µg/L) (Hughes 1993).

In general, the nearshore surface water samples collected to date show little contamination. What contamination there is appears to be associated with the suspended solids. This suggests that the nearshore sediments may be contaminated. Additional data are needed to evaluate this situation. No data are available on concentrations of pollutants in surface water or sediments in the marshes on J-Field.

TABLE 2.15 **Analytical Results for Soil Samples from the White Phosphorus Pits Area, April 1991**

Parameter	Concentrations by Soil Sample Location									
	1	2	3	4	5	6	7	8	9	10
Metals (mg/kg)										
Arsenic	4.2	2.7	2.8	2.3	ND[a]	ND	ND	ND	2.9	2.9
Cadmium	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Chromium	16	12	12	8.9	9.6	8.8	11	9.7	13	11
Copper	42	3.8	20	3.6	5.0	4.7	11	6.1	6.3	9.9
Lead	ND	25	41	5.3	19	18	15	18	15	17
Antimony	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	942	ND	ND	18	ND	ND	ND	ND	ND	26
Volatile Organic Compounds (μg/kg)										
Acetone	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Trichloroethylene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Semivolatile Organic Compounds (μg/kg)										
Butylbenzyl phthalate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzoic acid	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Di-n-butyl phthalate	4,830	ND	ND	ND	ND	ND	ND	ND	ND	ND

[a] ND = not detected.

Source: Hughes (1992).

TABLE 2.16 Analytical Results for TCL and TAL Analytes in Selected Soil Samples from the White Phosphorus Pits, 1992[a]

	Concentrations by Soil Sample Location					
Parameter	JWP1-E(2′)[b]	JWP1-E(4′)	JWP2-E(2′)	JWP2-E(4′)	JWPM-A(3″)	JWPM-A(1′)
Volatile Organic Compounds (μg/kg)						
Methylene chloride	ND[c]	ND	9.53	15.2	13.4	ND
Acetone	494	156	165	38.9	185	21.5
Toluene	ND	ND	ND	ND	ND	ND
Xylenes	ND	16.6	ND	ND	11.2	9.17
PCBs (μg/kg)						
Aroclor 1254	ND	ND	ND	ND	ND	ND
Aroclor 1260	ND	ND	ND	ND	ND	ND
TAL Analytes (mg/kg)						
Antimony	ND	ND	ND	ND	5.92	ND
Arsenic	3.22	2.24	2.82	ND	4.20	2.46
Beryllium	0.279	0.796	0.520	ND	0.318	0.335
Cadmium	ND	0.626	ND	ND	2.02	ND
Chromium	11.6	12.8	16.7	4.93	15.8	7.53
Cobalt	ND	ND	ND	ND	ND	ND
Copper	10.5	8.63	8.40	ND	59.4	11.0
Lead	8.37	8.87	6.46	4.89	209	44.3
Zinc	24.0	62.5	13.0	19.7	284	37.9
Nickel	ND	13.7	ND	6.18	ND	ND

TABLE 2.16 (Cont.)

Parameter	Concentrations by Soil Sample Location					
	JWPM-C(3")	JWPM-C(1')	JWPP-A(3")	JWPP-A(1')	JWPP-C(3")	JWPP-C(1')
Volatile Organic Compounds (μg/kg)						
Methylene chloride	10.8	5.83	17.0	7.51	9.29	8.35
Acetone	16.1	45.0	ND	252	ND	178
Toluene	7.42	ND	ND	ND	ND	6.54
Xylenes	18.4	ND	ND	ND	ND	11.8
PCBs (μg/kg)						
Aroclor 1254	ND	ND	ND	ND	323	ND
Aroclor 1260	215	ND	ND	ND	ND	ND
TAL Analytes (mg/kg)						
Antimony	ND	ND	ND	ND	10.2	ND
Arsenic	4.00	1.96	4.48	2.60	3.29	3.55
Beryllium	0.239	0.182	0.254	0.218	0.267	0.308
Cadmium	2.11	ND	ND	ND	1.62	0.576
Chromium	20.8	8.37	12.4	10.6	21.9	9.83
Cobalt	ND	ND	ND	ND	ND	ND
Copper	111	ND	10.4	ND	109	19.8
Lead	556	7.29	23.2	25.0	235	156
Zinc	15.2	7.57	109	34.9	651	257
Nickel	1,080	24.6	8.27	8.18	9.65	9.47

[a] Only detected analytes are reported; for samples with duplicate analyses, the higher value is reported.

[b] Sample depth shown in parentheses.

[c] ND = not detected.

Source: Mazelon (1993).

TABLE 2.17 Analytical Results for Surface Water Samples from the White Phosphorus Pits Area, 1986

Parameter	Location J37	Location J38
Dissolved Metals (µg/L)		
Cadmium	<1.0	3.0
Lead	6.0	44
Mercury	<0.20	<0.20
Inorganic Compounds (µg/L)		
Nitrate and nitrite as N	<30	200
Sulfate	160,000	15,000
Chloride	5,000	3,000
Total dissolved solids	388,000	114,000
Radioactivity (pCi/L)		
Gross alpha	2.8	4.2
Gross beta	8.0	8.7

Source: Nemeth (1989).

Groundwater

Three monitoring wells (designated TH) were installed at the WPP in 1977 (Figure 2.13) as part of an environmental contamination survey conducted by USATHAMA (Nemeth 1989). The depth of the wells ranged from 20 to 25 ft. The wells were screened in the surficial aquifer (Sonntag 1991). Water samples collected from the wells in 1977 were analyzed for metals, indicator chemicals, WP, mustard degradation products, cholinesterase inhibitors, BNAs, and VOCs.

Low levels of organic contamination were found in all wells. A mustard degradation product, 1,3-dithiane, was found at a concentration of 6 µg/L in well TH1 near the WPP. Aliphatic and aromatic organic compounds were found at levels up to 200 µg/L in most well samples. Organic compounds introduced by the well construction procedure or possible sample contamination were found at higher concentrations (e.g., tetrahydrofuran up to 8,000 µg/L).

Four additional wells were installed around the WPP (wells P5-P8 in Figure 2.13) as part of a munitions disposal study (Princeton Aqua Science 1984). The wells were 17-20 ft deep and were screened with 15-ft-long screens in the surficial aquifer (Sonntag 1991). Samples collected from the wells in 1983 were analyzed for metals, nitrate, TOX, TOC, radioactivity, some pesticides and herbicides, and secondary drinking water contaminants. Analyses indicated no major concentrations of metals, pesticides, or herbicides.

Samples collected from these four wells in 1986 as part of an RFA (Nemeth 1989) were analyzed for metals, explosives-related compounds, indicator parameters, radioactivity, thiodiglycol, VOCs, BNAs, pesticides, and PCBs. Sulfate, TDS, and TRCLE were the only parameters that showed any elevated concentrations.

Twelve additional monitoring wells were installed at the WPP in late 1988 and 1989 by the USGS (Sonntag 1991; Hughes 1993). The wells were installed as three-well nests at four different locations (Figure 2.13). At each site, the three wells were screened in the confined aquifer, the leaky confined unit, and the surficial aquifer of the Talbot Formation. The groundwater samples collected from the nested wells were analyzed for metals, other inorganic parameters, VOCs, and semivolatile organic compounds. Some analyses were performed for organosulfur, explosives-related, and radioactive compounds. Wells were selected for these analyses on the basis of their proximity to potential disposal areas for these materials (USGS 1991).

Potassium concentrations detected in the samples varied considerably, with most ranging from ND to 10 µg/L. All of the elevated values (above 50 µg/L) occurred in the leaky confined unit or the confined aquifer. Movement of sea water into the groundwater does not appear to be the source of the potassium, because wells with elevated potassium concentrations did not have elevated chloride concentrations.

Low levels of VOC contamination were detected in the WPP. Only one well, P8, showed contamination by TRCLE (40 µg/L). Some contamination by other VOCs was detected in wells P7 and JF10-2. (Acetone is excluded because of the possibility that its presence is a result of laboratory quality control [QC] procedures.)

2.3.2.3 Potential Pathways of Contaminant Migration

Existing data indicate that the main pathway of contaminant migration at the WPP AOC is movement through the vadose zone down into the groundwater and then transport by the groundwater.

The direction of groundwater movement in the Talbot aquifers appears to be away from the WPP AOC toward the Gunpowder River. However, the lateral gradients in the lower aquifers are quite small (USGS 1991). The vertical movement of groundwater appears to be down through the aquifers; however, offshore there may be upward flow from each of the three Talbot aquifers into the Gunpowder and Bush rivers. Movement in the surficial and confined aquifers is affected by the tides (USGS 1991).

Surface water and associated sediment transport may play some role in contaminant migration in that surface runoff, particularly after intense storms, may carry dissolved and suspended contaminants from the contaminated areas into the marshes and estuaries. Lateral contaminant migration by surface water is expected to be minor (Sonntag 1991). However, in the past, the surface water pathway may have been more significant because the pits were operated to allow drainage to flow to the Gunpowder River (Weston 1992). Surface water percolating through and leaching contaminated soils may be a major pathway by which contaminants, especially metals and VOCs, move down into the groundwater. Any contaminants that may have been present in the past in sufficient amounts to exist as free liquid in the soil would be expected to migrate downward, independent of the presence of water.

Because of the generally humid conditions in the J-Field study area, wind transport of contaminated soil in areas with a good vegetative cover is expected to be minor. Diffusion of contaminated soil gas into the atmosphere and direct volatilization of contaminants from the soil are also expected to be minor release mechanisms. However, because portions of the WPP AOC are unvegetated or are sparsely covered with stressed vegetation, and because at least part of the WPP AOC is expected to be used for OB/OD, the air pathway may be significant and will be investigated.

2.3.3 Riot Control Burning Pit

2.3.3.1 Types of Waste Present

The RCP area was used for burning of riot control agents and disposing of munitions filled with riot control agents and of materials contaminated with these chemicals. The primary riot control chemicals disposed of in the burning pit were tear agents (CS and possibly CN) and items contaminated with those agents.

2.3.3.2 Types of Contaminants Present

Soil Gas

Soil-gas sampling and analysis were conducted during Phase I of the USGS hydrological assessment. Soil-gas samples collected from 12 locations on a 100-ft grid around the RCP were analyzed for TRCLE, TCLEE, alkanes, combined hydrocarbons, and simple aromatics. Relative flux values indicated contamination by chlorinated solvents at areas north and south of the pits. Contamination by phthalates and heavy aromatic compounds appeared to be more extensive, with phthalates showing elevated contamination along Rickett's Point Road and at one location south of the pit. The highest measured flux value for aromatic compounds was at a location south of the pit. Figure 2.18 shows the relative flux contours for heavy aromatics at the pit.

Soil

A soil sample was collected immediately northeast of the disposal trench during the 1986 RFA (Nemeth 1989). That sample contained a significant amount of ash and other residue from burning operations; analysis showed slightly elevated levels of total cadmium, chromium, lead, and silver, and very low levels of polyaromatic hydrocarbons (PAHs).

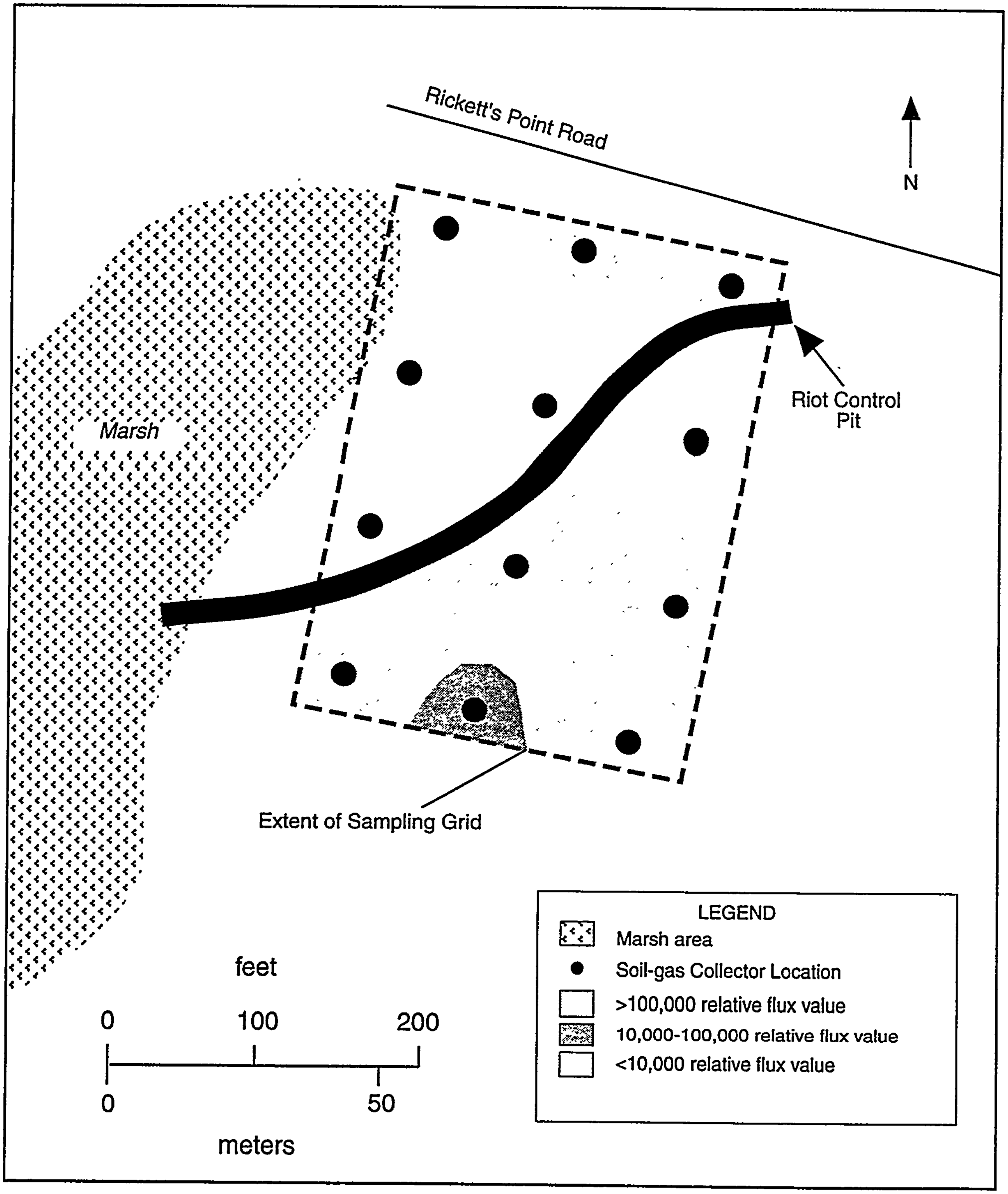


FIGURE 2.18 Relative Flux Contours of Heavy Aromatics at the Riot Control Burning Pit (Source: Adapted from Hughes 1993)

Soil samples were collected by the USGS at 36 sites at J-Field, including the RCP area (locations 16 through 20 in Figure 2.9). The samples were collected at 1-ft depths and were analyzed for indicator parameters, metals, VOCs, semivolatile compounds, and explosives-related compounds (Hughes 1992). The results of the analyses are presented in Table 2.18. Soil samples showed some metals contamination, especially at locations 16, 17, and 18 north of the pit, where lead concentrations ranged from 34 to 68 mg/kg. Zinc was found at 158 mg/kg at location 16. Organic compounds (acetone, butylbenzyl phthalate, and benzoic acid) were also detected in some samples.

Soil samples were also collected in the RCP area by Weston in October 1992 (Figure 2.19). The samples were collected at 3-in., 2-ft, and 4-ft depths in the pit and at 3-in. and 1-ft depths in the marshes and pushout areas. Tables 2.19 and 2.20 summarize the analytic results for parameters detected in some of these samples. The data indicate that several areas are contaminated with metals, mainly at the surface (within 3 in. to 2 ft). The highest concentrations of lead were found in the center of the RCP (up to 339 mg/kg at 3 in.). Lead concentrations ranged from 31 to 90 mg/kg at the ends of the pit, in the marshes, and in the pushout areas. Other metals detected include beryllium, up to 0.451 mg/kg in the marsh east of the RCP; chromium, up to 106 mg/kg at the eastern end of the RCP; copper, up to 742 mg/kg at the eastern end of the RCP; and zinc, up to 742 mg/kg in the center of the RCP. Organic compounds were also detected, including benzoic acid, chlorobenzene, di-n-butyl phthalate, acetone, methylene chloride, styrene, toluene, xylene, and pesticides. PCBs were not detected.

TABLE 2.18 Analytical Results for Soil Samples from the Riot Control Burning Pit Area, April 1991

	Concentration by Soil Sample Location						
Parameter	16	17	18	19	20	21	22
Metals (mg/kg)							
Arsenic	4.4	3.8	3.4	2.9	3.7	3.3	ND[a]
Cadmium	ND	ND	ND	ND	ND	ND	ND
Chromium	11	8.6	8.7	7.5	11	8.8	7.4
Copper	9.5	10	9.5	5.4	7.0	7.2	15
Lead	68	41	34	2.1	41	1.7	22
Antimony	ND	ND	ND	ND	ND	ND	ND
Zinc	158	ND	ND	ND	ND	ND	ND
Volatile Organic Compounds (μg/kg)							
Acetone	7.27	29.6	9.01	6.47	10.2	9.51	2.45
Trichloroethylene	ND	ND	ND	ND	ND	ND	ND
Semivolatile Organic Compounds (μg/kg)							
Butylbenzl phthalate	ND	ND	528	ND	ND	ND	3,700
Benzoic acid	3,400	12,000	ND	1,800	949	654	3,700

[a] ND = not detected.

Source: Hughes (1992).

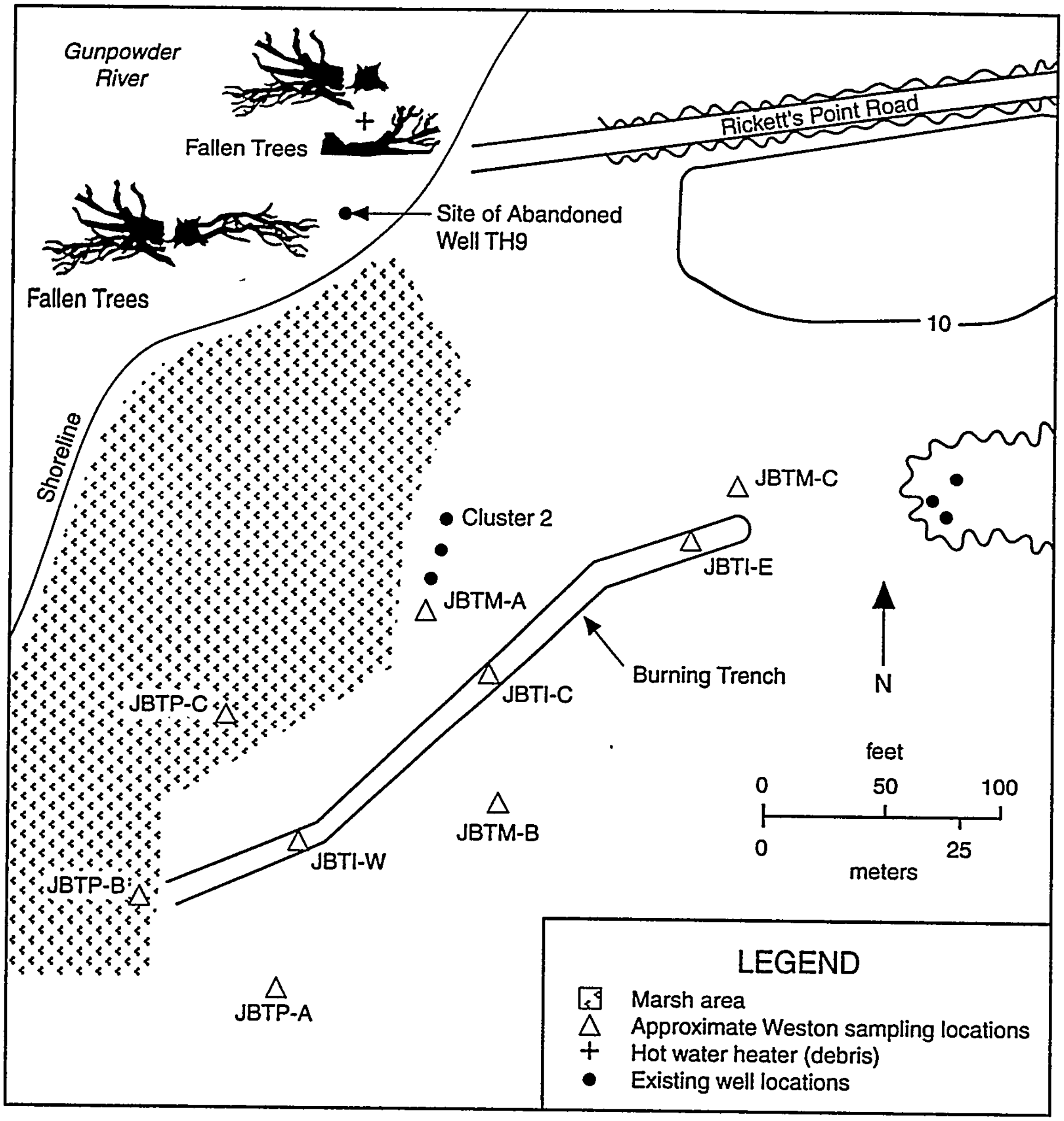


FIGURE 2.19 Locations of Soil Samples Collected by Weston in 1992 from the Riot Control Burning Pit (Source: Adapted from Mazelon 1993)

TABLE 2.19 Analytical Results for TCL Analytes in Selected Soil Samples from the Riot Control Burning Pit Area, 1992[a]

TCL Analyte	Concentrations (µg/kg) by Soil Sample Location					
	JBT1-E(3")[b]	JBT1-E(2′)	JBT1-E(4′)	JBP1-W(3")	JBT1-W(2′)	JBT1-W(4′)
Volatile Organic Compounds						
Acetone	61.8	46.2	191	236	82.2	18.5
Benzene	ND[c]	ND	ND	ND	ND	ND
Carbon disulfide	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND
Chloroethane	ND	ND	ND	ND	ND	ND
Chloromethane	10.3	7.7	5.22	13.2	17.6	6.75
Styrene	ND	ND	ND	ND	ND	ND
Toluene	ND	ND	ND	ND	ND	ND
Xylenes	ND	ND	ND	ND	ND	ND
Semivolatile Organic Compounds						
2-Methylnaphthalene	52	ND	ND	ND	ND	ND
Benzoic acid	ND	ND	ND	183	79.2	47.8
bis-(2-Chloromethyl) ether	ND	ND	ND	ND	ND	ND
bis-(2-Ethylhexyl) phthalate	ND	ND	ND	ND	ND	ND
Di-n-butyl phthalate	ND	ND	ND	217	111	54.1
Fluoranthene	ND	ND	ND	ND	ND	ND
Hexachlobenzene	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND
Pesticides						
4,4′ DDD	ND	ND	ND	ND	ND	ND
4,4′ DDE	2.22	ND	ND	10.6	ND	ND
4,4′ DDT	ND	ND	ND	ND	ND	ND
PCBs						
Aroclor 1248	ND	ND	ND	ND	ND	ND
Aroclor 1254	ND	ND	ND	ND	ND	ND

TABLE 2.19 (Cont.)

TCL Analyte	Concentrations (µg/kg) by Soil Sample Location							
	JBTM-A(3")	JBTM-A(1')	JBTM-C(3")	JBTM-C(1')	JBTP-A(3")	JBTP-A(1')	JBTP-C(3")	JBTP-C(1')
Volatile Organic Compounds								
Acetone	171	55.4	169	91	70.4	74.3	ND	ND
Benzene	ND	ND	ND	2.46	ND	ND	ND	ND
Carbon disulfide	ND	ND	ND	ND	4.89	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND	20.3	ND
Chloroethane	12.2	2.72	ND	ND	ND	ND	ND	ND
Chloromethane	10.2	5.75	5.87	9.75	12.2	5.69	5.69	3.26
Styrene	8.57	ND	ND	ND	ND	18	ND	ND
Toluene	42.3	16.2	7.9	1.77	ND	1.44	ND	ND
Xylenes	159	77.2	ND	ND	ND	ND	ND	ND
Semivolatile Organic Compounds								
2-Methylnaphthalene	ND	ND	ND	ND	ND	ND	ND	ND
Benzoic acid	4,380	100	ND	63.6	840	336	ND	106
bis-(2-Chloromethyl) ether	438	ND	ND	ND	64.5	ND	54	ND
bis-(2-Ethylhexyl) phthalate	ND	ND	ND	ND	ND	41.5	ND	ND
Di-n-butyl phthalate	126	53.5	ND	ND	ND	ND	ND	188
Fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND
Hexachlobenzene	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND	ND	ND
Pesticides								
4,4' DDD	ND	ND	ND	ND	ND	ND	ND	ND
4,4' DDE	32.9	ND	ND	1.79	10.1	ND	4.69	ND
4,4' DDT	8.28	ND	ND	ND	ND	ND	ND	ND
PCBs								
Aroclor 1248	ND	ND	ND	ND	ND	ND	ND	ND
Aroclor 1254	ND	ND	ND	ND	ND	ND	ND	ND

[a] Only detected analytes are reported; for samples with duplicate analyses, the higher value is reported.

[b] Sample depth shown in parentheses.

[c] ND = not detected.

TABLE 2.20 Analytical Results for TAL Analytes in Selected Soil Samples from the Riot Control Burning Pit Area, 1992[a]

TAL Analyte	Concentration (mg/kg) by Soil Sample Location						
	JBT1-E(3")[b]	JBT1-E(2′)	JBT1-E(4′)	JBT1-W(3")	JBT1-W(2′)	JBT1-W(4′)	JBTM-A(3")
Antimony	ND[c]	5.31	ND	ND	ND	ND	ND
Arsenic	4.96	4.27	ND	ND	2.94	1.84	2.77
Beryllium	0.374	0.343	ND	0.355	0.362	0.278	0.555
Cadmium	5.24	2.73	ND	0.907	0.690	ND	0.994
Chromium	106	40	11.9	11.3	17.3	16.6	14.2
Cobalt	ND	ND	ND	ND	ND	ND	ND
Copper	742	262	116	23.2	ND	9.79	12.3
Lead	1.14	49.2	10.9	60.5	8.98	8.92	57.1
Zinc	281	139	45.6	119	17.2	14.6	46.6
Nickel	40.2	23.2	9.89	ND	9.08	8.01	12.6

TAL Analyte	Concentration (mg/kg) by Soil Sample Location						
	JBTM-A(1′)	JBTM-C(3")	JBTM-C(1′)	JBTP-A(3")	JBTP-A(1′)	JBTP-C(3")	JBTP-C(1′)
Antimony	ND[c]	ND	ND	ND	ND	ND	ND
Arsenic	ND	1.87	1.72	ND	2.18	2.28	1.81
Beryllium	0.337	0.451	0.279	0.418	0.328	ND	0.745
Cadmium	0.586	0.898	0.696	1.7	0.601	ND	ND
Chromium	8.06	12.1	11.1	12.6	14.2	14.1	24.3
Cobalt	ND	ND	ND	ND	ND	ND	ND
Copper	ND	9.01	ND	8.98	ND	11.3	9.41
Lead	5.97	52.2	7.61	33.2	7.23	41.8	9.13
Zinc	5.02	58.9	6.77	22.2	11.3	39.4	36.3
Nickel	ND	8.27	7.16	17.5	ND	ND	11.2

[a] Only detected analytes are reported; for samples with duplicate analyses, the higher value is reported.

[b] Sample depth shown in parentheses.

[c] ND = not detected.

Surface Water

Surface water samples were collected by the USGS at low tide close to the shore near the RCP area (locations 7-12 in Figure 2.11). Both filtered and unfiltered samples were analyzed for major water quality parameters, metals, and a few organic compounds. Nitrate concentrations from location 7 ranged from 200 to 400 µg/L. Phenol, TOC, and TOX were also detected in the unfiltered sample from location 7 (51.9, 7,000, and 20 µg/L, respectively). As described in Section 2.3.1.2, the USGS and the EPA ERT sampled surface water and sediment from areas offshore of the RCP.

In general, the nearshore surface water quality data from the samples collected to date show essentially no contamination. What contamination there is appears to be associated with the suspended solids. This finding suggests that the nearshore sediments may be contaminated.

Groundwater

Two monitoring wells (TH9 and TH10 in Figure 2.13) were installed near the RCP area as part of the 1977 environmental contamination survey (Nemeth 1989). The depth of the wells ranged from 20 to 25 ft. The wells were screened in the surficial aquifer (Sonntag 1991). Water samples collected from the wells in 1977 were analyzed for metals, indicator chemicals, WP, mustard degradation products, cholinesterase inhibitors, BNAs, and VOCs. Only very low levels of organic contamination were detected. Because of the erosion of the shoreline west of the RCP, well TH9 was abandoned, and the shoreline was stabilized with gabion baskets and riprap.

Two monitoring well nests (JF1 and JF2 in Figure 2.13) were installed near the RCP in late 1988 and 1989 by the USGS (Sonntag 1991; Hughes 1993). At each site, the wells were screened in the confined aquifer, the leaky confined unit, and the surficial aquifer of the Talbot Formation. One monitoring well (well 143) was installed south of the RCP AOC in 1992.

Groundwater samples were analyzed for metals, VOCs, and semivolatile organic compounds during a 1990 sampling episode. Samples from wells JF22 and JF23 were analyzed for organosulfur and explosives-related compounds. None of these compounds was detected, but the results showed some contamination by fluoride in both wells. Cyanide was found in well JF22 at a concentration of 65.6 µg/L. The VOC measurements for well JF13 showed the presence of benzene (1,500 µg/L) and methylisobutylketone (640 µg/L). Benzene was also detected at 800 µg/L in well JF13 during a 1992 sampling episode. No volatile organic compounds were detected in the newly installed well (143) (USGS 1992).

2.3.3.3 Potential Pathways of Contaminant Migration

Existing data indicate that the main pathway of contaminant migration at the RCP AOC is movement through the vadose zone down into the groundwater and then transport by groundwater.

The direction of groundwater movement in the Talbot aquifers appears to be away from the RCP AOC toward the Gunpowder River and Chesapeake Bay. However, the lateral gradients in the lower aquifers are quite small (USGS 1991). Vertical movement of groundwater appears to be down through the aquifers. Offshore, there may be upward flow from each of the three Talbot aquifers into the Gunpowder and Bush rivers. Movement in the surface and confined aquifers is affected by the tides (USGS 1991).

Surface water and associated sediment transport may play some role in contaminant migration in that surface runoff, particularly after intense storms, may carry dissolved and suspended contaminants from the contaminated areas into the river and bay. Lateral contaminant migration by surface water is expected to be minor (Sonntag 1991). However, surface water percolating through and leaching contaminated soils may be a major pathway by which contaminants, especially metals and VOCs, move down into the groundwater. Any contaminants that may have been present in the past in sufficient amounts to exist as free liquid in the soil would be expected to migrate down, independent of the presence of water.

Because of the generally humid conditions in the J-Field study area, wind transport of contaminated soil in areas with a good vegetative cover is expected to be minor. Diffusion of contaminated soil gas into the atmosphere and direct volatilization of contaminants from the soil are also expected to be release mechanisms.

2.3.4 South Beach Trench

2.3.4.1 Types of Waste Present

No information is available concerning chemical or hazardous material disposal in the SBT. It is possible that the trench was originally used as a borrow pit to obtain soil for the demolition work on the South Beach of J-Field (Nemeth 1989). A review of aerial photographs reveals the presence of an additional trench, which is now filled in but visible, about 40 ft west of current SBT. In the photographs, the western trench is oriented east-west and is about 300 ft in length. Small drums are scattered in the woods near the western trench (U.S. Army 1965).

2.3.4.2 Types of Contaminants Present

Soil Gas

Soil-gas samples have not been collected from this area.

Soil

Analysis of a single soil sample collected in the SBT area as part of an environmental survey in 1983 (Nemeth 1989) showed a low level of chlordane (53 µg/kg) and tentatively identified several other organic compounds. Two soil samples were collected by the USGS in the SBT area (locations 21 and 22 in Figure 2.9). The samples were collected at 1-ft depths and analyzed for indicator parameters, metals, VOCs, semivolatile compounds, and explosives-related compounds (Hughes 1992). The results indicate that metals are present in low concentrations: lead, ranging from 2 to 22 mg/kg; copper, from 7 to 15 mg/kg; and chromium, from 7 to 9 mg/kg. Acetone was the only organic compound detected (ranging from 10 to 25 mg/kg).

Surface Water

Surface water samples have not been collected at the SBT.

Groundwater

A monitoring well (TH10 in Figure 2.13) was installed south of the trench during the 1977 environmental survey (Nemeth 1989). Water collected from this well was analyzed for extractable organic compounds; analyses showed the presence of hydrocarbons, dimethylnaphthalene, and N,N-dimethylformamide. This well was also sampled as part of the RFA, with analysis for VOCs, BNAs, pesticides, and PCBs. No contaminants were detected in the water at that time (Nemeth 1989).

The USGS sampled well TH10 in 1991 as part of the hydrological assessment, Phase I. The water was analyzed for metals, water quality parameters, major ions, VOCs, and explosives-related compounds. No contamination was detected. Samples collected in 1992 from wells JF1 and JF2 were analyzed for VOCs. Benzene concentrations ranged from 110 to 800 µg/L in the surficial aquifer. Low levels of acetone were also detected.

2.3.4.3 Potential Pathways of Contaminant Migration

The main pathway of contaminant migration at the South Beach Trench is believed to be movement through the vadose zone into the groundwater and then transport by the groundwater.

The direction of groundwater movement in the Talbot aquifers appears to be away from the trench area toward the bay. However, the lateral gradients in the lower aquifers are quite small (USGS 1991). The vertical movement of groundwater appears to be down through the aquifers; however, offshore there may be upward flow from each of the three Talbot aquifers into the Gunpowder and Bush rivers. Movement in the surficial and confined aquifers is affected by the tides (USGS 1991).

Surface water and associated sediment transport may play some role in contaminant migration in that surface runoff, particularly after intense storms, may carry dissolved and suspended contaminants from contaminated soil down into the bay. Lateral contaminant migration by surface water is expected to be minor (Sonntag 1991). However, surface water percolating through and leaching contaminated soils may be a major pathway by which contaminants, especially metals and VOCs, move down into the groundwater. Any contaminants that may have been present in the past in sufficient amounts to exist as free liquid in the soil would be expected to migrate down independent of the presence of water.

Because of the generally humid conditions and the presence of a vegetative cover over the South Beach Trench, wind transport of contaminated soil is expected to be minor. Diffusion of contaminated soil gas into the atmosphere and direct volatilization of contaminants from the soil are also expected to be minor.

2.3.5 South Beach Demolition Ground

2.3.5.1 Types of Waste Present

The SBDG was used as a demolition site for HE during the 1960s and 1970s. Items were detonated either at the ground surface or buried several feet deep. Because of the high rates of erosion at J-Field, the SBDG is now offshore in the Chesapeake Bay (Hughes 1993). Its presence is marked only by the abundant fragments of munitions and pieces of metal that can be observed at low tide.

2.3.5.2 Types of Contaminants Present

Soil Gas and Soil

Soil-gas and soil sampling and analysis were not conducted because the area is now offshore.

Surface Water

Surface water samples were collected by the USGS in 1991 at low tide close to the SBDG shore (locations 12 and 13 in Figure 2.11). Both filtered and unfiltered samples were analyzed for major water quality parameters, metals, and a few organic compounds. Phenol, TOC, and TOX were detected in the unfiltered sample from location 13 (9.6, 4,000, and 30.4 µg/L, respectively).

As described in Section 2.3.1.2, the USGS and EPA ERT sampled surface water and sediment from the location of the SBDG. In general, the nearshore surface water data from the samples collected to date show essentially no contamination. What contamination that does exist appears to be associated with the suspended solids. This suggests that the nearshore sediments may be contaminated. Additional data are needed to evaluate the nearshore sediments.

Groundwater

Groundwater sampling and analysis were not performed because the area is now offshore and no wells are present in the immediate area.

2.3.5.3 Potential Pathways of Contaminant Migration

The main pathway of contaminant migration at the SBDG is expected to be by surface water, including wave action and tidal action. This conclusion is valid only for metals, because organic compounds most likely would have degraded in the bay. Because this area is currently under water, wind transport of contaminants is expected to be an insignificant migration pathway.

2.3.6 Prototype Building

2.3.6.1 Types of Waste Present

The PB area was believed to be used primarily for the storage of solid waste when disposal operations were active at J-Field. In addition, a review of aerial photographs suggests that there was a burning area about 200 ft west of the PB and near the edge of the existing tree line. The southern boundary of the area is marked by piles of soil, while its northern edge is marked by tall reeds and shallow ponded water. A rusted drum and scrap metal have been found on the ground surface (U.S. Army 1965). Another suspect burning area is located northeast of the PB. No records were kept of the types or quantities of material stored or potentially burned at the PB.

2.3.6.2 Types of Contaminants Present

Soil Gas

Soil-gas sampling and analysis were not performed in this area.

Soil

As part of the 1986 RFA (Nemeth 1989), surface soil samples collected at several locations near the PB (Figure 2.8) were analyzed for metals, extractable metals, and explosives-related compounds. Composites of samples from different locations were analyzed for BNAs, pesticides, and PCBs.

Cadmium and lead were detected at concentrations of 16.6 and 1,622 mg/kg (respectively) near the southern side of the PB. Organic compounds were also present in the soil samples, but below measurable levels. A composite sample taken near the PB contained low concentrations of pesticides, including 1.0 mg/kg each of DDD, DDE, and DDT.

Soil samples were collected by the USGS in 1991 at 36 sites in J-Field, including the PB (locations 11 through 15 in Figure 2.9). The samples were collected at 1-ft depths and analyzed for indicator parameters, metals, VOCs, semivolatile compounds, and explosives-related compounds (Hughes 1992). The analyses showed that metals contamination is present at the site, especially at location 15, where lead was detected at 93.3 mg/kg, chromium at 18.8 m/kg, copper at 47.5 mg/kg, and zinc at 158 mg/kg. Limited analyses for organic compounds were also conducted; no significant contamination was found.

Surface Water

As noted in Section 2.3.1.2, the USGS and EPA ERT sampled surface water and sediment offshore from the PB.

Groundwater

Three monitoring wells were installed in the area of the PB (wells TH5, TH6, and TH8 in Figure 2.13). Analysis of a water sample collected from TH5 during an environmental survey (Nemeth 1989) showed only compounds related to well construction. Minor amounts of hydrocarbons were detected in groundwater from TH8. The compounds 111TCE and dimethyl disulfide were detected in well TH6 (on the southern side of the PB).

An additional monitoring well nest, JF3, was installed near the PB by the USGS (Sonntag 1991; Hughes 1993). The well nest consists of three wells, screened in the confined aquifer, the leaky confined unit, and the surficial aquifer of the Talbot Formation (Figure 2.13). Groundwater samples were analyzed for metals, water quality parameters, VOCs, and semivolatile organic compounds. The results of VOC measurements on samples from well TH8 showed that benzene (6.43 µg/L) and methylisobutylketone (120 µg/L) contamination is present. However, no VOCs were detected in well TH8 or in wells JF3-1, JF3-2, and JF3-3 during a 1992 sampling episode (USGS 1992).

2.3.6.3 Potential Pathways of Contaminant Migration

The main pathway of contaminant migration at the PB is believed to be movement through the vadose zone into the groundwater and then transport by the groundwater.

The direction of groundwater movement in the Talbot aquifers appears to be away from the PB toward the Gunpowder River. However, the lateral gradients in the lower aquifers are quite small (USGS 1991). The vertical movement of groundwater appears to be down through the aquifers; however, offshore there may be upward flow from each of the three Talbot aquifers and into the Gunpowder and Bush rivers. Movement in the surface and confined aquifers is affected by the tides (USGS 1991).

Surface water and associated sediment transport may play some role in contaminant migration in that surface runoff, particularly after intense storms, may also carry dissolved and suspended contaminants from the soil toward the river. Lateral contaminant migration by surface water is expected to be minor (Sonntag 1991). However, surface water percolating through and leaching contaminated soils may be a major pathway by which contaminants, especially metals and VOCs, move down into the groundwater. Any contaminants that may have been present in the past in sufficient amounts to exist as free liquid in the soil would be expected to migrate down, independent of the presence of water.

Because of the generally humid conditions in the J-Field study area, wind transport of contaminated soil in areas with a good vegetative cover is expected to be a minor migration pathway. Diffusion of contaminated soil gas into the atmosphere and direct volatilization of contaminants from the soil are also expected to be minor. However, because portions of the PB area are unvegetated or are sparsely covered with stressed vegetation, and because at least part of the area is expected to be used for open burning, the air pathway may be significant.

2.3.7 Robins Point Tower Site

2.3.7.1 Types of Waste Present

Robins Point was a launch and observation site for rocket testing programs conducted in the J-Field area. No information has been uncovered to indicate that solid or hazardous waste was generated or handled at this site. However, Nemeth (1989) found records indicating that radioactive contaminated wood may have been burned at this site.

2.3.7.2 Types of Contaminants Present

Soil Gas

Soil-gas sampling and analysis were not conducted in this area.

Soil

Field inspection of this site found no visual evidence of soil contamination. Because no information exists that waste was ever handled in this area, soil sampling and analysis were not conducted. No radiation above normal background levels was detected in a field radiation survey conducted during February 1988 (Nemeth 1989).

Surface Water

As noted in Section 2.3.1.2, the USGS and the EPA ERT sampled surface water and sediment offshore from the RPTS.

Groundwater

Groundwater samples from monitoring well TH11 (Figure 2.13) were analyzed for extractable organic compounds. Results indicated very low levels of triethylchlorobenzene and TCLEE. As part of the 1986 RFA, the well was resampled for VOCs, BNAs, pesticides, and PCBs. No contaminants were detected.

An additional monitoring well (JF1) was installed near the tower by the USGS as part of their hydrological assessment (Sonntag 1991; Hughes 1993). The well is screened in the Potomac Group (Figure 2.13). Groundwater samples were analyzed for metals, water quality parameters, VOCs, and semivolatile organic compounds. Data for well JF1 showed low levels of VOC contamination (2.25 µg/L 111TCE at a depth of 185-190 ft). However, this finding must be taken as provisional, because one of the two quality control water blanks also showed contamination with TCLEA, TCLEE, and TRCLE (USGS 1992). For the sake of comparison, an upgradient well (JF2) of similar depth, located at the J-Field gate entrance also had detectable concentrations of TRCLE during the same sampling episode. Acetone and 1,1-dichloroethane were detected at concentration of 4 and 1 µg/L, respectively in a 1992 sampling event (USGS 1992).

2.3.7.3 Potential Pathways of Contaminant Migration

No information is available to verify that solid or hazardous waste was generated or handled at this site. A test burn of radioactive contaminated wood may have occurred at the site; however, the limited sampling conducted to date indicates that this area is not a source of contamination. Thus there are no potential pathways for contaminant migration.

2.3.8 Robins Point Demolition Ground

2.3.8.1 Types of Waste Present

The inactive portion of the RPDG was used primarily for demolition of explosive materials. Small amounts of sensitive and unstable chemicals were occasionally destroyed at the area. A portion of the RPDG is still used for emergency disposal operations.

2.3.8.2 Types of Contaminants Present

Soil Gas

Soil-gas sampling and analysis were not conducted in this area.

Soil

Surface soil collected during the 1986 RFA was analyzed for metals, explosives-related compounds, and organic compounds. The analyses did not detect any contamination in the RPDG (Nemeth 1989).

Soil samples were collected by the USGS at 36 sites at J-Field, including the RPDG (locations 37 through 41 in Figure 2.9). The samples, collected at 1-ft depths, were analyzed for indicator parameters, metals, VOCs, semivolatile organic compounds, and explosives (Hughes 1992b). The results indicated the presence of metals in low concentrations, including lead, up to 20.3 mg/kg at location 38; chromium, up to 16.3 mg/kg at location 37; copper, up to 75.5 mg/kg at location 37; and zinc, up to 22.8 mg/kg at location 39. Limited analyses for organic compounds were also conducted; no significant contamination was found.

Surface Water

Laboratory analyses of standing water conducted during the 1986 RFA did not detect any contamination by metals, explosives, or organic compounds (Nemeth 1989).

Groundwater

Two monitoring wells were installed in the active portion of the RPDG in 1992 and will be sampled as a part of the RI. However, groundwater contamination is not expected given the short period of time the site was used, the nature of the operations, and the absence of soil and surface water contamination.

2.3.8.3 Potential Pathways of Contaminant Migration

Given the nature of the operations at the site and the absence of soil and surface water contamination, it is doubtful that any contamination still exists at this site. However, surface water that ponds west of a berm separating the active from the inactive portion of the RPDG seeps through the berm and discharges into the inactive portion of the site. As a result, surface water may play some role in contaminant migration in that surface runoff may carry dissolved and suspended contaminants from the active portion of the site into the inactive portion.

3 SAMPLING ACTIVITIES

The goal of the sampling activities described in this FSP is to collect data of sufficient quality and quantity to characterize the nature and extent of contamination and to carry out human health and ecological risk assessments. This process involves developing an appropriate conceptual site model for J-Field. Model development includes consideration of the significance of different primary and secondary contaminant sources and release mechanisms and of contaminant migration pathways to human and ecological receptors. To this end, it is necessary to determine the nature and extent of contamination in the different environmental media and to identify the important contaminant migration pathways at each of the eight AOCs at J-Field.

Planned activities include the collection and analysis of samples of soil gas, soil, sediments, surface water, air, and groundwater. These activities have been planned to address the anticipated data needs for the J-Field Ecological Risk Assessment, the Human Health Risk Assessment (ICF-Kaiser Engineers 1993a,b), the Feasibility Study (FS), and the Focused Feasibility Study (FFS) for the TBP AOC.

3.1 SAMPLING JUSTIFICATION AND STRATEGIES

3.1.1 Data Gaps

The planned sampling activities are designed to complement existing data and concurrent investigations for J-Field and to fill data gaps. The information summarized in Section 2 indicates that the existing data are insufficient to carry out baseline human health and ecological risk assessments. Some of the data gaps are summarized below:

- Existing soil-gas data show contamination at the edges of the surveyed areas, an indication that soil-gas contamination extends for unknown distances outside the surveyed areas. Additional data are needed to determine the extent of soil-gas contamination.

- Existing surface soil sampling locations at the AOCs are insufficient to characterize the nature and extent of contamination to the extent needed for human health and ecological risk assessment. Some areas with a potential for contamination, particularly within the PAOCs, have not been sampled. In other areas, the existing data and the data planned for collection in concurrent investigations are insufficient to give good statistics on the nature and extent of contamination. Demolition craters and areas denuded of vegetation also need to be sampled.

- So far, minimal subsurface soil sampling has been conducted. In addition, the subsurface soil sampling planned in concurrent investigations does not extend to sufficient depths to adequately characterize contamination at depth at the AOCs, especially for the TBP and RCP areas.

- Very little sediment and surface water sampling has been done or is planned concurrently in the marshes. Such sampling is especially needed in the marshes near the South Beach and RCP AOCs, the RPTS AOC, and around the TBP AOC (where preliminary thermal imagery suggests that groundwater discharge to surface water could be a significant migration pathway). Because of a potential for groundwater discharge, nearshore sampling is needed near the PB. Almost no surface water sampling has been done or is planned so far at the RCP area.

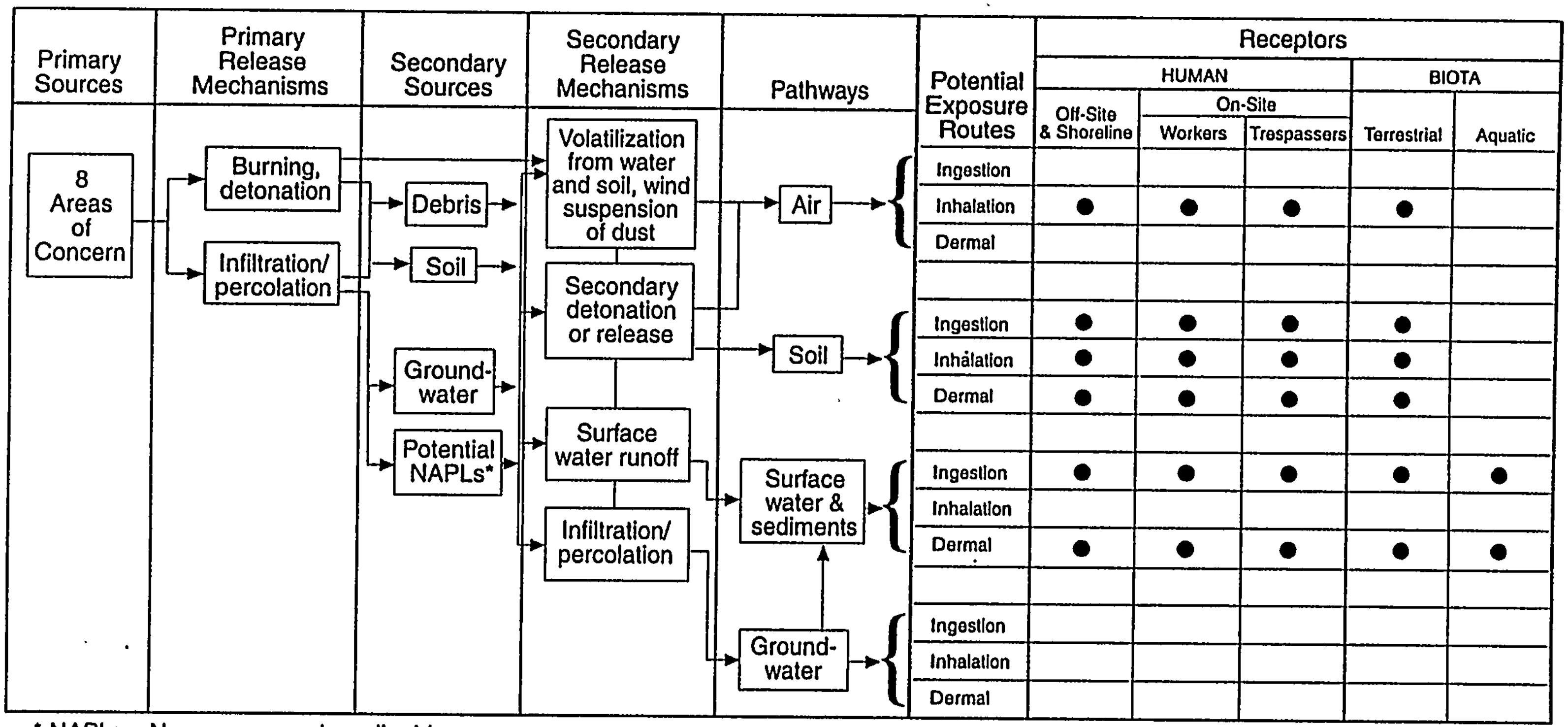
- Existing and planned monitoring wells are not designed to determine the possible presence of separate phases of dense nonaqueous liquids. Such information is especially needed at the TBP area, where existing data show the presence of groundwater and soil contamination by VOCs.

- Because of contamination found in blanks, the reliability of existing groundwater data in some cases is poor, and the existing data thus are of questionable value in determining the nature and extent of groundwater contamination. Additional monitoring data of good quality are needed for all the existing and new wells. Existing groundwater data have also been collected too infrequently to reveal any temporal variations in the quality of the groundwater at J-Field.

- An air monitoring program is needed to evaluate whether current conditions at J-Field affect the ambient air quality and whether the air pathway contributes to public health risk. Meteorological data for APG will be gathered to gain a better understanding of wind patterns over the peninsula. Continuous downwind monitoring for particulate matter and organic compounds will be conducted in the summer of 1995. The air monitoring program will support modeling and analysis that will be needed to assess risk associated with ambient conditions and future remedial activities.

3.1.2 Conceptual Site Model

A conceptual site model for J-Field, which links sources and release mechanisms to receptors through various pathways and exposure routes, is presented in Figure 3.1. The model has been prepared on the basis of our current understanding of the contamination scenario at J-Field. It is based on the human health risk assessment work plan prepared by ICF-Kaiser Engineers (1993a) and on existing data.



* NAPLs = Non-aqueous-phase liquids

FIGURE 3.1 Conceptual Site Model for J-Field

At this stage of the investigation, the proposed conceptual site model shown in Figure 3.1 is applicable to each of the AOCs on J-Field. As additional information is gathered, it may be necessary to modify the model; it may even become necessary to define a separate conceptual site model for each AOC. However, such action would be taken only if contaminant conditions, exposure routes, and potential receptors were significantly different for the different AOCs.

In the conceptual site model, the main sources of contamination are considered to be the eight AOCs. The primary release mechanisms associated with these AOCs are considered to be related to the primary waste-handling activities conducted at J-Field — OB/OD. Precipitation falling on the OB/OD areas and other contaminated areas would cause the infiltration/percolation of contaminants. In addition, because operating procedures could have involved the addition of decontaminating agents (such as DANC) and assorted fuels to facilitate open burning, infiltration and percolation of these contaminants are also considered primary release mechanisms.

Because of the potential for soils at each AOC to have become contaminated through the primary release mechanisms, soil is considered to be one of the more significant secondary sources of contamination. Groundwater is also considered a significant secondary source of contamination because of the possible presence of nonaqueous phase liquids (NAPLs) such as fuel, solvents, and CWA decontaminating fluids that may exist in discrete pockets in the subsurface. One example of a commonly used decontaminating agent is DANC, which contains 90-95% TCLEA (Nemeth 1989). TCLEA, if present in high enough concentrations in groundwater, can exist in a nonaqueous phase. In addition, because of the nature of OB/OD activities, significant amounts of debris (such as exploded or unexploded ordnance) could likely exist within each AOC. Such debris could also represent a significant secondary source of contamination.

Several processes have been identified as secondary release mechanisms in the conceptual site model. Because of the potential for the existence of areas of contaminated soil and debris, an associated potential exists for the release of contaminants in dust and as volatilization products of contaminants into the air pathway from debris, soil, and groundwater. The discharge of groundwater into surface water bodies, such as marshes and streams, and potentially into Chesapeake Bay, as suggested by infrared imagery studies, is a potentially significant release mechanism for groundwater into media with exposure routes to receptors.

Because of the possible existence of UXO, some potential exists for contaminants to be released to the soil or air pathways as a result of "secondary" detonations. Infiltration and percolation are also considered significant secondary release mechanisms because they can cause contaminants in soil and debris to migrate to groundwater or to surface water and sediments. Surface runoff can also be a significant mechanism for the release of contaminants to surface water, sediments, and to areas of previously uncontaminated soil.

Analysis of potential impacts to human receptors at J-Field is based on the current limited human activity at the field. The active portions of the RPDG are currently the main active site for demolition of munitions. The WPP is also occasionally used for emergency disposal activities. Fishing and crabbing from boats occurs just offshore, even though it is not permitted along the J-Field shoreline. Trapping and hunting takes place at nearby I-Field, and migratory bird hunting is approved for the area along the J-Field shoreline. Trespassing is not likely because of increased security in the area.

The conceptual site model (Figure 3.1) accounts for these activities by separating the human receptors into on-site (workers and trespassers) and off-site (hunters and fishermen). Potential exposures to these receptors and to terrestrial and aquatic biota through different pathways and exposure routes are indicated in the figure by solid black dots.

No potential receptors are indicated for groundwater because no direct routes are likely. Groundwater is not used downgradient of J-Field; the nearest pumping well is about 4 mi distant across the Gunpowder River (Hughes 1993). The potential for dermal exposure of workers to groundwater while withdrawing samples from monitoring wells is minimal. Potential indirect exposure routes for groundwater by upwelling into Chesapeake Bay or discharge to marshes and streams are indicated in Figure 3.1 by a pathway arrow from groundwater to surface water and sediments.

3.1.3 Sampling Strategies

In Stage I of the three-stage sampling approach, soil and sediment samples analyzed on-site will be limited to EPA analytical level I and II analyses. Additional details are given in the Section 5 of the RI Work Plan and in Section 3.2 of this document. A subset of the soil and sediment samples will be analyzed on-site, and surface water and groundwater samples collected during Stage I will be sent off-site for analysis at EPA levels III and IV. This action is possible because of the relatively rapid breakdown of CWA in water and because a subset of the soil and sediment samples to be collected are expected to be free from CWA. The data quality objectives (DQOs) for Stage I sampling activities are summarized in Tables 3.1 and 3.2. The DQOs for Stage II sampling activities are summarized in Table 3.3. Stage III DQOs will be developed as necessary to ensure that sufficient data exist to support the remedial alternative selection as part of the FS.

Stage I soil/sediment sampling activities are designed so that the results, combined with existing data, can be used to determine locations and depths free from CWA or UXO and to choose sampling locations for off-site CLP analyses. In addition, these activities can be used to help determine the nature and extent of contamination sources. Stage I soil/sediment activities may require several rounds or phases of sampling in which the area sampled is progressively extended until sampling shows little or no contamination. The Stage I soil/sediment sampling stops with this last phase as both the lateral extent and depth of the contaminated region are delineated by the results of this and previous rounds of Stage I sampling. The Stage I phasing is potentially applicable to sampling activities for soil,

TABLE 3.1 DQOs for Stage I Surveys and Hydrogeological Investigations at J-Field

DQO	Topographic Surveying and Grid System Establishment	Geophysical Survey	Soil-Gas Survey	Hydrogeologic Investigation
Objective	Global Positioning System (GPS) or conventional survey methods will be used to map the topography of each AOC and to provide locational information for surveys, soil sampling, and monitoring well installation.	Electromagnetic, total-intensity magnetic, and ground-penetrating radar (GPR) electromagnetic survey measurements will be made to define boundaries of known burial trenches and to identify any yet-undiscovered trenches. Borehole electromagnetic induction (EMI) will be used to determine the vertical distribution of conductive zones. Surface electromagnetic (EM) surveys will be conducted to obtain information on contaminant plume movement. Seismic reflection, seismic refraction, and electrical resistivity data will be used to characterize the leaky confining unit. Other remote sensing data, such as thermal imagery, near-red, and infrared, will be used to evaluate the J-Field site for any other potential contamination source areas.	Active and passive soil-gas sampling will be conducted at the TBP, WPP, the Prototype Building, and RCP areas to define the extent of contamination and to identify new areas with elevated levels of soil-gas contaminants. These results will also be used to establish surface soil sampling locations.	ANL will install one new monitoring well at J-Field, downgradient of the TBP. This well will be constructed with a well screen located just above the surface of the confining layer. Groundwater samples will be collected and analyzed to determine the nature and extent of contamination in the surficial aquifer. Water levels will be measured periodically to construct a groundwater elevation map.

TABLE 3.1 (Cont.)

DQO	Topographic Surveying and Grid System Establishment	Geophysical Survey	Soil-Gas Survey	Hydrogeologic Investigation
Chemical Data	None.	None.	A minimum of 165 active and/or passive soil-gas samples will be collected. Analytes will include chlorinated solvents (12DCE, 112TCE, TRCLE, TCLEE, and TCLEA); phthalates; benzene; and toluene, ethylbenzene, and xylenes (TEX).	Groundwater samples will be analyzed for TCL (VOCs, semivolatile compounds, PCBs, and pesticides), CWA degradation products, TAL (metals, dissolved metals, and cyanide), explosives, TOX, TOC, phosphate, sulfate, and radioactivity.
Physical Data	Details to be determined.	Geophysical surveys will be interpreted by the J-Field team and will be used to guide the placement of soil gas monitoring points, surface and sub-surface soil sample locations, and/or monitoring wells.	None.	Temperature, pH, specific conductance, redox, dissolved oxygen, and turbidity will be measured before, during, and after presample purging. Other general parameters will be analyzed as stipulated in Section 3.4.3. Water-level measurements will be taken within a 24-hour period from all wells, accurate to 0.01 ft.
Sampling Method	None.	***Chemical Data:*** No chemical data will be collected. ***Physical Data:*** Biased, non-intrusive.	***Chemical Data:*** Biased, intrusive. ***Physical Data:*** No physical data will be collected.	***Chemical Data:*** Biased, intrusive, environmental, discrete. ***Physical Data:*** Biased, intrusive, environmental, discrete.
Data Use	Site characterization.	Site characterization.	Site characterization.	Site characterization, risk assessment.

TABLE 3.1 (Cont.)

DQO	Topographic Surveying and Grid System Establishment	Geophysical Survey	Soil-Gas Survey	Hydrogeologic Investigation
Analytical Data Level	All data will be equivalent to EPA level I.	All data will be equivalent to EPA level I.	All data will be equivalent to EPA level II.	AEC- and CLP-certified analyses will be equivalent to EPA levels III and IV. All other data (measurements of temperature, pH, conductivity, and water levels) will be equivalent to EPA level I.
Analytical Method — AEC, CLP,[a] and ASTM[b]	No chemical or physical analytical data are required for surveying and grid establishment.	No chemical or physical analytical data are required for geophysical surveys.	Soil-gas samples will be analyzed by noncertified methods.	***Chemical Testing:*** see Table 2.1 of the QAPjP. ***Physical Testing:*** TBD.[c]
Typical Detection Limit	None.	None.	Typically 1 ppm.	Varies depending upon environmental media and matrix interference effects (see QAPjP).
Quality Control Samples	None.	None.	Duplicates, others to be determined.	Trip blanks, rinse blanks, duplicates, filter blanks, ambient blanks, method blanks, internal laboratory standards.
Background Samples	None.	None.	None.	None.

[a] CLP = Contract Laboratory Program.

[b] ASTM = American Society for Testing and Materials.

[c] TBD = to be determined.

TABLE 3.2 DQOs for Stage I Soil, Surface Water, and Sediment Sampling and for Tidal Monitoring

DQO	Subsurface Soil Sampling	Surface Water/Sediment Sampling	Surface Soil Sampling	Tidal Monitoring
Objective	Subsurface soil samples will be collected and analyzed to determine the nature and extent of contamination.	Surface water samples will be collected from marshes near the AOCs. In addition, tidal areas offshore of the Gunpowder Neck will be sampled. The results of the walkover inspection and surveys at each AOC will be used to locate any intermittent surface water features indicating that surface water drainage is a possible contaminant migration pathway.	Surface soil samples will be collected and field X-ray fluorescence (XRF) metal scans performed at the AOCs and PAOCs to locate areas of contamination. UXO/CWA screening will be required.	A tidal gauge equipped with a digital recorder will be installed in the Chesapeake Bay, about 200-300 yd east of Robins Point, to help determine the impact of tidal fluctuations on the aquifers and to determine groundwater flow velocity.
Chemical Data	Subsurface soil samples will be analyzed on-site for CWA and UXO (screen) and the Stage I analytical suite.	Surface water samples will be analyzed for the CLPAS.[a] Sediment samples will be analyzed on-site for CWA and UXO (screen) and the Stage I analytical suite.	Surface soil samples will be analyzed on-site for CWA (screen) and the Stage I analytical suite minus the MICKIT analyses. Gross beta and gamma spectrometry measurements will be made on some samples.	None.
Physical Data	Map coordinates for all sampling locations will be generated. General parameters will be analyzed as stipulated in Section 3.2.2.	Map coordinates for all sampling locations will be generated. General parameters will be analyzed as stipulated in Section 3.2.2.	Map coordinates for all sampling locations will be generated. Visual characterization of soils. General parameters will be analyzed as stipulated in Section 3.2.2.	The tidal gauge station will continuously record water levels in the Chesapeake Bay with a digital recorder for approximately 3 years.

TABLE 3.2 (Cont.)

DQO	Subsurface Soil Sampling	Surface Water/Sediment Sampling	Surface Soil Sampling	Tidal Monitoring
Sampling Method	***Chemical Data:*** Biased, intrusive, environmental, discrete. ***Physical Data:*** No physical data will be collected.	***Chemical Data:*** Biased, intrusive, environmental, discrete. ***Physical Data:*** No physical data will be collected.	***Chemical Data:*** Biased, intrusive, environmental, discrete. ***Physical Data:*** No physical data will be collected.	***Chemical Data:*** No chemical data will be collected. ***Physical Data:*** Biased, intrusive, discrete.
Data Use	Site characterization, risk assessment.	Site characterization, risk assessment.	Site characterization, risk assessment.	Site characterization.
Analytical Data Level	On-site analyses of the Stage I analytical suite equivalent to EPA levels I and II. AEC and CLP-certified analyses will be equivalent to EPA level IV for subsurface soil.	AEC- and CLP-certified analyses will be equivalent to EPA level IV for surface water and sediment. For sediment, on-site analyses equivalent to EPA levels I and II.	On-site analyses of the Stage I analytical suite equivalent to EPA levels I and II. AEC and CLP-certified analyses will be equivalent to EPA level IV for surface soil. Visual inspection will be equivalent to EPA level I.	All data will be equivalent to EPA level I.
Analytical Method — AEC, CLP, and ASTM	***Chemical Testing:*** see Table 2.3 of the QAPjP.	***Chemical Testing:*** see Tables 2.4 and 2.5 of the QAPjP.	***Chemical Testing:*** see Table 2.2 of the QAPjP.	No chemical or physical analytical data are required for tidal gauge measurements.
Typical Detection Limit	TBD[b]	TBD	TBD	None.

TABLE 3.2 (Cont.)

DQO	Subsurface Soil Sampling	Surface Water/Sediment Sampling	Surface Soil Sampling	Tidal Monitoring
Quality Control Samples	Trip blanks, rinse blanks, duplicates, filter blanks, ambient blanks, method blanks, internal laboratory standards.	Trip blanks, rinse blanks, duplicates, ambient samples, method blanks, internal laboratory standards.	Rinse blanks, duplicates, method blanks, ambient samples, internal laboratory standards.	None.
Background Samples	APG is developing a sitewide background study.	APG is developing a sitewide background study.	APG is developing a sitewide background study.	None.

[a] CLPAS = Contract Laboratory Program Analytical Suite.

[b] TBD = to be determined.

TABLE 3.3 DQOs for Stage II Soil, Subsurface Soil, Sediment, and Monitoring Well Sampling

DQO	Surface Soil Sampling	Subsurface Soil Sampling	Sediment Sampling	Hydrogeologic Investigation
Objective	Surface soil samples will be collected at the AOCs to define the extent of contamination. UXO/CWA screening will be required.	Subsurface soil samples will be collected and analyzed to determine the nature and extent of contamination. UXO/CWA screening will be required.	Sediment samples will be collected from marshes near the AOCs. In addition, sediment borings will be drilled near the TBP. The results of the walkover inspection and surveys at each AOC will be used to locate any intermittent surface water features indicating that surface water drainage is a possible contaminant migration pathway. CWA and UXO screening will be required on sediment samples.	A subset of the monitoring wells will be sampled to further site characterization efforts. If needed, additional monitoring wells will be installed and sampled upon approval of well site and construction specification by EPA and MDE.[a]
Chemical Data	Subsurface soil samples will be analyzed on-site for CWA (screen) and the CLPAS. Gross beta and gamma spectrometry measurements will be made on some samples.	Subsurface soil sampling sites will be analyzed on-site for CWA and UXO (screen) and the CLPAS.	Sediment samples will be analyzed on-site for CWA and UXO (screen) and the CLPAS.	Groundwater samples will be analyzed for TCL (VOCs, semivolatile compounds, PCBs, and pesticides), CWA degradation products, TAL (metals, dissolved metals, and cyanide), explosives, TOX, TOC, phosphate, sulfate, and radioactivity.

TABLE 3.3 (Cont.)

DQO	Surface Soil Sampling	Subsurface Soil Sampling	Sediment Sampling	Hydrogeologic Investigation
Physical Data	Map coordinates for all sampling locations will be generated.	Map coordinates for all sampling locations will be generated.	Map coordinates for all sampling locations will be generated.	Temperature, pH, specific conductance, redox, dissolved oxygen, and turbidity will be measured before, during, and after presample purging. Other general parameters will be analyzed as stipulated in Section 3.4.3. Map coordinates for any additional wells will be generated.
	Visual characterization of soils.	General parameters will be analyzed as stipulated in Section 3.2.2.	General parameters will be analyzed as stipulated in Section 3.2.2.	
	General parameters will be analyzed as stipulated in Section 3.2.2.			Water-level measurements will be taken before the sampling event from all wells, accurate to 0.01 ft.
Sampling Method	***Chemical Data:*** Biased, intrusive, environmental, discrete.	***Chemical Data:*** Biased, intrusive, environmental, discrete.	***Chemical Data:*** Biased, intrusive, environmental, discrete.	***Chemical Data:*** Biased, intrusive, environmental, discrete.
	Physical Data: No physical data will be collected.	***Physical Data:*** No physical data will be collected.	***Physical Data:*** No physical data will be collected.	***Physical Data:*** Biased, intrusive, environmental, discrete.
Data Use	Site characterization, risk assessment.	Site characterization, risk assessment.	Site characterization, risk assessment.	Site characterization, risk assessment.

TABLE 3.3 (Cont.)

DQO	Surface Soil Sampling	Subsurface Soil Sampling	Sediment Sampling	Hydrogeologic Investigation
Analytical Data Level	AEC- and CLP-certified analyses will be equivalent to EPA level IV for surface soil sampling. Visual inspection will be equivalent to EPA level I.	AEC- and CLP-certified analyses will be equivalent to EPA level IV for subsurface soil sampling. Visual inspection will be equivalent to EPA level I.	AEC- and CLP-certified analyses will be equivalent to EPA level IV for sediment.	AEC- and CLP-certified analyses will be equivalent to EPA levels III and IV. All other data (measurements of temperature, pH, conductivity, and water levels) will be equivalent to EPA level I.
Analytical Method — AEC, CLP, and ASTM	***Chemical Testing:*** see Table 2.2 of the QAPjP. ***Physical Testing:*** TBD[b]	***Chemical Testing:*** see Table 2.3 of the QAPjP. ***Physical Testing:*** TBD	***Chemical Testing:*** see Tables 2.4 and 2.5 of the QAPjP. ***Physical Testing:*** TBD	***Chemical Testing:*** see Table 2.1 of the QAPjP. ***Physical Testing:*** TBD
Typical Detection Limit	TBD	TBD	TBD	TBD
Quality Control Samples	Rinse blanks, duplicates, method blanks, ambient samples, internal laboratory standards.	Trip blanks, rinse blanks, duplicates, filter blanks, ambient blanks, method blanks, internal laboratory standards.	Trip blanks, rinse blanks, duplicates, ambient samples, method blanks, internal laboratory standards.	Rinse blanks, duplicates, method blanks, ambient samples, internal laboratory standards.
Background Samples	APG is developing a sitewide background study.	APG is developing a sitewide background study.	APG is developing a sitewide background study.	APG is developing a sitewide background study.

[a] MDE = Maryland Department of the Environment.

[b] TBD = to be determined.

sediment, and soil gas. The existing soil-gas data, which show soil-gas contamination out to the edge of the areas surveyed, exemplify the need for this use of phasing. A decision tree for Stage I activities, which lead to Stage II, is provided in Figure 3.2.

The goal of Stage II activities for soil and sediment sampling is characterization of contamination within the areas delineated by the phases of Stage I sampling (and/or verification that apparently uncontaminated areas are "clean") to the extent needed to carry out human health and ecological risk analyses. Both the analytes and the choice of sampling locations will be based on the Stage I results. At this time, it is assumed that analytical methods will include off-site analyses of soils and sediments with CLP and AEC methods yielding data of EPA analytical levels III, IV, or V.

Stage II sampling activities for soil, sediment, surface water, and groundwater will consist of collecting additional samples of environmental media and collecting additional samples from existing wells. Stage I results will be used to determine the location and number of additional samples and additional monitoring wells (if any) and any changes in the analytical suites. The groundwater, soil, and sediment samples for Stage II will be analyzed off-site to provide EPA level III, IV, or V data. These data will be combined with the Stage I data to determine the extent of areas of contaminated surface water or of plumes of contaminated groundwater, to determine the extent of contaminated soil and sediment, and to characterize the contamination within those areas or plumes.

In Stage III, sampling and analyses strategies will be developed, if necessary, to ensure that the desired DQOs for remedial alternative selection have been achieved in the previous stages.

Essentially no background samples will be collected in any of the stages. Instead, data collected by APG as part of a sitewide background study and other background data collected by APG contractors will be used.

As shown in the conceptual site model, the air pathway could be of potential significance. An air monitoring program will be implemented to evaluate the current conditions at J-Field.

3.1.4 Sampling Activities

The first round of Stage I will include the following activities:

- UXO/CWA surveys and field surveys of the AOCs;
- Video inspection of the several USATHAMA and Princeton Aqua Science wells;
- If necessary, the abandonment of damaged or unusable wells (in accordance with MDE well-abandonment procedures);

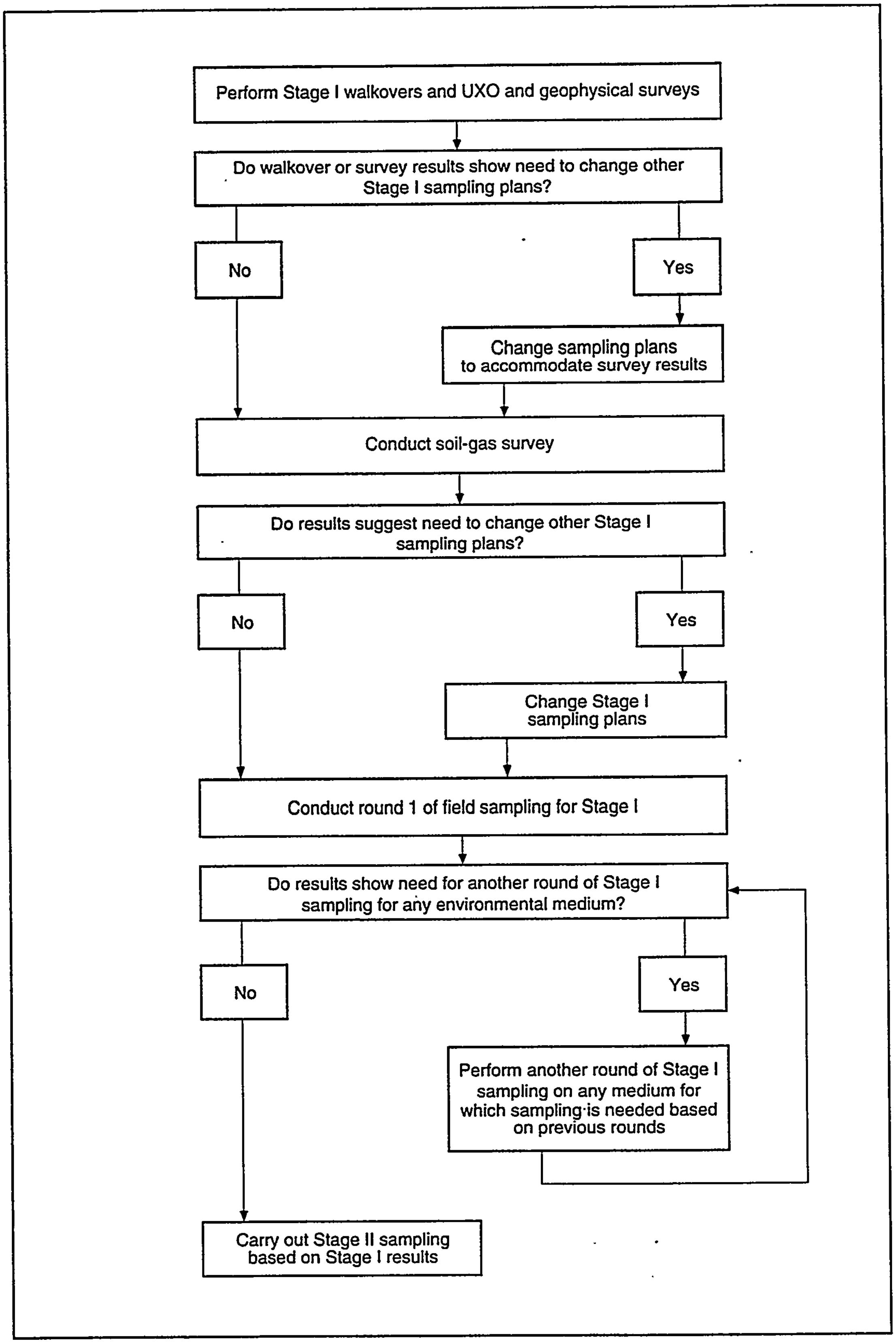


FIGURE 3.2 Decision Tree for Stage I Sampling Activities, Leading to Stage II

- Installation of a tidal gauge near the RPTS AOC;
- Performance of a topographic survey and the generation of a site map for each AOC;
- Performance of a variety of geophysical surveys, including (but not limited to) ground penetrating radar, electrical conductivity, electrical resistivity depth soundings, magnetics, seismic reflection, and seismic refraction;
- Implementation of a groundwater and surface water monitoring program using Contract Laboratory Program (CLP)-certified methods;
- Analysis of soil, soil gas, and sediment samples with field screening and field analytical methods augmented with the off-site analyses of samples with CLP-certified methods; and
- Installation of a monitoring well.

The geophysical surveys and soil-gas surveys will be used to locate buried UXO or CWA containers and other buried items, to help verify the locations of former OB/OD areas, and to aid in the exploration of unknown contamination sources. The soil-gas surveys will also be useful because of the reported widespread use of DANC as a decontaminating agent for CWA. DANC contained about 90-95% TCLEA (Nemeth 1989).

3.2 OVERVIEW OF THE SAMPLING AND ANALYTICAL PROGRAM

3.2.1 Potential Contaminants of Concern for J-Field

The potential contaminants of concern for J-Field include diverse organic and inorganic chemicals. Archival data suggest that a variety of CERCLA hazardous substances or explosives-related compounds could have been disposed of in the various J-Field AOCs. As previously stated, lethal chemical agents, incapacitating agents, decontaminating agents, smoke/incendiary materials, explosives-related compounds, volatile and semivolatile organic compounds, oils, fuels, and a variety of miscellaneous compounds associated with the research and development mission at the Edgewood Area of APG were handled at J-Field. Table 3.4 lists potential chemicals of concern for J-Field.

3.2.2 Field Screening Analytical Methods

An important constraint on soil and sediment sample collection at J-Field is that many locations and depths to be sampled must be certified free of CWAs with both gross and sensitive CWA screens before samples can be collected for other analyses. Field screening

TABLE 3.4 Summary of Potential Chemicals of Concern for J-Field[a]

Volatile/Semivolatile Organic Compounds

- Acetone (ACET)
- Benzene (C6H6)
- Carbon tetrachloride (CCL4)
- Chlorobenzene (CLC6H5)
- Chloroform (CHCL3)
- 1,2-Dichloroethane (12DCLE)
- 1,1-Dichloroethylene (11DCE)
- 1,2-Dichloroethylene (12DCE)
- 2,4-Dimethylphenol (24DMPN)
- Ethyl benzene (ETC6H5)
- Nitrobenzene (NB)
- p-Chlorophenylmethyl sulfone (CPMSO2)
- Phenol (PHENOL)
- 1,1,2,2-Tetrachloroethane (TCLEA)
- Tetrachloroethylene (TCLEE)
- Toluene (MEC6H5)
- 1,1,1-Trichloroethane (111TCE)
- 1,1,2-Trichloroethane (112TCE)
- Trichloroethylene (TRCLE)
- Vinyl chloride (C2H3CL)

Fuels/Oils

- Fuel oil
- Oil resin
- Fog oil

Metals and Anions

- Arsenic (AS)
- Cyanide (CYN)
- Fluoride (F)
- Lead (PB)
- Mercury (HG)
- Nickel (NI)
- Nitrite/nitrate (NIT)
- Selenium (SE)
- Sulfate (SO4)

Radioactive Materials

- Strontium-90/Yttrium-90
- Radium
- Cesium-137
- Uranium

Lethal Chemical Agents

- Tabun (GA)
- Sarin (GB)
- Methylphosphonothioic acid (VX)
- Mustard (H)

Incapacitating Agents/Liquid Smoke

- Adamsite (DM)
- Chloroacetophenone (CN)
- o-Chlorobenzylidene malononitrile (CS)
- Titanium tetrachloride (FS)
- Sulfur trioxide/chlorosulfonic acid (FM)

Incendiary Materials

- White phosphorus (WP)

Munitions Compounds

- 2,4,6-Trinitrotoluene (TNT)
- Cyclotetramethylene tetranitrate (HMX)
- Hexahydro-1,3,5 trinitro-1,3,5-triazine (RDX)
- 2,4,6-Trinitrophenyl methylnitramine
- Nitrobenzene (NB)
- 1,3-Dinitrobenzene (13DNB)
- Pentaerythritol tetranitrate (PETN)

Chemical Warfare Agent Degradation Products[b]

Product	Agent
Hydrogen cyanide	GA
Isopropyl methyl phosphonic acid	GB
Methyl phosphonic acid	GB, VX
Ethyl methyl phosphonic acid	VX
Thiodiglycol	Mustard
1,4-Dithiane	Mustard
1,4-Oxathiane	Mustard

Miscellaneous Compounds

- Heptachlor Epoxide
- Chlordane
- DDD, DDE, DDT
- Picric acid
- PCBs (Aroclor 1248)
- Hydrazine sulfate

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[a] The Installation Restoration Data Management System (IRDMS) abbreviations for the chemicals are given in parentheses after each name, if appropriate.

[b] Via hydrolysis and other processes.

Source: Adapted from ICF-Kaiser Engineers (1993a) and the J-Field RI Work Plan.

methods are useful at J-Field in that some of these methods can be used to analyze surface soils or sediments in-situ without the need to excavate the sample and thereby trigger the need for gross and sensitive CWA screens. In addition, these methods are useful in determining which locations, depths, and matrices need to be sampled for level III, IV, or V analyses in off-site labs. Section 3.2.4 gives additional details on soil and sediment sample management protocols.

The on-site field screening methods expected to be available will include those listed in Table 3.5. These various analytical methods, which are described in detail in the J-Field QAPjP, represent what is termed the "Stage I analytical suite." Sample analyses will typically involve a subset of the analytes summarized for Stage I.

The Stage I analytical suite has been selected to address, at least on a rudimentary basis, the contaminants of concern. Except for the MICKIT method, each of the methods in the Stage I analytical suite can be related to one or more of the classes of chemicals, products, or materials listed in Table 3.4. The MICKIT method has been selected for use in characterizing indigenous soil microbes as part of the FFS for the TBP and the overall FS.

The following discussions provide some information on the Stage I analytical suite methods. Additional details are given in the J-Field QAPjP.

Active Soil-Gas Analysis: Active soil-gas analysis includes the use of an adsorbent tube to concentrate soil-gas samples before analysis, or the direct injection of soil gas into a gas chromatography (GC) unit to analyze soil gas for halogenated and nonhalogenated organic compounds. Photo and flame ionization detectors (PIDs/FIDs) are used with the GC unit to screen samples. These instruments have detection limits around 200 ppb. Electron capture detectors (ECDs), with a detection limit of 5 ppb, are used when more sensitive analysis is required (Layne Geosciences, Inc. undated).

Passive Soil-Gas Analysis: Passive soil-gas analysis uses adsorbents placed at a fixed location to collect soil-gas contaminants over a period of time (e.g., 72 hours). The adsorbent used depends on the contaminants and site conditions. The samples collected are analyzed by thermally desorbing the contaminants into a gas chromatography/mass spectrometer (GC/MS) unit for analysis. Analytical results are typically given in relative concentration units rather than as direct concentrations in the soil gas. A wide range of organic contaminants can be detected by this method. (The J-Field QAPjP gives a detailed list of detectable contaminants.)

Headspace Analysis: Headspace analysis is an analytical technique used to measure VOCs. The process involves placement of samples in sealed glass containers for equilibration at 90°C with the headspace gas, as described in EPA Method 3810, SW 846 (EPA 1986). A sample of the equilibrated headspace gas is withdrawn for analysis by standard EPA methods, such as GC or GC/MS (EPA 1986).

TABLE 3.5 Summary of Stage I Analytical Methods and Corresponding Analytes

Analytical Method	Analyte Groups[a]
Head space analyses	Volatile organic compounds
Soil-gas analyses[b]	Volatile organic compounds and some semivolatile organic compounds, including phthalates and some others
Gas chromatography (GC), gas chromatography/mass spectrometry (GC/MS)	Volatile and semivolatile organic compounds
Colorimetric immunoassay	Total petroleum hydrocarbon (PEH), total polycyclic aromatic hydrocarbons (PAHs), PCBs, and pentachlorophenol
Colorimetric	Nitroaromatics — explosives, PCBs, BTEX[c]
X-ray flourescence (XRF)[d]	Metals
HNu	Volatile organic compounds
MicroTox	Total toxic chemicals
MICKIT	Different bacterial types
CLP TCL of organic compounds	Organic compounds
CLP TAL of metals and cyanide	Metals and cyanide
Analyses of general parameters for soil, sediment, surface water, and groundwater	Some physical and chemical parameters for each environmental medium

[a] Analyte groups denoted as "total" mean that the individual parameters in the group are not measured. Only the sum of contributions from all parameters in the group is measured.

[b] Includes both active and passive soil gas analytical methods.

[c] Benzene, toluene, ethylbenzene, and xylenes.

[d] To include both field and laboratory XRF.

Field Organic Vapor Analyzers: A variety of hand-held instruments are available for survey measurements of VOCs in the field. Included are HNu meters with PID, organic vapor analyzers (OVAs) with FIDs, and PID units with small pumps to draw a gas sample into a chamber for ionization. Concentrations from 0.1 to 2,000 ppm can be measured, with a detection limit of 0.05 ppm for benzene (Photovac Inc. undated).

Field GC or GC/MS Analyzers: Mobile GC or GC/MS systems are useful in conducting screening analyses and in detecting a variety of organic contaminants, such as volatile and semivolatile compounds (including PCBs and pesticides). Volatile compounds can be extracted from soil samples by use of a purge and trap method employing thermal desorption. Semivolatile and volatile compounds can be extracted with a solvent extraction process. Target method detection limits (TMDLs) for soil quoted for one mobile GC system using solvent extraction and different detectors are 0.12 to 0.62 ppm for volatile compounds with a PID or electrolytic conductivity detector, 0.1 ppm for PCBs and pesticides with an ECD, and 1.0 ppm for polycyclic aromatic hydrocarbons (PAHs) with a FID (Harrison et al. undated; Pace Inc. 1992).

X-Ray Fluorescence: XRF uses X-ray-emitting radioisotopes to ionize elements, which then emit K or L X-rays. The K and L X-rays have energies characteristic of the emitting element. The X-rays are detected in either a proportional counter or a silicon-lithium (Si[Li]) solid state detector coupled to a multichannel analyzer. A wide range of elements, ranging from silicon to uranium, can be analyzed by use of different X-ray-emitting radioisotopes as sources. Field portable units can analyze elements in the periodic table from sulfur to uranium.

Detection limits for portable units depend on the element and the degree of interference from other elements. For one unit, interference-free detection limits for soil range from 30 ppm for cadmium to 180 ppm for chromium. Detection limits with all elements present range from 50 ppm for cadmium to 200 ppm for chromium. Use of the Si(Li) probe gives typical soil detection limits of 30 to 80 ppm for zinc, lead, copper, and arsenic. Detection limits range from 0.035 to 0.073 ppm for water samples (OutoKumpu Electronics undated; Poirek and Pasmore 1991). Other XRF units are reported to have detection limits in the low parts-per-million range for soil.

Colorimetric Methods: Available field screening techniques include the colorimetric methods for detection of contaminants. Immunoassay methods can be used to screen soil and water samples quickly for organic compounds such as PCBs, PAHs, pentachlorophenol (PCP), and petroleum hydrocarbons (PEHs). The tests are accurate (the methods correlate to accepted EPA methods at 85% or more) and can be completed in less than 20 minutes. Soil samples must be extracted and the extractant filtered; water samples require filtration and pH adjustment. Detection limits are stated to be <0.5 ppm for PCP, 100 ppm for PAHs, and <5 ppm for PCBs (Carter 1992; EnSys Inc. 1992).

Other colorimetric methods are available for field testing for explosives; PCBs; and benzene, toluene, ethylbenezene, and xylenes (BTEX) in soil and water. The tests can be carried out in less than 20 minutes, with an additional 5 minutes required for initial extraction of soil samples. The assay ranges for one type of unit are stated to be 5-60 ppb for trinitrotoluene (TNT) in water, 0.2-2 ppm for TNT in soil, 0.5-50 ppm for PCBs in soil, 0.5-50 ppm for BTEX in water, and 1-50 ppm for BTEX in soil. Minimum detection limits for explosives-related compounds in water are higher than that for TNT (3 ppb in water) by factors ranging from 5 for tetryl to 170 for 2,6-dinitrotoluene (26DNT), hexahydro-1,3,5-trinitro-1,3,4-triazine (RDX), cyclotetramethylene tetranitrate (HMX), and other compounds (Sawyer 1993).

MicroTox: The MicroTox method relies upon changes in bioluminescence as a measure of toxicity. Luminescent microorganisms contained in the MicroTox reagent are exposed to contaminants. Toxic materials in the sample interfere with the metabolism of the organisms and reduce their light output in proportion to the toxicity. The light output of the organisms in a filtrate is measured to determine sample toxicity.

MICKIT: The MICKIT is a field method designed to detect and distinguish between sulfate-reducing bacteria, anaerobic or partially anaerobic bacteria, acid- producing bacteria, and general aerobic bacteria.

General Parameter Analyses: Information on several general parameters are needed for the environmental media at J-Field to conduct risk analyses and to provide better understanding of contaminant movement. For soils, measurements will be taken to determine grain size, moisture content, Unified Soil Classification System type, and percent organic carbon. In addition, the sizes of areas denuded of vegetation, such as those near the TBP AOC, must be determined. Information needed for sediments includes percent organic carbon, temperature, pH, and grain size. For surface water and groundwater, the data needed include pH, conductivity, temperature, salinity, dissolved oxygen content, alkalinity, and hardness.

CLP Analytical Methods: The Stage I analytical suite also includes CLP analytical methods. CLP-related analyses will be conducted by an off-site laboratory on CWA-cleared samples. A subset of the Stage I soil and sediment samples will be analyzed for volatile and semivolatile compounds on the CLP TCL. A subset of the Stage I soil and sediment samples will also be analyzed for metals and cyanide on the CLP TAL.

3.2.3 Contract Laboratory Program

The analytical methods to be used for soil, sediment, surface water, and groundwater samples sent off-site for analysis in Stages I, II, and III are CLP and/or AEC methods. In general, the analytical suite for those samples that can be sent off-site will include volatile and semivolatile compounds and pesticides/PCBs on the TCL; metals and cyanide on the TAL; chemical agent degradation products; and explosives and related compounds. These methods, referred to as the Contract Laboratory Program Analytical Suite (CLPAS), are detailed in the J-Field QAPjP and are summarized in Table 3.6. The possibility of replacing some of the CLPAS methods with indicator parameters for groundwater monitoring will be considered after a few calendar quarters of data have been collected. Changes, as necessary, will be proposed in a technical update. Table 3.7 summarizes the number of samples to be collected at each J-Field AOC.

3.2.4 Sample Screening

3.2.4.1 Stage I

In many cases, the sampling and analyses of sediment and soil samples will require at least two subsamples from each sampling location: the first one for the required on-site gross CWA screen and the remaining one for the sensitive CWA screen. However, sediment and soil samples from the 0- to 6-in. interval collected from sites located some distance from the pushout and burning pits are not required to undergo a CWA screening. When it is collected, each sample will be divided into two subsamples in the field. As required by APG protocol, the handling and analyses of the subsamples will be restricted until the samples are shown to contain no CWA. Alternatively, the same subsample can be used for both the gross and the sensitive CWA screen.

TABLE 3.6 Contract Laboratory Program Analytical Suite (CLPAS)

CLP TCL organic compounds
CLP TAL metals
AEC chemical agent degradation products
AEC explosives and related compounds
TOX
TOC
Conductivity[a]
Major cations and anions[a]
Radioactivity (gross alpha and gross beta)

[a] For water samples only.

Both the gross and sensitive CWA screens will be conducted at APG. Gross screens will be done with headspace analysis and toxicity tests by the Chemical Research, Development, and Engineering Center (CRDEC) Laboratory at the Chemical Transfer Facility (CTF). The sensitive CWA screen will be performed by an on-site laboratory under contract to APG.

If the first subsample from a sampling location is certified as CWA-free by the initial gross CWA screen, the second subsample will be released for the sensitive CWA screen. Samples that clear the sensitive CWA screen can be released for any desired additional screening or for off-site analysis. The locations from which cleared soil or sediment samples were collected will be certified as CWA-free. Additional analyses of the samples cleared by screening will be of limited use because CLP sample holding times are expected to have been exceeded for many analyte groups by the time the sensitive CWA screen is completed.

If either the gross or sensitive CWA screen indicates contamination by chemical agents, both subsamples will be given to APG for appropriate handling, and the corresponding sample location will be marked as CWA-contaminated. No further sample collection or analyses will be allowed at that location.

3.2.4.2 Stage II

All locations certified to be free of CWA will be candidates for Stage II soil and sediment sample locations. Because of the relatively fast degradation rates of CWA in water, all water sampling locations are assumed to be free from CWA.

TABLE 3.7 Approximate Numbers of the First Round of Stage I Samples Required, by Media and by Site

	Number of Samples by Media					
AOC	Ground-water[a]	Surface water[a]	Surface Soil	Soil Boring	Surface Sediment	Sediment Boring[b]
Toxic Burning Pits	21	9	53(+)[c]	80[d]	11	35
White Phosphorus Burning Pits	14	5	36(+)	32[e]	5	0
Riot Control Burning Pit	6	7	9	12[f]	0	5
Prototype Building	1	2	6	6[g]	0	0
South Beach Demolition Ground	1	5	0	0	2	0
South Beach Trench	1	0	4	1	0	0
Robins Point Demolition Ground	2	7	6	0	3	0
Robins Point Tower Site	1	3	8(+)	0	3	0
Other	1	1	0	0	1	0
Opportunity available[h]	0	5	0	0	0	0
Total (approximate)	48	44	122(+)	131	25	40

[a] Groundwater and surface water samples will be analyzed for the Contract Laboratory Program Analytical Suite (CLPAS).

[b] Number assumes five depth intervals sampled per sediment boring.

[c] The "+" refers to an additional (but unknown) number of samples to be collected. Additional details are given in the text.

[d] Number assumes six depth intervals sampled per boring in the toxic, VX, and mustard pits, and four per boring for the eight other locations.

[e] Number assumes four depth intervals sampled per boring.

[f] Number assumes three depth intervals sampled per boring.

[g] If boring is drilled, it is assumed that six depth intervals will be sampled.

[h] Surface water that accumulates in the TBP main pits, WPP principal pits, and/or the RCP may be sampled on an opportunity available basis.

Samples of environmental matrices chosen for Stage II sampling and certified to be free of CWA contaminants will be sent to an analytical laboratory for level III, IV, or V analyses for one or more of the analytical suites listed in Table 3.6. The SOPs for sample collection and management procedures are given by the COE (1993) and in the J-Field QAPjP.

3.2.5 Field Inspections and UXO and CWA Surveys

Before environmental samples are collected, the areas around sampling/staging areas for each AOC will be thoroughly inspected for the presence of UXO and CWA. Where possible, the inspections will be sufficiently extensive to cover areas (including marshes and nearshore locations) from which samples will be collected, as well as areas that might be used in any future sampling and/or remediation activities. UXO/CWA surveys will be conducted as sampling sites are selected or as sampling occurs.

In any areas where "intrusive" sampling (such as the collection of soil borings, the placement of active or passive soil-gas monitoring points, or the installation of additional monitor wells) will be needed, the UXO/CWA surveys will be carried out to determine the potential presence of dangerous items to the maximum depths to be sampled by the relevant sampling method. Areas surveyed as part of the work by Weston (1992) may not need to be resurveyed. The J-Field Health and Safety Plan and the J-Field QAPjP contain more details regarding the UXO/CWA surveying protocols.

Surveys for UXO/CWA will be needed at the South Beach Demolition Ground and other offshore points at locations where sediment samples are collected.

All surveys (whether walkover or geophysical), all excavations and removals, and all drum surveys and management should be conducted in compliance with appropriate health and safety procedures, as required by the U.S. Army.[1] These procedures include bubble tests to determine the degree of CWA contamination of all discovered debris and potentially dangerous items and other tests that may be appropriate to ensure health and safety of personnel (Weston 1992). Compliance with these procedures is important because of the potential existence of dangerous materials such as UXO and CWA-contaminated items and the potential presence of CWA-contaminated soils and sediments, especially in the marshes and estuaries (USGS 1991).

As noted in Section 4 of the RI Work Plan, in addition to the surveys of the AOCs, a walkover survey of all the rest of J-Field should be considered because of the potential presence of CWAs and explosive materials disposed of at J-Field and the lack of detailed disposal records. Data collected during the surveys of the AOCs and surrounding areas may also indicate the need to survey other areas of J-Field, including the PAOCs detailed in Appendix B.

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[1] Some of these procedures are outlined in the Weston work plan (Weston 1992).

3.3 SOURCE AND PATHWAY CHARACTERIZATION

3.3.1 Geophysical and Other Remote Sensing Surveys

Although most of the subareas within each AOC can be readily identified, some (particularly subareas within the TBP AOC) are not readily apparent on the ground surface. Of particular concern are the boundaries of the mustard burning pit, the VX burning pit, the liquid smoke disposal pit, the TBP pushout area, and the inactive suspect burning and storage area of the WPP AOC, pits, and pushout area. Historical aerial photographs and a variety of geophysical and remote sensing techniques will be used to better define the locations and extent of these subareas.

Several geophysical techniques will be used for this study because no single procedure can provide all the information needed to direct the sampling effort. At a minimum, ground-penetrating radar (GPR), electromagnetic (EM), and seismic reflection surveys will be conducted. Other types of surveys, including seismic refraction, electrical resistivity, and magnetic, may also be conducted. Each technique will yield independent data that can be combined with other available data to provide the required information on surface and subsurface features. Geophysical strategies will be designed to detect burial trenches and contaminant plumes and to define the stratigraphy and structure beneath J-Field.

The geophysics program should be viewed as an aspect of the Stage I effort that will be constantly evolving in the field. The first investigation will involve the use of GPR. Measurements made with GPR will be interpreted in the field and will be used along with other information to guide the EM survey. Likewise, EM data may influence the configuration of the seismic reflection survey. Therefore, the discussions below avoid specifying exact locations, which must be determined in the field in order to optimize results from this phase of the site investigation.

3.3.1.1 Ground-Penetrating Radar

Ground-penetrating radar will be used to define the boundaries of known burial trenches and to identify any additional trenches not yet discovered. The USGS briefly tested GPR at J-Field and found that it performed well at most locations. Initial GPR traverses will be made on a widely spaced grid. Tighter grid patterns will be used at locations where the initial survey shows evidence of disturbed soils and at locations where historical data indicate that trenches may be located. Wave velocity characteristics of the materials at J-Field will be derived from correlation of radar reflectors with known subsurface features determined from previous drilling. More information about the use of GPR can be found in SOP-017 (Ground Penetrating Radar Survey) (COE 1993).

3.3.1.2 Electromagnetic Induction (Terrain Conductivity) Surveys

The USGS conducted EM surveys in the TBP, the RCP, and the WPP AOCs. The results suggest that a subsurface conductive contaminant plume may be present near the main burning pits at the TBP AOC. Initially, borehole induction (EM-39) logs will be run in the deepest well at each USGS cluster to provide control for the surface EM surveys and to determine the vertical distribution of conductive zones. The surface EM surveys will then be conducted at the TBP AOC to complete the delineation of (close) the contours on the basis of results of the USGS survey and to determine how the conductive and nonconductive zones have changed over time. This "temporal" aspect of the EM survey may yield information on plume movement. EM surveys will also be conducted in the areas adjacent to any previously unidentified burial pits detected during the GPR survey. More information about electromagnetic induction (EMI) is provided in SOP-018 (Electromagnetic Induction [Terrain Conductivity] Surveys) (COE 1993).

3.3.1.3 Seismic Reflection

Seismic reflection profiles will be developed to accurately map the surface of the leaky confining unit at the base of the surficial aquifer. The contours of this surface may affect the lateral movement of dense, nonaqueous phase liquids (DNAPLs), and depressions in this surface may provide sinks where DNAPLs could become trapped. Seismic reflection surveys will be conducted primarily in areas where groundwater data indicate the presence of DNAPL contamination and the leaky confined unit is 40 ft or more below the ground surface. (Seismic reflection is of limited usefulness in mapping contours at depths less than 40 ft.)

Seismic reflection surveys will be preceded by a short test program to determine the optimum spread configuration, as well as the best energy source. The test phase will require a very tightly spaced geophone spread that will cover only a small portion of the required offset distribution; consequently, a number of source points will be used at varying distances from the test spread to simulate a full suite of energy source-receiver offsets. Potential source locations will be surveyed to ensure that no UXO is present before generating the signal by dropping weights. It is likely that most source locations will be on roads in J-Field.

3.3.1.4 Photographic Interpretation

The thermal imagery, near-red, infrared, and visible remote sensing data generated by USGS as part of the RI will be evaluated. These remote sensing data will be used to determine if all contamination sources have been identified, .to better delineate known sources, and to adjust sampling locations and sampling strategies as needed to satisfy the objectives of the SAP.

3.3.2 Soil-Gas Sampling

Both passive and active soil-gas monitoring techniques will be used to obtain soil-gas data for J-Field. Some of the locations for both active and passive soil-gas sampling will be close to or at some of the locations sampled in the USGS study (Hughes 1993). Other new sampling locations will be chosen either to fill in or to extend the area sampled by the USGS. Protocols for surveying CWA and UXO, which apply to all stages of sampling activities, will be implicitly assumed to be included in the following descriptions of soil-gas sampling requirements at the AOCs.

Active soil-gas sampling will be conducted to obtain direct data on concentrations of chemicals in soil gas and to corroborate data from passive soil-gas sampling. Locations for a first round of active soil-gas sampling will be chosen as noted above. Additional rounds, which will extend the area sampled or fill in data on areas already sampled, will be based on the completed rounds. Passive sampling will be conducted after the lateral extent of areas of contaminated soil gas has been determined by active sampling.

If deemed acceptable on the basis of UXO/CWA surveys, active and passive soil-gas sampling will be performed at several AOCs. If necessary, remote manipulation techniques will be used to emplace and withdraw sampling points or collection tubes. Where possible, standard operating procedures SOP-026 (Active Soil Gas Analysis) and SOP-027 (Passive Soil Gas Surveys) will be followed (COE 1993).

3.3.2.1 Toxic Burning Pits

As displayed graphically in Figures 2.4 through 2.7, existing data for the TBP AOC indicate that soil-gas relative flux concentration contours for dichloroethylene and trichloroethane, tri- and tetrachloroethylene, phthalates, and heavy aromatics extend beyond the area sampled (Hughes 1993; J-Field RI Work Plan). These results suggest that soil-gas contamination exists outside of the areas sampled by previous investigators and that there could be contamination sources other than the TBP subareas. Additional soil-gas data are needed to extend the areas sampled and to determine the extent of contamination. Sampling locations along Rickett's Point Road are included because of possible temporary storage of leaking drummed solvent wastes in areas along the road (Broadwater 1992).

Sampling locations for the first round of soil-gas sampling, which include the wetland area that straddles the TBP AOC, are shown in Figure 3.3. Some of the locations are outside the areas surveyed by the USGS, and others coincide with or are near locations already sampled with Petrex tubes by the USGS. These locations have been selected to permit a relative comparison of the new data with the old.[2]

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[2] It should be noted that analysis results for samples collected from wetland areas under saturated conditions cannot be directly compared with vadose zone results. The media that sorb the contaminants are different for the two conditions (water for saturated conditions and soil particles for vadose zone conditions), with correspondingly different partition coefficients between the sorbing medium and the gaseous phase.

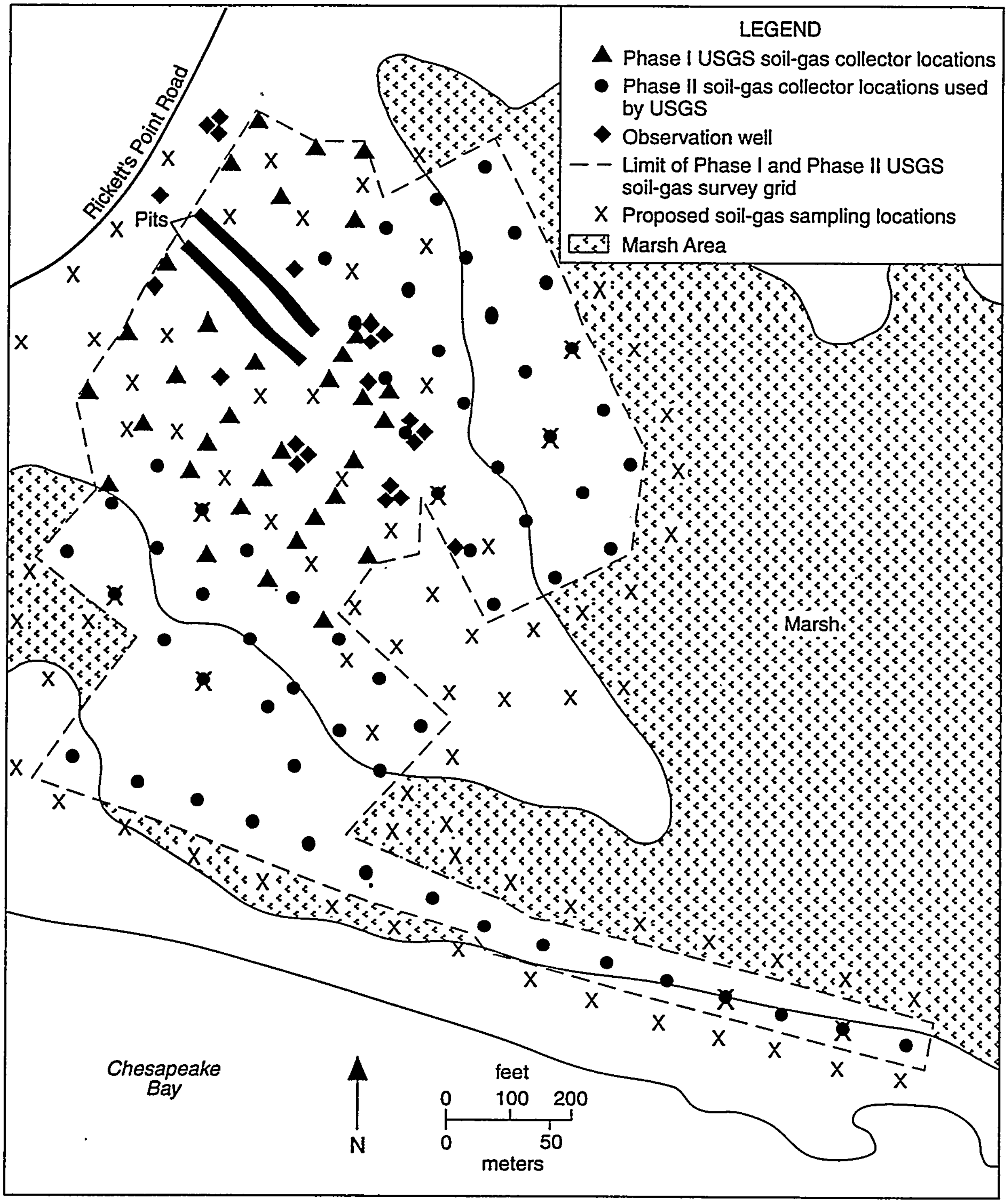

FIGURE 3.3 Proposed First-Round Soil-Gas Sampling Locations in the TBP AOC (Source: Adapted from Hughes 1993)

The analytes of concern will include each of the major chlorinated solvents already studied (12DCE, 112TCE, TRCLE, and TCLEE), as well as TCLEA; benzene; and the sum of toluene, ethylbenzene, and xylenes (TEX). The tentative sampling locations are depicted in Figure 3.3.

3.3.2.2 White Phosphorus Burning Pits

As is the case with the TBP AOC, soil-gas sampling data for the WPP AOC (shown in Figure 2.15) indicate that contamination extends beyond the area sampled (Hughes 1993). This condition is the case for all the contaminants measured: TRCLE, TCLEE, simple aromatics, and combined hydrocarbons. To determine the extent of the contaminated area and to find out if additional sources of contamination exist at or near the suspect storage area and/or the suspect burning area, sampling will be extended to close the contours. This process may require sampling the near offshore sediments in the Gunpowder River and extending the sampling grid to the north, south, and southwest of the WPP AOC. If possible, locations closer to and between the pits will be sampled, because the immediate area of the pits was not sampled in previous investigations. Locations along Rickett's Point Road will also be sampled because of the possible temporary storage of leaking drummed solvent wastes in areas near the road (Broadwater 1992).

The analytes of concern will include each of the major chlorinated solvents already studied (12DCE, 112TCE, TRCLE, and TCLEE), as well as TCLEA, benzene, and TEX. The tentative sampling locations are depicted in Figure 3.4. To permit comparison of the new data with results of previous sampling, some of the tentative sampling points include locations sampled in the previous study (Figure 2.15).

3.3.2.3 Riot Control Burning Pit

The area sampled around the RCP also must be extended to close the existing soil-gas contours for chlorinated solvents and (especially) phthalates and heavy aromatics. The existing relative flux contours (shown in Figure 2.18) suggest that contamination extends well beyond the area previously sampled. Therefore, sampling efforts will be extended in all directions beyond the previous sampling boundaries. (Some locations already sampled will be included as well.) Samples will be collected along Rickett's Point Road and on both sides of the road located east of the RCP. These areas will be included because of the possible temporary storage of leaking drummed solvent wastes near Rickett's Point Road and the possible use of the area east of the RCP for burning and other activities (Broadwater 1992).

The analytes of concern will include each of the major chlorinated solvents already studied (DCE, TCE, and TCLEE), as well as benzene and TEX. The tentative sampling locations are depicted in Figure 3.5.

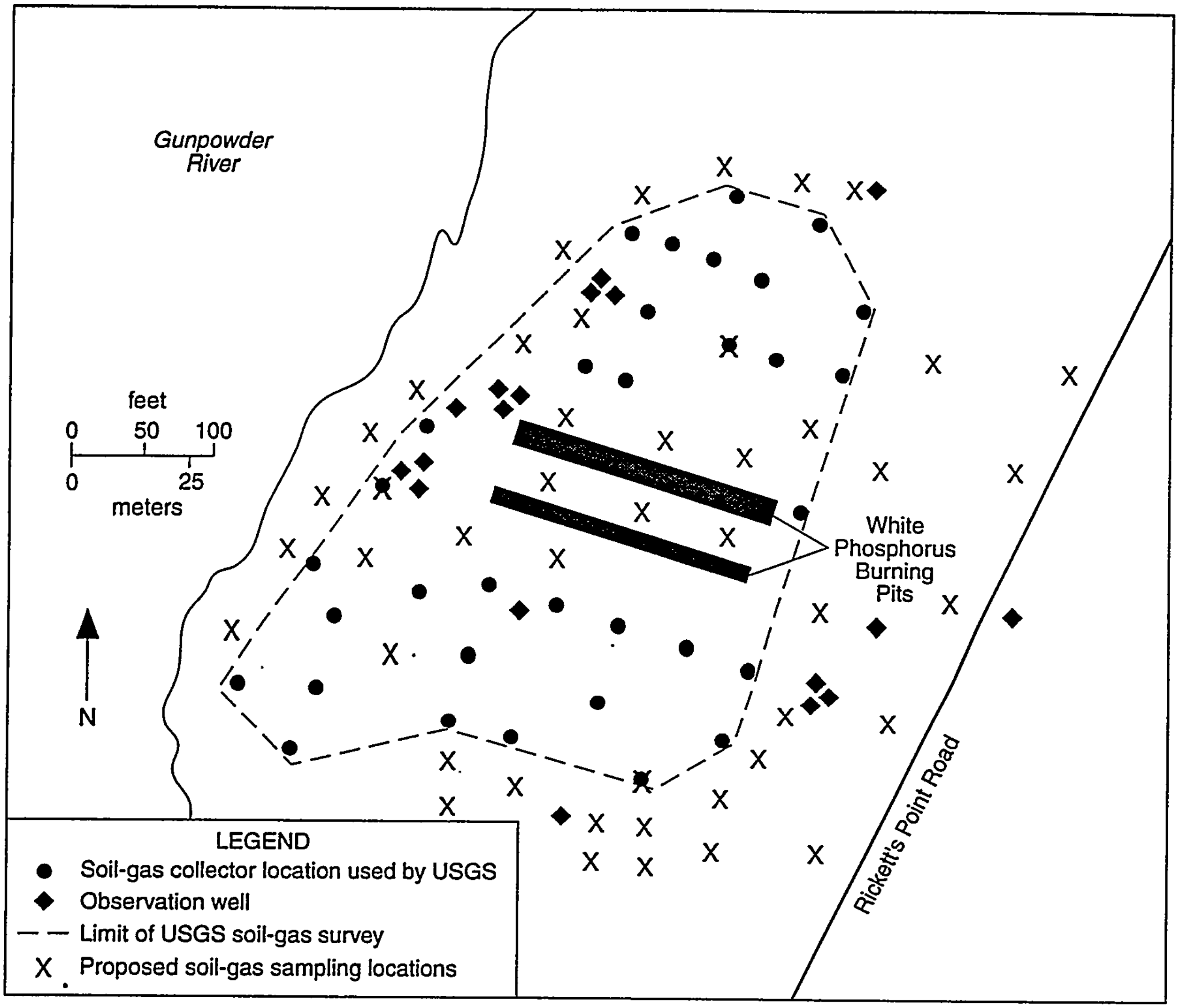

FIGURE 3.4 Proposed First-Round Soil-Gas Sampling Locations in the WPP AOC (Source: Adapted from Hughes 1993)

3.3.2.4 Prototype Building

A soil-gas survey should also be conducted in the flat area around the PB because of the reported widespread usage of DANC (which contained 90-95% TCLEA) to decontaminate scrap. The area around the PB and between the PB and Rickett's Point Road may have been used for decontamination activities (Nemeth 1989; Flannery 1992).

The survey should be conducted in a circular area of about 300-ft radius centered on the PB. The approximate extent of the area is shown in Figure 3.6. If samples were collected on a grid area of about 100 ft, there would be about 30 sample locations in the survey area. The exact locations sampled and extent of the area surveyed should be adjusted on the basis of field observations.

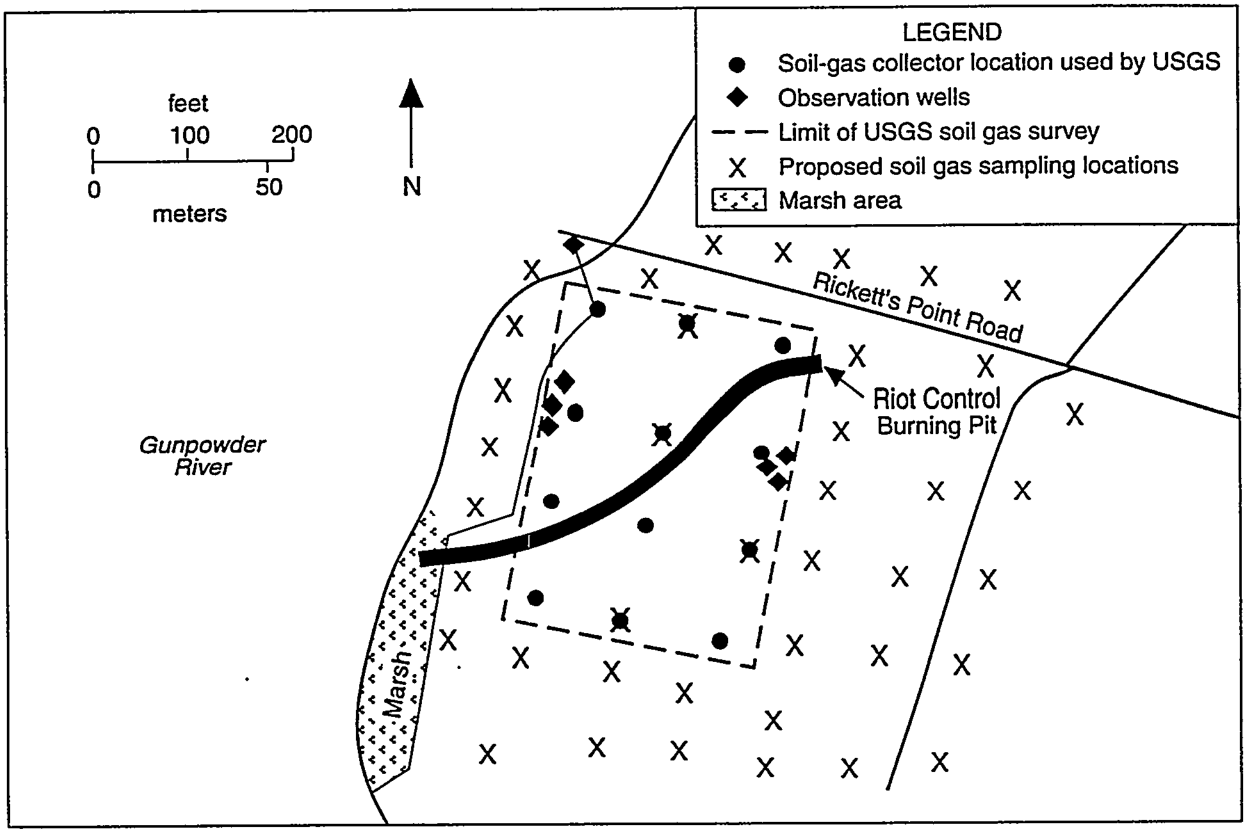

FIGURE 3.5 Proposed First-Round Soil-Gas Sampling Locations in the RCP AOC

3.3.2.5 Other Areas

The history of J-Field gives no indication that VOCs were extensively used at the remaining AOCs; therefore, soil-gas surveys at these locations are not warranted. However, as discussed in Appendix B, passive soil-gas surveys will be conducted at some of the PAOCs.

3.3.3 Surface Soil Sampling

This section outlines the plan for first-round surface-soil sampling at the eight J-Field AOCs. In areas with potential CWA contamination, Army protocol requires that several sample portions be collected at each sampling location and depth. Some of the sample portions are used for CWA screening and analyses; the others are reserved for conducting the desired analyses after the CWA screening results are available. In addition, intrusive sampling activities, such as collecting soil samples, must always be preceded by UXO clearance protocols. Sampling protocols are described in the QAPjP and by the COE (1993). These protocols, which apply to all stages of sampling activities, will be implicitly assumed in the following descriptions of soil sampling needs at the AOCs.

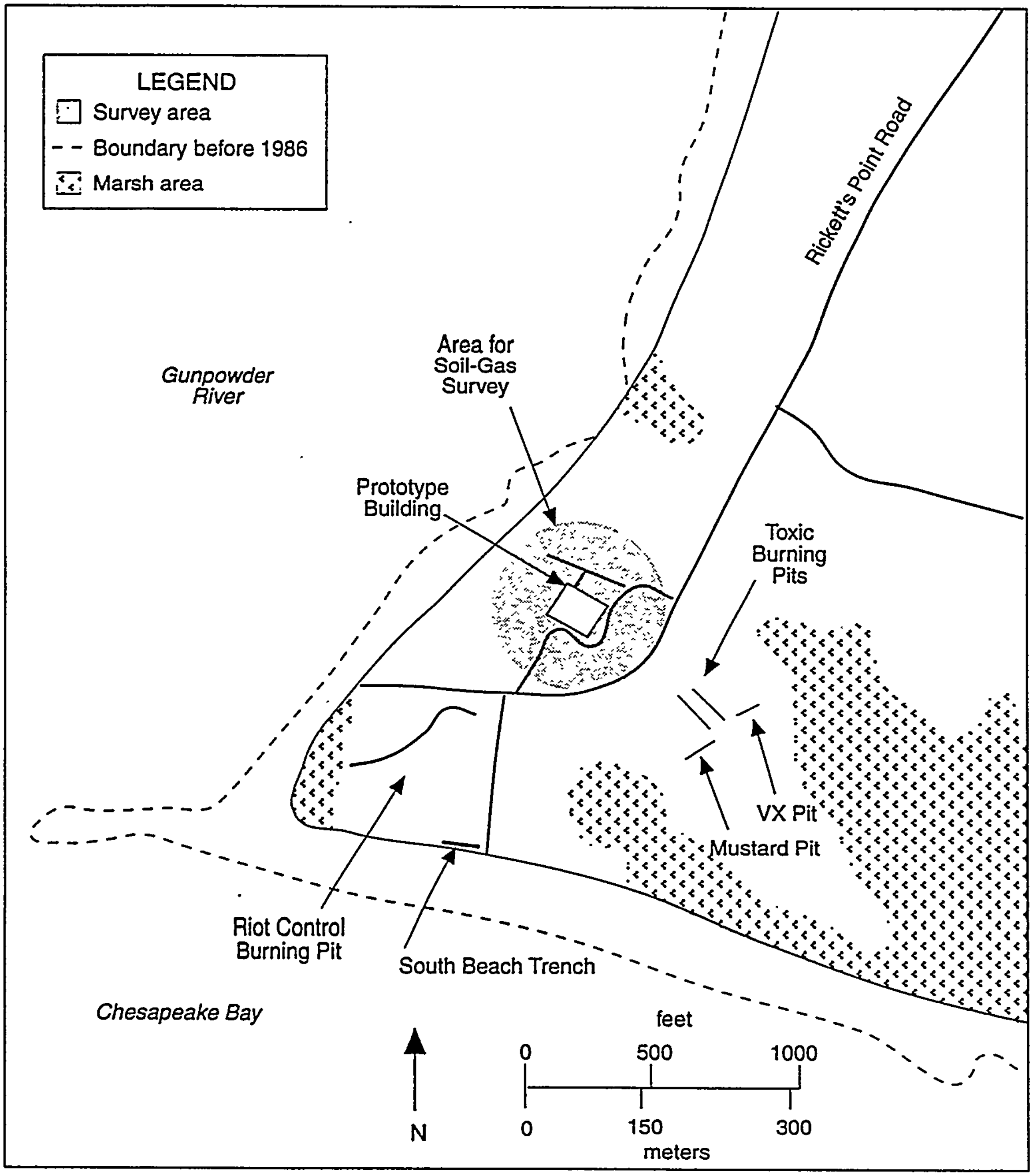

FIGURE 3.6 Proposed First-Round Soil-Gas Sampling Area at the Prototype Building AOC (Source: Adapted from USGS 1991)

The topography of most of the AOCs at J-Field is fairly flat, and no prominent free-flowing or intermittent water features exist. However, portions of some of the AOCs are elevated above surrounding areas. As a result, rainfall runoff and sediment transport could be significant contaminant migration pathways. Therefore, the results of the geophysical study and field inspection will be used to determine whether intermittent surface water or erosional features indicative of potential surface water contaminant migration exist at each AOC.

If intermittent surface water features can be identified, surface-soil samples will be collected. The purpose will be to evaluate the surface water migration pathway at the pertinent AOCs. Sampling and analyses of perennial surface water features are discussed in Section 3.3.5.

Contaminants produced by OB/OD at J-Field could have been dispersed away from the AOCs by wind. This concern will be addressed by sampling in the vicinity of subareas not likely to have been affected by other contaminant migration pathways.

At each sampling location, surface soil samples will be collected according to SOP-025 (Soil Sampling). The samples will be collected to a depth of 6 in. because data for the 0- to 6-in. depth interval is relevant for the risk assessment. At many of the locations, surface soil samples will also be collected from the 6- to 12-in. depth interval. The deeper samples are needed because VOCs are expected to volatilize from the 0- to 6-in. depth interval. The specific locations at which the 6- to 12-in. samples should be collected will be specified in the plans for each AOC.

Tentative sampling locations are specified for each AOC. Exact locations for surface, and subsurface soil, and surface water sampling will depend on field observations and the results of geophysical, UXO, and soil-gas surveys. Some of the surface and subsurface soil sampling locations should be chosen to coincide with locations of elevated soil-gas contaminant concentrations.

Only the first round of surface soil sampling will be specified in this report. The need for and extent of additional rounds of Stage I sampling will depend on the results obtained from the first round. Specific sampling plans will not be developed for Stage II surface soil sampling activities at this time because the extent of and need for such sampling will depend on the results obtained from the Stage I rounds. Unless otherwise indicated, the analytes of interest for each of the samples to be collected are the Stage I analytical suite minus the MICKIT analyses (Table 3.5).

3.3.3.1 Toxic Burning Pits

In the TBP AOC, a concerted effort will be made to delineate the boundaries of the subareas that are currently obscured by vegetation or buried beneath the surface, including the VX burning pit, the mustard burning pit, the liquid smoke disposal pit, the suspect sump disposal area, and the pushout area. The techniques to be used to delineate these areas include, but will not be limited to, geophysical methods, visual site inspection, use of historical aerial photographs, and active and passive soil-gas analyses. If located, these areas will be delineated on the site maps to be generated during Stage I.

Efforts will also be made to identify any intermittent surface water drainage features that could drain water from each of the subareas. Surface soil samples will be collected at two or more locations along any drainage channel located. In addition, surface soil samples will be collected in the quadrant extending from the northeast to the southeast of the pits and for a radial distance of about 500 ft or to the edge of the marsh, whichever comes first. Figure 3.7 shows the area to be sampled. The need to investigate conditions in these areas is inferred from site history and the results of the USGS surface soil sampling (Hughes 1993). The USGS results for some locations show elevated concentrations of metals, TOX, and Kjeldahl nitrogen (used here to represent an upper limit for explosives analysis because data on explosives were not given). A triangular grid system with a node spacing of 100 ft will be used to randomly select 20 sampling locations. In addition, the results of field XRF metal scans will be used to determine 10 additional sampling locations. A total of about 30 grid locations will be sampled over the area shown in Figure 3.7.

Each location will be sampled to a depth of 6 in. Alternate locations will also be sampled in the 6- to 12-in. depth interval, yielding a total of 45 samples.

During a recent site visit, several areas of stressed vegetation or areas with no vegetation east of the pits were observed. To determine if this condition is due to contamination, two locations at least 6 ft apart in two of the most extensive of these areas will be sampled from 0 to 6 in. and from 6 to 12 in. to give a total of eight samples. The choice of areas and sampling locations within each area will be based on field observations.

3.3.3.2 White Phosphorus Burning Pits

The WPP AOC is currently an active area used for emergency disposal operations. Therefore, the two main pits will not be addressed in the RI. The subareas to be sampled at the WPP AOC include a suspect storage area in the southeastern corner of the WPP AOC (about 40 ft west of Rickett's Point Road) and suspect burning areas in the northwestern and southwestern corners of the WPP AOC. Surface soil samples will be collected from depth intervals of 0 to 6 in. and of 6 to 12 in. at two or more locations in the suspect storage area and each suspect burning area (Figure 3.8). The samples will be analyzed for analytes in the Stage I analytical suite minus the MICKIT method. Appropriate SOPs will be used to collect the samples from the mounds.

3.3.3.3 Riot Control Burning Pit

Surface soil samples will be collected at six approximately equally spaced intervals around the RCP. At least three additional samples will be collected from the pushout area. Exact locations will be determined from field observations and the results of UXO/CWA and

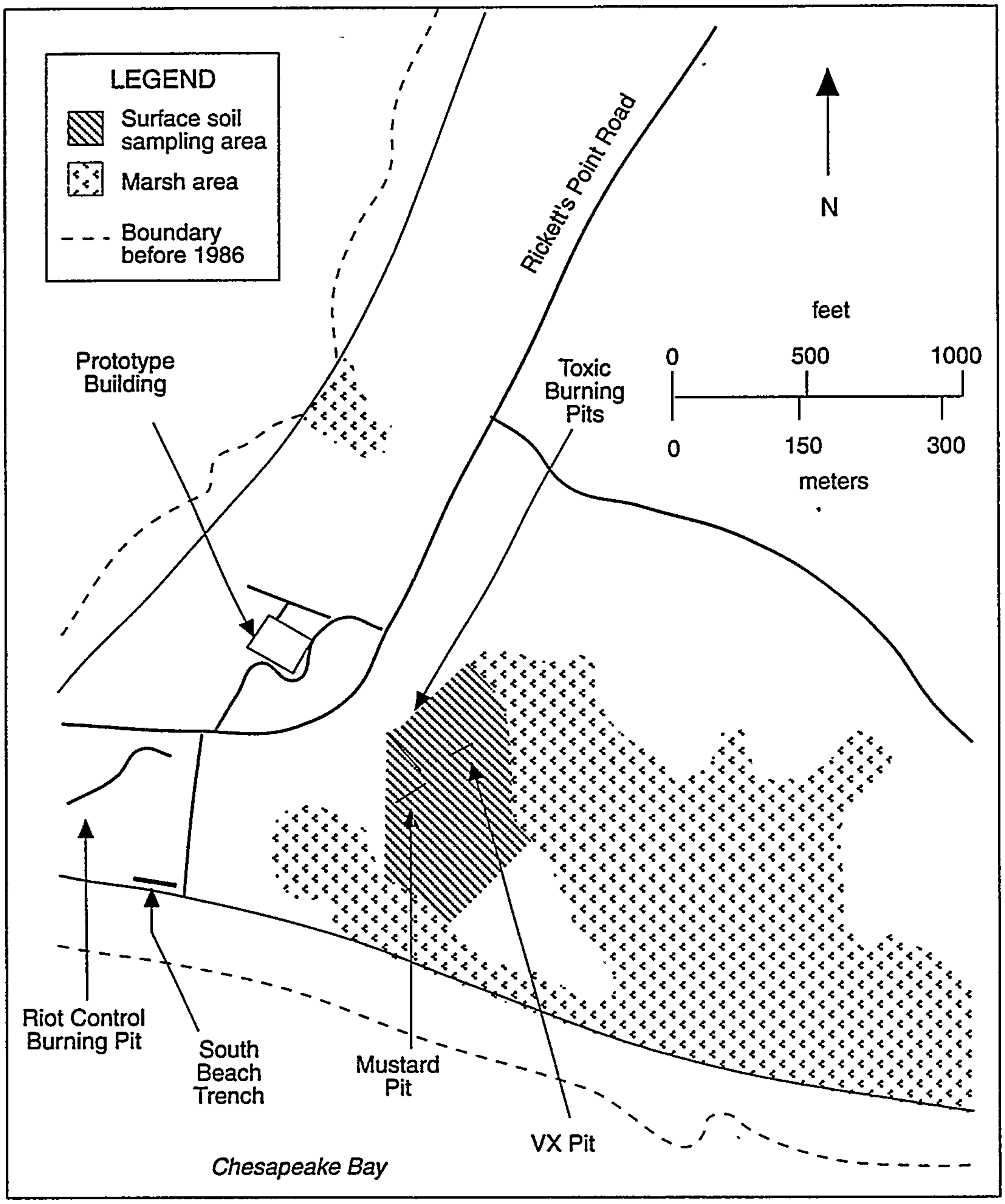

FIGURE 3.7 Stage I Surface Soil Sampling Area at the TBP AOC (Source: Adapted from USGS 1991).

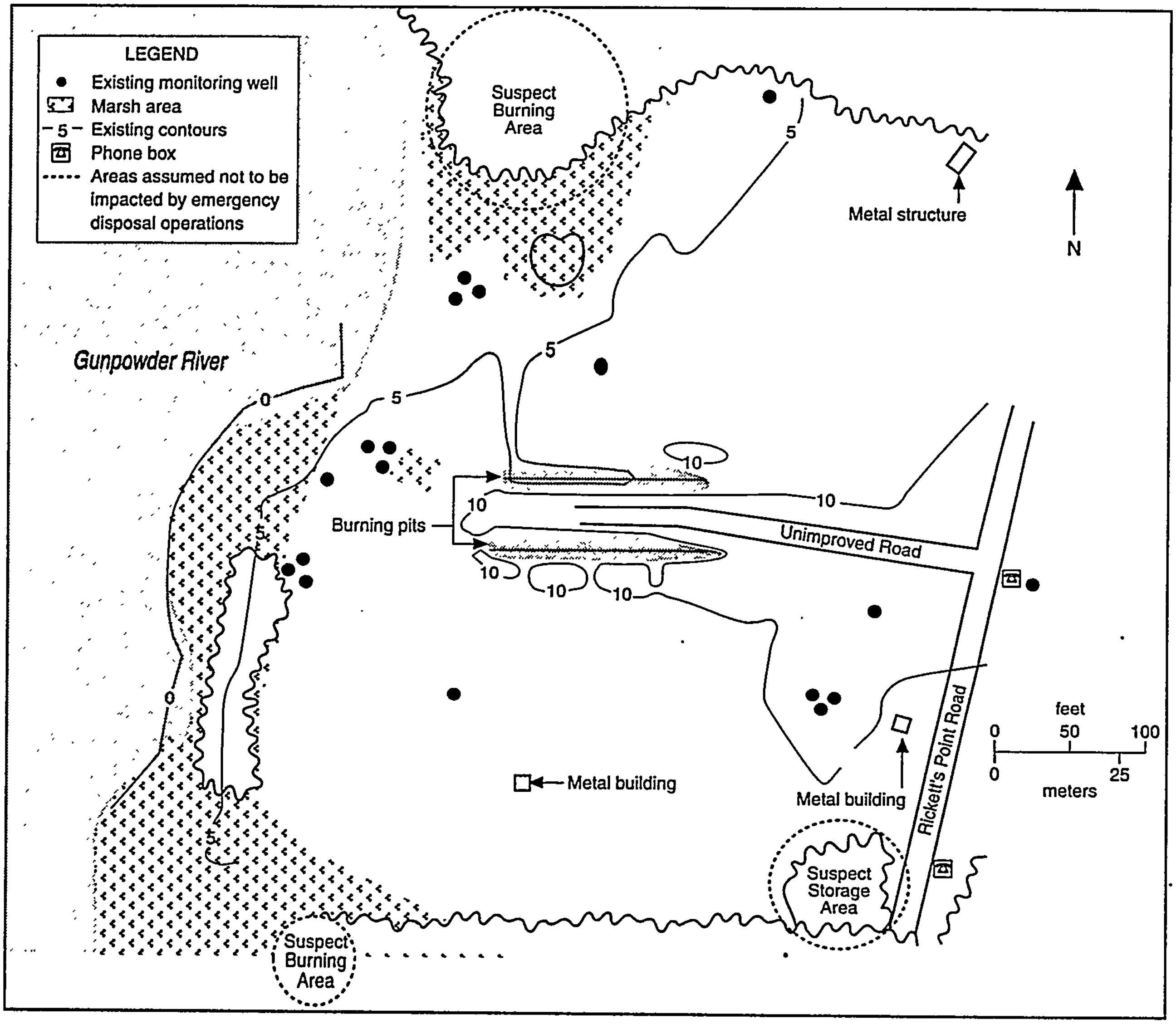

FIGURE 3.8 Stage I Surface Soil Sampling Areas at the WPP AOC (Source: Adapted from Weston 1992)

other surveys. The general sampling locations have been selected to complement the sampling done by Weston (1992) and to help determine whether the current boundary of the RCP was different in the past. The need for this sampling is based on the USGS results, which show elevated TOX and Kjeldahl nitrogen at some locations. In addition, the literature indicates the presence of "... ground scarring in the area later used for the disposal of riot control agents ..." in a 1951 photograph. The current layout of the RCP did not exist until approximately August 1960, suggesting a need to conduct sampling and analyses beyond the limits of the existing RCP and associated drainage trench (Nemeth 1989).

Approximate sample locations and location numbers for the RCP area are shown in Figure 3.9. Pushout area sampling locations, which have not been depicted, will be selected on the basis of the results of the field XRF metal analyses. In addition to the 0- to 6-in. depth interval sampling at each location, samples will be collected to a depth of 6-12 in. at

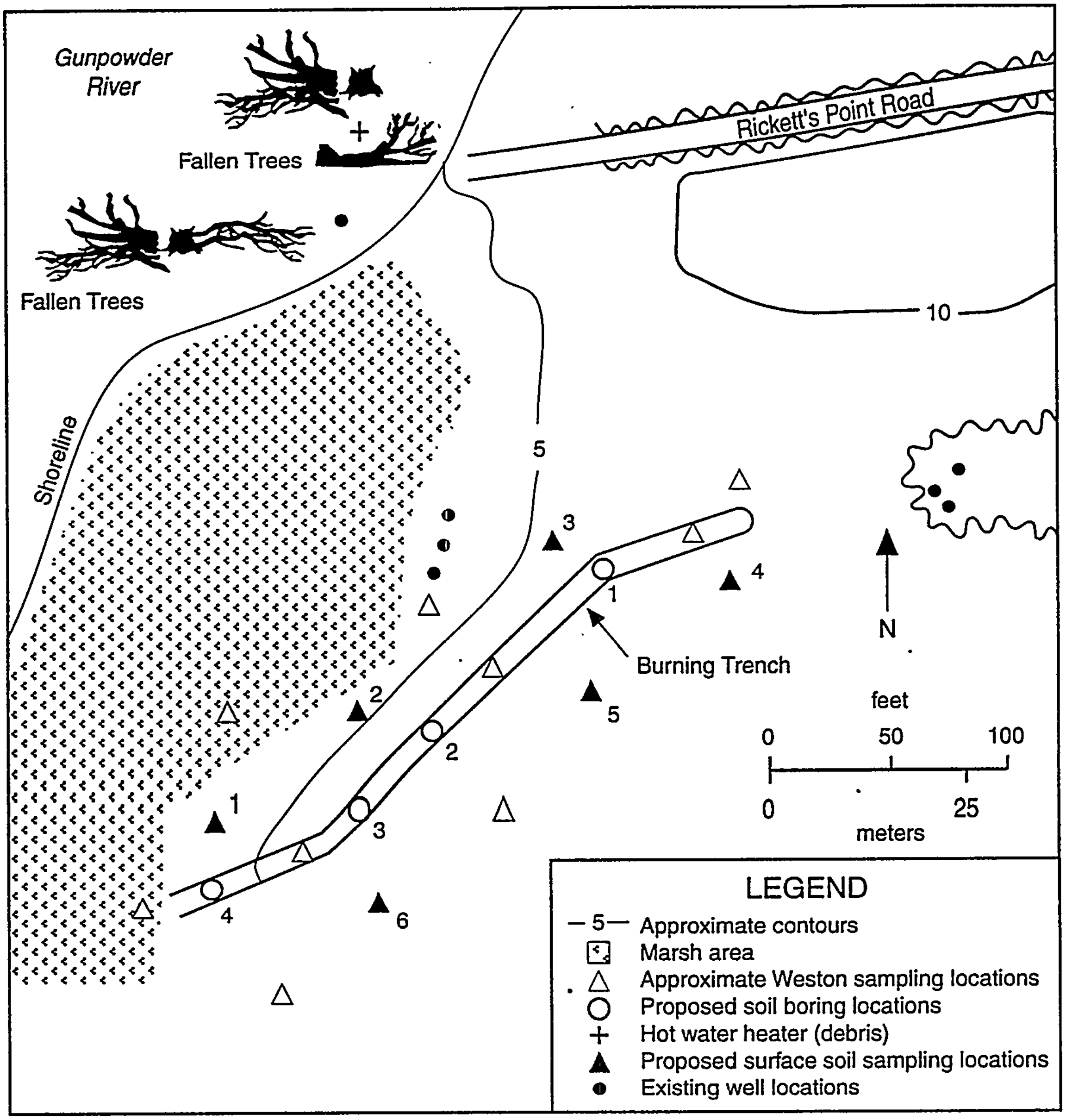

FIGURE 3.9 Stage I Soil Sampling Locations at the RCP AOC (Source: Adapted from Weston 1992)

the even-numbered locations, for a total of nine samples. Surface soil samples (from the 6- to 12-in. depth) will also be collected at additional locations east and northeast of the RCP if the results of the soil-gas survey show elevated contaminant concentrations in those areas.

3.3.3.4 Prototype Building

The results of USGS sampling (Hughes 1992) at the PB showed up to 93 mg/kg lead, 158 mg/kg zinc, and 1,560 mg/kg Kjeldahl nitrogen at the four locations sampled (Figure 2.6), and the earlier composite sampling (Nemeth 1989) showed up to 1,622 mg/kg lead, 16.6 mg/kg cadmium, and 1 mg/kg DDD+DDE+DDT in composite samples taken along the building walls. These results suggest that soil around the PB is contaminated. Because of these findings and the history of the building, additional surface soil sampling is needed to determine the level and extent of contamination in the area. Surface soil samples will be collected to a depth of 6 in. at six locations around the building. The 6- to 12-in. depth interval will also be sampled at two of the six locations. In addition, two samples from the 0- to 6-in. depth interval will be collected from each of the two suspect burning areas. Samples will be analyzed for analytes in the Stage I analytical suite. Approximate sampling locations and the location numbers are shown in Figure 3.10. Exact locations will be selected on the basis of field observations, field XRF metal scans, and the results of the UXO and CWA surveys.

3.3.3.5 South Beach Trench

Because of the limited previous use of the SBT and the presence of some metal fragments and low levels of chlordane in the soil, Stage I soil sampling will not be extensive. Surface soil samples will be collected at two locations in the trench approximately 18 ft from each end of the trench. Both the 0- to 6-in. and 6- to 12-in. depth intervals will be sampled at each location, for a total of four samples. Surface soil samples will also be collected from the 0- to 6-in. and 6- to 12-in. depth intervals from the fill in the suspect trench.

3.3.3.6 South Beach Demolition Ground

Because the SBDG is now offshore and exposed only during low tide (Hughes 1993), sediments are the main solid matrix available for sampling. Data needs for this matrix are discussed in Section 3.3.5.

3.3.3.7 Robins Point Demolition Ground

The eastern area of the RPDG was used from the late 1970s until 1985, when a berm was built and OD activities were then limited to the area west of the berm (Nemeth 1989).

Stage I surface soil sampling at the RPDG will be carried out in the area east of the berm, thought to be least influenced by current emergency disposal activities. This Stage I

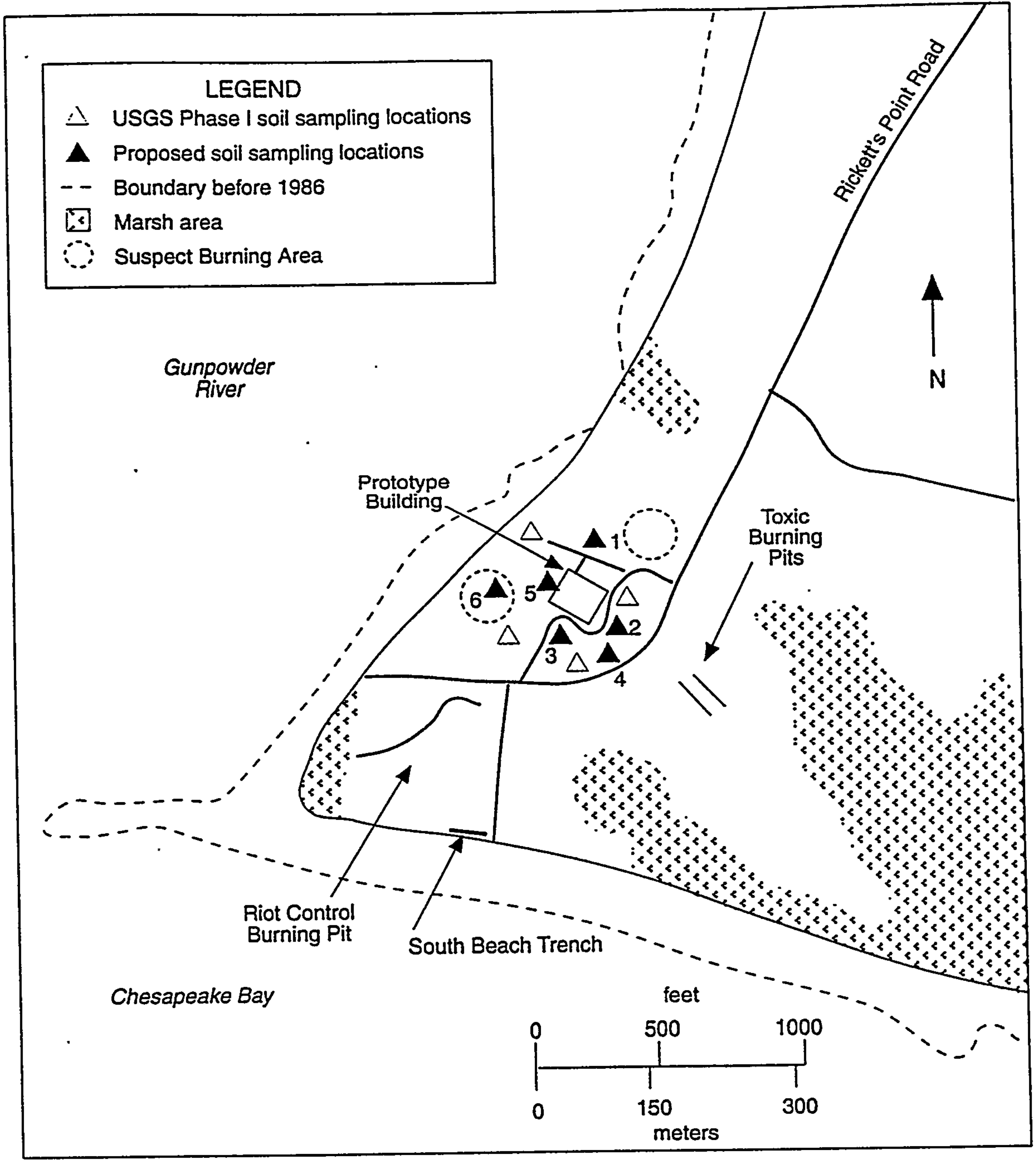

FIGURE 3.10 Stage I Surface Soil Sampling Locations at the Prototype Building AOC (Source: Adapted from USGS 1991)

sampling is needed because studies in this area have been quite limited to date. Two samples collected in part of this area (locations are shown in Figure 3.11) during the 1986 RFA (Nemeth 1989) showed little or no contamination. Five surface soil samples were collected in the general area by the USGS in 1991 (Hughes 1992). However, the map scale and locations shown in Figure 2.6 (and in the corresponding figure in Hughes 1992) make it impossible to determine if any of the USGS samples were collected in the area east of the berm.

No sampling will be carried out in the area west of the berm because this area is still being used for OD. These OD activities are regulated under state-equivalent RCRA regulations and are expected to be addressed under a future RCRA Part B permit.

Six locations will be sampled over the 0- to 6-in. depth interval in the area east of the berm — three locations along the marsh edge and three between the berm and marsh edge. Tentative locations and location numbers are shown in Figure 3.11; selection of exact locations will be based on the results of field observations, field XRF metal scans, and the UXO/CWA surveys. No sampling of the 6- to 12-in. depth is needed. Samples will be analyzed for analytes in the Stage I analytical suite.

According to Nemeth (1989), a test burn of wood contaminated with radium and strontium-90 may have occurred at a Robins Point site in the late 1950s or early 1960s. Nemeth (1989) does not specify which Robins Point area (the RPDG or the RPTS) was the site of the possible test burn. RPTS is the most likely area because the RPDG did not exist in this time frame and no roads to the RPDG can be seen in aerial photographs until after 1970. However, a radiological survey will be conducted at the inactive portion of the RPDG. The radiological survey will initially involve a walkover with a beta-gamma survey meter. The path taken in the walkover will be along the lines of a regular grid covering the AOC. In addition, areas of possible contamination (based on field inspection) will also be surveyed. Surface soil samples will be collected at each area showing elevated radioactivity.

Gross beta and gamma spectrometry measurements will also be conducted on three of the six surface soil samples collected, as well as on additional soil samples collected on the basis of the walkover survey. These measurements, which are more sensitive than those to be made during the walkover survey, will complement the survey results.

3.3.3.8 Robins Point Tower Site

The RPTS was reportedly used as a rocket launching and observation site (Nemeth 1989). In addition, the 1986 RFA suggests (on the basis of aerial photographs) the presence of a surface impoundment and an aboveground tank in the area. Because of this suggestion and the possibility of a test burn of radioactively contaminated wood at the site during the 1950s or 1960s (Nemeth 1989), surface soil sampling and a radiological survey will be conducted at this AOC.

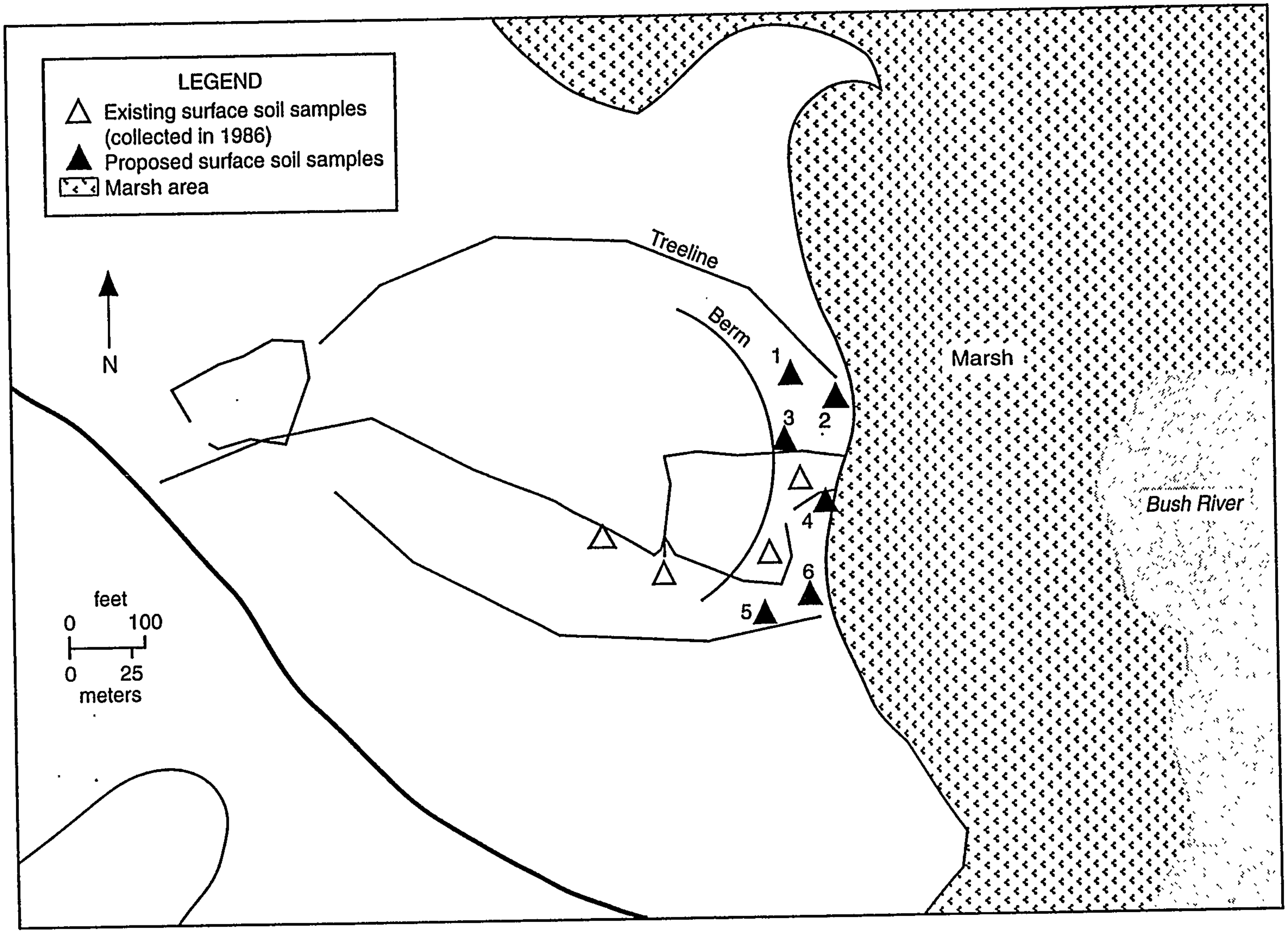

FIGURE 3.11 Stage I Surface Soil Sampling Locations at the Robins Point Demolition Ground AOC (Source: Adapted from Nemeth 1989)

At least eight locations in the RPTS will be sampled to a depth of 6 in. Sampling locations will be selected in part on the basis of professional judgment and a thorough inspection of the tower site in an effort to identify potentially contaminated areas. In addition, a triangular grid will be used over the area shown in Figure 3.12 to help select random sampling locations. Soil samples will be analyzed for analytes in the Stage I analytical suite. As proposed for the RPDG AOC, a walkover radiological survey will also be carried out over this AOC, and surface soil samples will be collected at any location showing elevated radioactivity. Gross beta and gamma spectrometry measurements will be conducted on those samples and on half of the other surface soil samples collected at the AOC.

3.3.3.9 Other Areas

As discussed in Appendix B, surface soil sampling will be conducted at several of the PAOCs.

3.3.4 Subsurface Soil Sampling

Because only minimal subsurface soil sampling has been performed at any of the AOCs to date, soil borings will be drilled for collection of subsurface soil samples at several J-Field locations. Because of the possible presence of CWA and UXO, sampling may not be possible at all the proposed locations. Therefore, sample locations and the desired analytical suite discussed below are tentative and could change depending on the results of UXO/CWA surveys, field surveys, soil-gas surveys, and professional judgment.

Unless otherwise indicated, samples will be collected at 2-ft intervals from the surface down to the water table or mean sea level, whichever is deeper. During augering and sample collection, it will be important to avoid mobilizing contamination such that it spreads to different depths through the auger hole. This precaution would be especially important if highly contaminated groundwater, free DNAPL, or other solvents were encountered. The drilling and sample collection protocol will follow SOP-025 (Soil Sampling), which should include procedures to avoid contaminant mobilization. Samples will be collected from the center of the core to minimize volatilization of volatile components. Depending upon the observed characteristics of the soil, several samples may be collected from a given 2-ft interval. In addition to the samples collected at 2-ft intervals, samples will also be collected from zones that are discolored or that appear to be rich in organic materials. Discoloration may be indicative of contamination, and zones with high organic matter content may provide a sink for some contaminants of potential concern. All samples will be analyzed for analytes in the Stage I analytical suite.

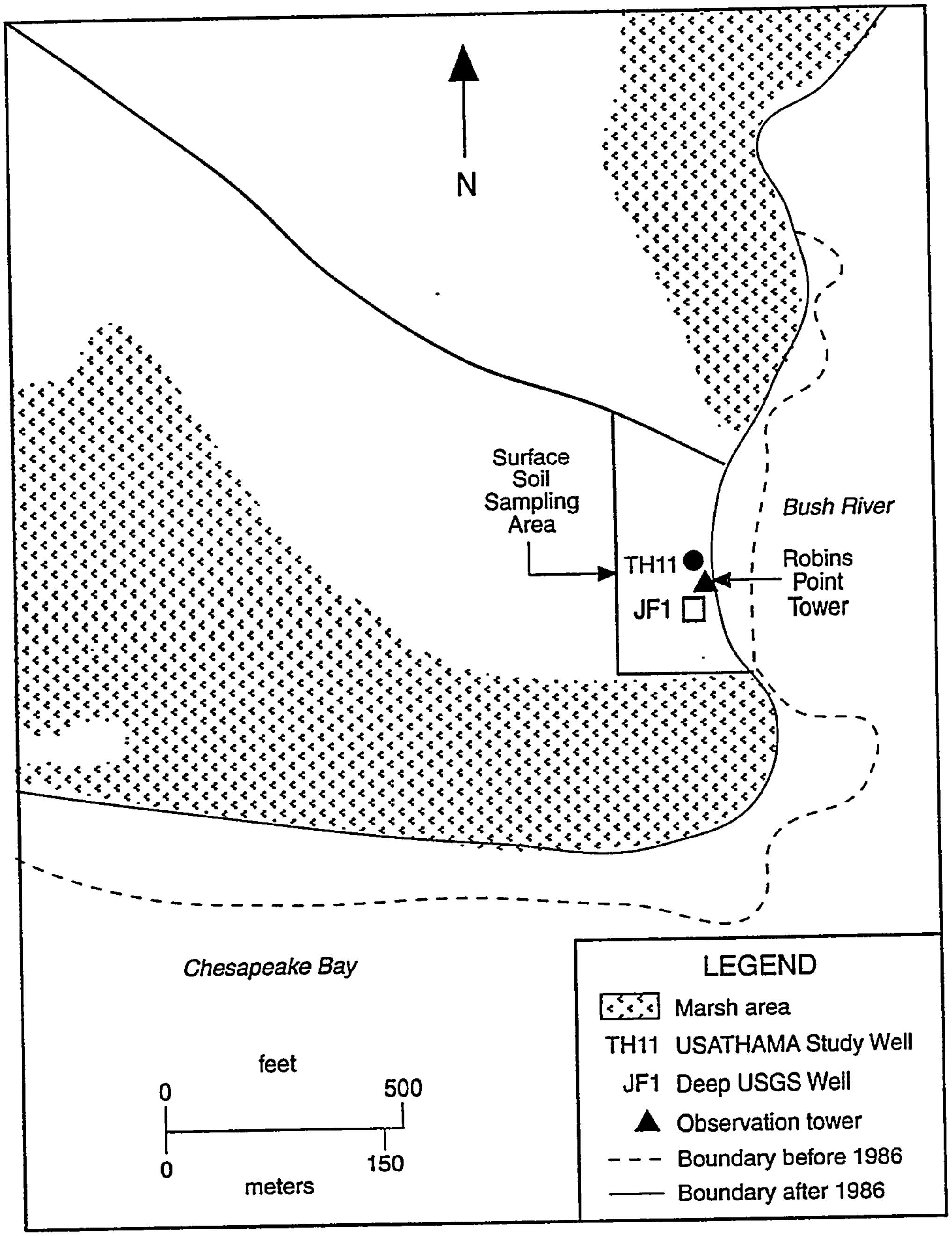

FIGURE 3.12 Stage I Surface Soil Sampling Area at the Robins Point Tower Site AOC

3.3.4.1 Toxic Burning Pits

To test for the possible presence of contamination at depth, two soil borings will be drilled at equally spaced intervals to depths of at least 10 ft along the center of each of the two main burning pits in the TBP AOC. (The boring points will be located approximately 1/4L, and 3/4L from one end of each pit, where L is the pit length.) These borings will complement those of Weston at the ends and middle of each pit with sampling at depths of 2 and 4 ft (Mazelon 1993).

The exact locations of the former VX pit, mustard pit, demolition area, suspect sump disposal area (also referred to as the square pit disposal area), storage area, and liquid smoke disposal pit will be ascertained from aerial photographs, soil-gas monitoring, and geophysical methods (if needed). Two 10-ft soil borings will be drilled along the center of each of the VX and mustard pits. The Weston borings showed elevated VOC concentrations down to 6 ft in the center of the southern main pit. A boring is not needed in the liquid smoke disposal pit (if the assumed location is correct) because Weston has sampled soil to a depth of 6 ft in the center of the pit (Mazelon 1993). If geophysical surveys indicate a different location for the liquid smoke pit, the new location will be sampled with a 6-ft boring in the center of the pit.

Visual observations and surface soil sampling results indicate that the pushout area in the TBP AOC is contaminated and fairly extensive. Pushout operations reportedly moved the marsh border east by about 100 ft (Nemeth 1989). To determine the extent and type of contamination, six soil borings will be drilled to below the water table or mean sea level, whichever is deeper. Three of the borings will be located along and close to the marsh border, and three will be located away from the border but east of the toxic, mustard, and VX pits. Exact locations will be chosen in the field in areas of peak soil-gas concentrations and field XRF metal scans, with one near the location found to have elevated lead concentrations in the surface soil (Nemeth 1989). Boring location numbers and tentative locations, which place borings in locations of peak TRCLE + TCLEE and heavy aromatic soil-gas areas and along the marsh edge, are shown in Figure 3.13. Soil borings may also be needed along Rickett's Point Road if the soil-gas survey shows the presence of elevated contaminant levels.

During a recent site visit, ANL staff found several round pits, 10-15 ft in diameter and 4-8 ft deep, in the woods south and southeast of the TBP. Because these pits may have been used for either detonation or disposal operations, they will be sampled to determine the nature and level of potential contamination. To this end, one soil boring will be drilled in the center of each of two pits (approximate locations 15 and 16 in Figure 3.13). Samples will be collected at the surface and at 2-ft intervals down to the water table, or a depth of 4 ft, whichever is encountered first, for a total of at most three samples per boring. The choice of the pits to be sampled will be based on a walkover inspection of the wooded area.

Subsurface soil sampling is useful because of the possibility of infall of ejected contaminated material just after the detonation, as well as subsequent slumping from the sides, which may bury contamination in the pit bottom. Also, more than one detonation may have occurred in some of the pits.

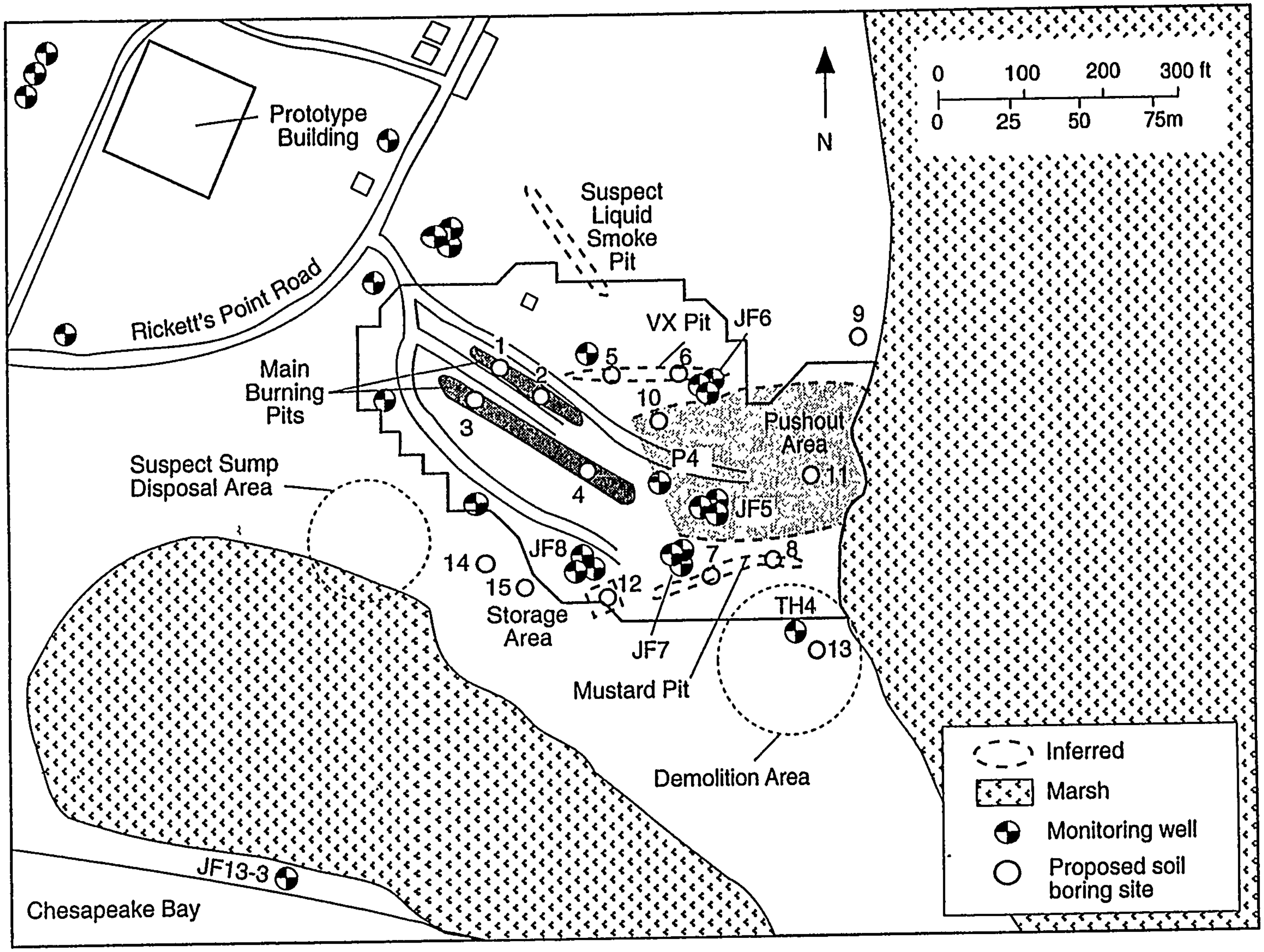

FIGURE 3.13 Stage I Subsurface Soil Sampling Locations at the TBP AOC

Samples from the borings will be analyzed for the Stage I analytical suite and gross beta activity. Gamma spectrometry will be conducted on those samples showing elevated beta activity. This analysis is needed because of the presence of elevated radioactivity in some groundwater samples from the area.

3.3.4.2 White Phosphorus Burning Pits

If geophysical methods locate an obvious contamination source associated with formerly used areas at the WPP AOC, at least two soil borings will be made in the approximate location of the areas identified. Tentative locations and location numbers for the two borings are shown in Figure 3.14. Samples will be analyzed for analytes in the Stage I analytical suite.

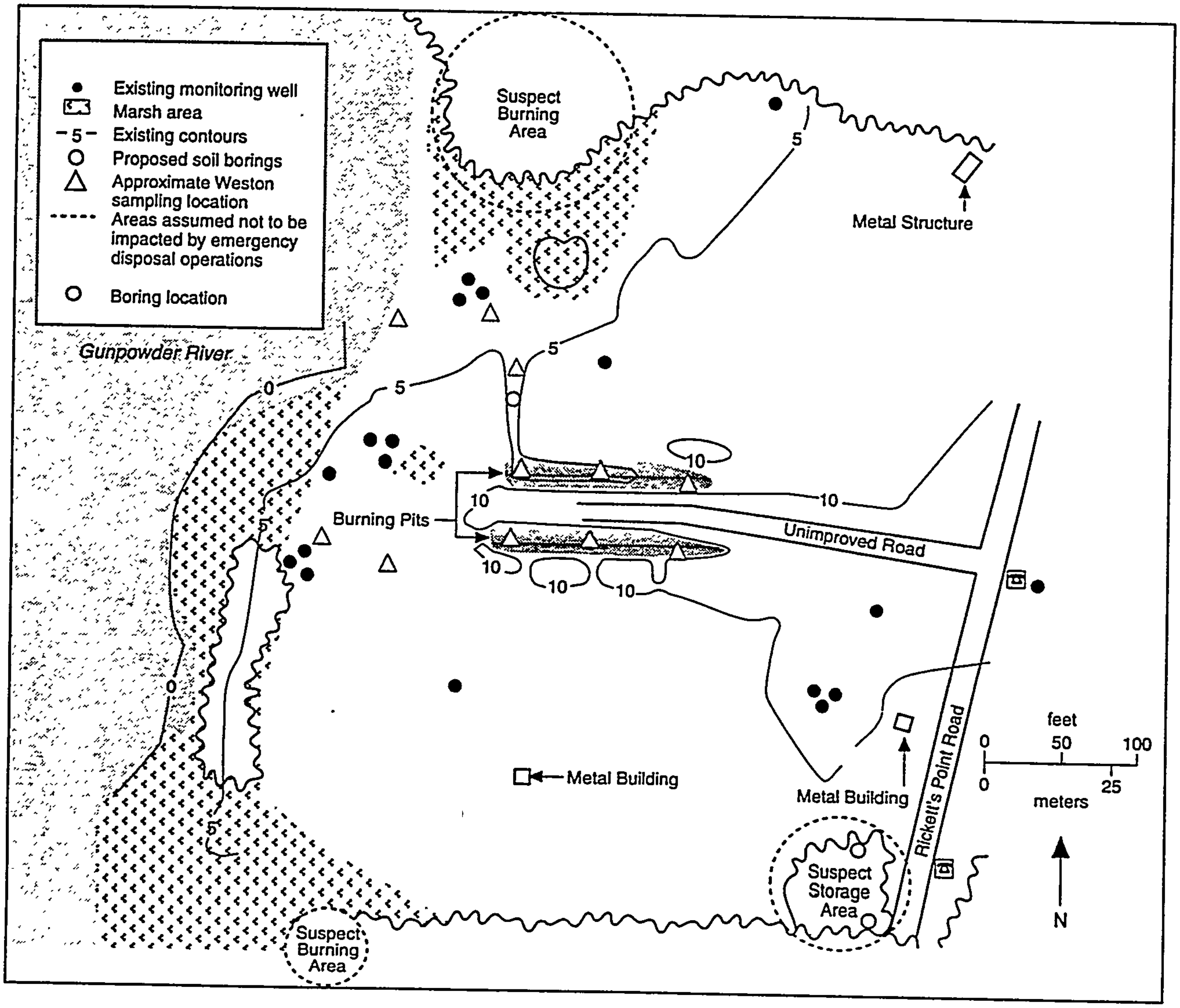

FIGURE 3.14 Stage I Surface Soil Sampling Areas at the WPP AOC

3.3.4.3 Riot Control Pit

Because of the lack of surface and subsurface soil data, soil borings will be drilled at four approximately equally spaced locations in the RCP and trench. Tentative locations and location numbers are shown in Figure 3.9. Specific boring locations will be chosen on the basis of field observations; the results of the UXO/CWA surveys, geophysical surveys, aerial photograph analysis, and soil-gas surveys; and the Weston data (Mazelon 1993). If the soil-gas survey shows more than four areas of elevated contamination, additional soil borings may be needed.

3.3.4.4 Prototype Building

No Stage I soil borings are needed at the PB unless the rumored disposal pit west-northwest of the building is found (Nemeth 1989). If the pit is located, a soil boring will be drilled in the pit.

3.3.4.5 South Beach Trench

The site history and existing data for the SBT suggest that little (if any) contamination is likely to be present. However, at least one subsurface soil sample will be collected from the western trench for a verification. Boring locations will be chosen on the basis of field observations and the results of the UXO/CWA surveys, geophysical surveys, and aerial photograph analysis. Soil samples will be collected from 2-ft intervals from the surface to 10 ft below ground surface and will be analyzed for the Stage I analytical suite.

3.3.4.6 South Beach Demolition Ground

Because the SBDG is now offshore and exposed only during low tide (Hughes 1993), sediments are the main solid matrix available for sampling. Data needs for this matrix are discussed in Section 3.3.5.

3.3.4.7 Robins Point Demolition Ground

The site history and existing data on contamination at the RPDG do not warrant the collection of Stage I subsurface soil samples. The need for Stage II subsurface soil sampling will depend on the results of the Stage I surface soil sampling and survey activities. It is expected, however, that at least two Stage II borings will be needed to confirm the absence of subsurface contamination if no contamination is found in the Stage I surface soil samples. The locations of the borings and the specific soil sample analytes will be chosen on the basis of the results of the surface soil sample analyses. The analyte list would probably include VOCs and cyanide. The VOC analyses would serve as a confirmation that past site activities did not involve the use of solvents. Cyanide is a possible breakdown product of cyanogen chloride, which was reportedly destroyed at the site (Nemeth 1989).

3.3.4.8 Robins Point Tower Site

Subsurface sampling at the RPTS is not needed in Stage I.

3.3.4.9 Other Areas

As discussed in Appendix B, subsurface soil sampling will be conducted at several of the PAOCs.

3.3.5 Surface Water and Sediment Sampling

Since SOP-021 (Sediment Sampling) (COE 1993) specifies that sediment samples be collected in conjunction with surface water samples, sediment and surface water sampling needs have been combined in this section. However, it is important to note that even though surface water and sediment samples will be collected together, CWA constraints dictate that sediment samples must undergo CWA screens before further analyses. Surface water samples can be sent off-site for analysis without CWA clearance.

The proposed surface-soil monitoring program outlined in this FSP addresses the surface water migration pathway, at least for intermittent surface water flow. However, the site also contains perennial surface water features, such as marshes, that could be important contaminant migration pathways. These features will be sampled because they may receive contaminated groundwater discharged from the various AOCs and contaminated surface runoff. Conventional and chemical UXO may also be present.

Surface water/sediment sampling locations and location numbers are depicted in Figure 3.15. The locations are numbered separately for each AOC. The sampling sites selected include areas indicated by the USGS thermal imagery studies to be areas of groundwater discharge. Locations were also selected to evaluate surface water/sediment runoff as a contaminant migration pathway. In all cases, the sample locations specified are tentative and approximate and will be influenced by UXO/CWA surveys, other Stage I sampling results, sample location accessibility, and professional judgment.

Unless otherwise specified, surface sediment samples will be collected to a depth from 0 to 6 in. Surface water samples will be collected over the bottom 1-ft interval of the water column, or over the whole column if the depth is 1 ft or less at the sampling location. Sediment borings will be drilled at a few locations to determine the potential for finding contamination at depth. The choice of locations is based on site history and existing data. Sediment borings will be sampled over 2- or 3-ft intervals. Deep sediment samples will be collected as provided for in SOP-021 (Sediment Sampling) (COE 1993). All Stage I sediment samples will be analyzed for analytes in the Stage I analytical suite.

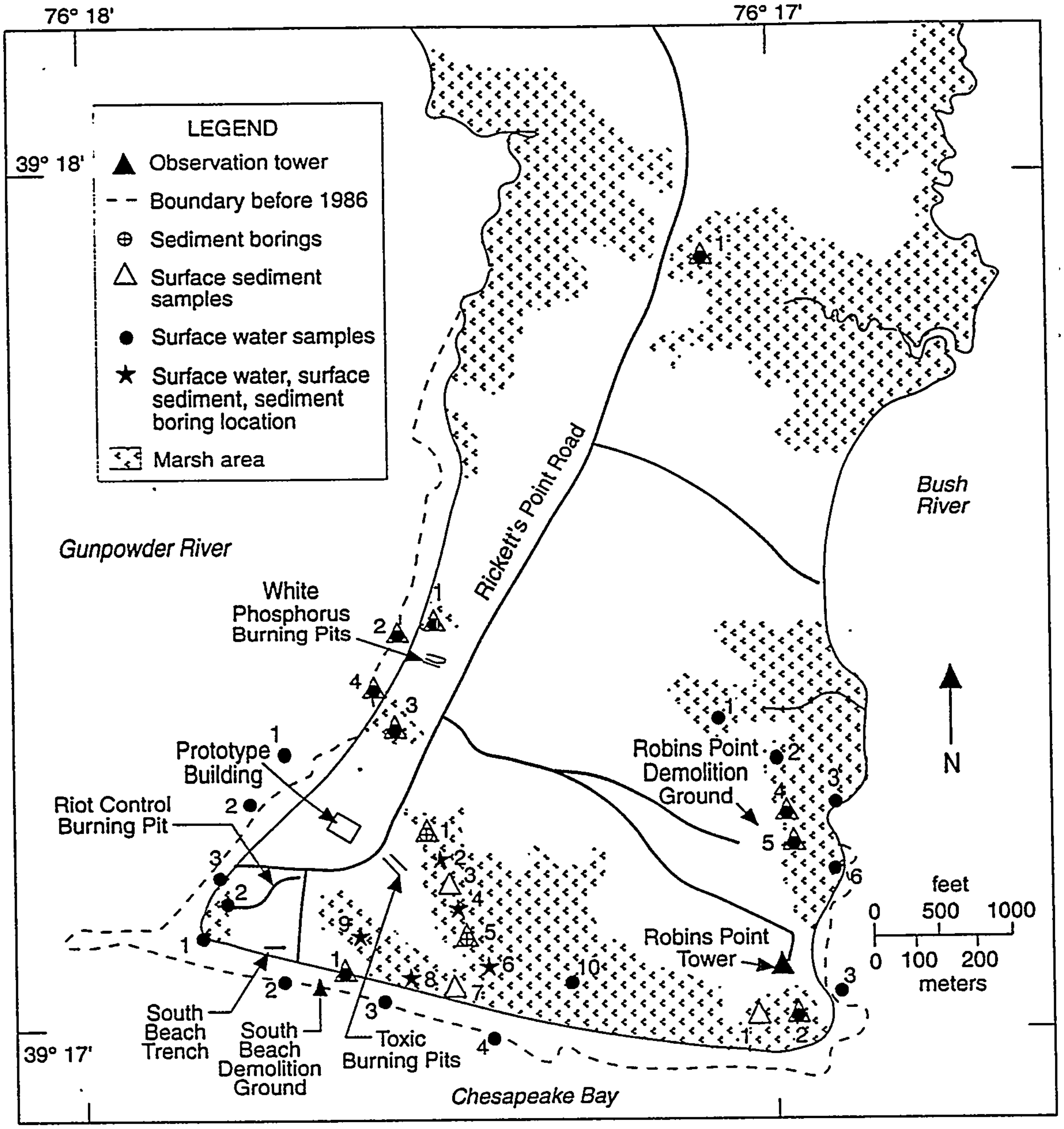

FIGURE 3.15 Proposed Stage I Surface-Water and Sediment Sampling Sites in the AOCs

Stage II sediment sampling will include collection of samples for analytical level III, IV, or V analyses at marsh locations selected on the basis of Stage I sampling results. Uses of Stage II surface and subsurface sediment sampling will include confirmation of suspected uncontaminated areas and quantification of contamination levels.

3.3.5.1 Toxic Burning Pits

The site history and record of use for the TBP AOC indicate that an extensive program of surface water/sediment sampling is needed in the marsh area that straddles it. Tentative locations, seven for surface water and nine for sediment, are depicted in Figure 3.15. Surface water (if present) and surface sediment samples will also be collected from tentative locations 15 and 16 (demolition craters) in Figure 3.13.

Surface water samples collected from nine locations (two shown in Figure 3.13 and seven shown in Figure 3.15) will be analyzed for the CLPAS. Sediment samples from 11 locations (2 in Figure 3.13 and 9 in Figure 3.15) will be analyzed for the Stage I analytical suite on a one-time basis. Stage I activities will also include the drilling of sediment borings to a depth of 10 ft at seven locations in the marsh. The tentative locations and location numbers are depicted in Figure 3.15.

3.3.5.2 White Phosphorus Burning Pits

For Stage I, surface water/sediment samples will be collected in the marsh west of the WPP. The sampled area will include both pushout areas and points of discharge from both ditches from the pits. Sediment samples will also be collected in the near offshore area adjacent to the marsh. The tentative sample locations and location numbers are shown in Figure 3.15.

3.3.5.3 Riot Control Burning Pit

No Stage I surface sediment samples are recommended at the RCP and trench. Surface water samples will be collected from at least three locations associated with the RCP AOC. These sample locations are shown in Figure 3.15.

3.3.5.4 Prototype Building

No sediment samples are needed from the PB AOC because there are no sediments nearby. However, because there is some potential that a component of groundwater flow discharges into the Gunpowder River in the vicinity of the PB, surface water samples will be collected from two offshore locations and analyzed quarterly for the CLPAS. The sampling locations and location numbers are depicted in Figure 3.15.

3.3.5.5 South Beach Trench

No surface water/sediment samples are needed from the SBT AOC because of the lack of surface water and sediment at the site.

3.3.5.6 South Beach Demolition Ground

At this time, no additional estuarine sediment samples are being proposed for the SBDG because sediment in the area was sampled during the EPA study. The results of that survey will be used to determine the need for additional sampling in the area. Should additional sampling and analyses be required, an effort will be made to specify sampling locations in areas that have already been cleared as part of the UXO survey associated with the sediment study. Furthermore, if additional sediment sampling is required in the area and if the results of the sediment study adequately demonstrate the absence of CWA, then it will be proposed to consider sediment samples collected from the area as non-CWA-contaminated and to allow CLPAS analyses.

During a recent site visit, ANL staff located a large pit, about 12 ft deep and 25 ft across, just onshore in the trees in the SBDG. This pit appears to be the remnant of a high-explosive demolition crater. A visual inspection will be conducted for any additional pits in the area. Sediment samples will be collected over a depth interval of 0-12 in. at two locations 6 ft apart in the swampy bottom of the large pit. Surface water samples will be collected at the same locations.

Surface water samples will also be collected at three offshore locations in the bay. Tentative sampling locations and location numbers for the pit and offshore surface water samples are shown in Figure 3.15.

3.3.5.7 Robins Point Demolition Ground

Sediment samples will be collected at three locations in the marsh to determine if surface runoff from the site has carried contaminants into the marsh adjacent to the RPDG. Surface water samples will be collected at six locations in the marsh. Tentative locations and location numbers are indicated in Figure 3.15.

3.3.5.8 Robins Point Tower Site

A potential exists for contamination of the marsh by runoff from the RPTS. Therefore, sediment samples will be taken from two locations in the marsh southeast of the site, and surface water samples will be collected from two marsh locations and one estuarine location. Tentative locations and location numbers are shown in Figure 3.15. Exact locations will be based on field observations and the results of a UXO/CWA survey.

3.3.5.9 Other Areas

As discussed in Appendix B, surface water/sediment samples will be conducted at some of the PAOCs.

3.4 HYDROGEOLOGICAL INVESTIGATION

Review of the groundwater data from past J-Field surveys indicates that significant quantities of organic and inorganic contaminants are present in the aquifers beneath J-Field. However, previous sampling efforts have not provided a clear picture of the extent of this contamination.

Several organic compounds known to have been used at J-Field and detected in environmental media samples collected from J-Field AOCs can exist as DNAPLs. Some of these compounds found at J-Field are 111TCE, 112TCE, TCLEE, TRCLE, and 11DCE. In addition, fuel oil used to initiate open burning in some J-Field OB subareas contains constituents that would be considered DNAPLs. The chemical and physical properties of these DNAPL compounds vary, but most are slightly soluble in water and more dense and less viscous that water. These properties cause the DNAPL fluids, when present as a separate phase, to sink rather rapidly through water. If DNAPL compounds are present as a separate phase within the aquifer system, the fluid will sink through the water column until it encounters the leaky confining layer present beneath J-Field. The fluid will then either pool in low areas or spread out and flow along the top of the confining unit. Because the confining layer is leaky, DNAPLs may continue to migrate downward, at a much slower rate, through this layer and into the underlying aquifer. Understanding this behavior and determining if this problem is present at J-Field are critical to both characterizing and cleaning up an aquifer containing DNAPLs. To this end, the sampling program outlined in this FSP has been developed to help determine the possible extent and magnitude of groundwater contamination caused by past disposal practices at J-Field.

3.4.1 Monitoring Well Installation

Currently 61 monitoring wells are located on J-Field: 9 Princeton Aqua Science wells, 10 USATHAMA (AEC) wells, and 42 USGS wells. Well-construction data for some of the wells are given in Tables 3.8 through 3.10. The Princeton Aqua Science and USATHAMA wells are old, and polyvinyl chloride (PVC) glue was used at the joints. These wells also produce very silty water. This silting may be due to incorrect well screen size, poor initial well development, or silt accumulation from lack of use. Table 3.11 lists wells that should not be used during this RI and the reasons for not using them. These wells will be inspected with a downhole video camera and will be properly abandoned if necessary.

TABLE 3.8 Well Construction Data for Monitoring Wells Installed at J-Field[a]

Well Number	Elevation of Land Surface (ft MSL)	Depth of Boring (ft)	Screened Interval (ft below surface)	Well Volume (gal)
JF1	4.95	190	185-190	123.5
JF2		300	208-213	138.4
JF11	7.42	90	85-90	58.5
JF12	7.30	55	50-55	35.7
JF13	7.18	25.5	20.5-25.5	16.6
JF21	2.99	71	68-71	46.1
JF22	2.99	52.5	47.5-52.5	34.1
JF23	3.10	19	16-19	12.3
JF31	7.67	81.3	73.8-78.8	51.2
JF32	7.70	54.4	49.4-54.4	35.4
JF33	7.79	20	15-20	13.0
JF41	10.22	90	85-90	58.5
JF42	10.30	62	57-52	NA[b]
JF43	10.63	35	30-35	22.7
JF51	5.02	115	110-115	74.7
JF52	5.27	65	60-65	42.2
JF53	5.10	19.2	14.2-19.2	12.5
JF61	4.29	100	95-100	65.0
JF62	4.08	65	60-65	42.2
JF63	4.10	19	16-19	12.3
JF71	7.26	125	120-125	81.2
JF72	8.28	81	76-81	NA
JF73	7.48	18	15-18	11.7
JF81	10.01	123	120-123	80.0
JF82	10.39	75	70-75	48.7
JF83	10.42	20	15-20	13.0
JF91	10.18	79	74-79	51.3
JF92	10.60	55.5	50.5-55.5	NA
JF93	10.28	25	20-25	16.2

TABLE 3.8 (Cont.)

Well Number	Elevation of Land Surface (ft MSL)	Depth of Boring (ft)	Screened Interval (ft below surface)	Well Volume (gal)
JF101	5.36	76	73-76	49.4
JF102	5.70	55	52-55	NA
JF103	5.41	28	25-28	18.2
JF111	6.51	75	69.1-75.0	48.7
JF112	6.19	50	47-50	NA
JF113	6.77	25	22-25	16.2
JF121	4.16	70	67-70	45.5
JF122	4.42	55	52-55	35.7
JF123	4.15	28	25-28	18.2

[a] Wells were constructed with 4-in. flush-threaded polyvinyl chloride casing and 4-in. flush-threaded stainless steel screen.

[b] NA = not applicable. These wells will not be sampled, so no well volumes were calculated.

TABLE 3.9 Well Construction Data for USATHAMA Wells[a]

Well Number	Elevation of Land Surface (ft MSL)	Well Diameter (in.)	Screened Interval (ft below surface)	Well Volume (gal)
TH1	3.44	4	6.0-16.0	10.4
TH2	9.45	2	8.0-18.0	NA[b]
TH3	6.07	4	8.0-18.0	11.7
TH4	4.36	2	8.0-18.0	NA
TH5	8.27	2	10.0-20.0	NA
TH6	8.83	4	10.0-20.0	NA
TH7	4.72	4	7.0-17.0	NA
TH8	5.31	4	7.0-17.0	11.0
TH9	4.82	4	8.0-18.0	NA
TH10	7.19	4	8.0-18.0	11.7
TH11	4.10	2	8.0-18.0	NA

[a] Well-construction details are not available. It is believed that polyvinyl chloride glue was used on joints.

[b] NA = not applicable. These wells will not be sampled, so well volumes were not calculated.

TABLE 3.10 Well Construction Data for Princeton Aqua Science Wells[a,b]

Well Number	Screened Interval (ft below surface)	Total Well Depth (ft)	Well Volume (gal)
P1	5.0-20.0	20.0	NA[c]
P2	5.0-20.0	20.0	3.2
P3	5.0-20.0	20.0	3.2
P4	5.0-20.0	20.0	3.2
P5	2.0-17.0	17.0	NA
P6	2.0-17.0	17.0	3.2
P7	5.0-20.0	20.0	3.2
P8	5.0-20.0	20.0	3.2
P9	2.0-17.0	17.0	3.2

[a] Wells were constructed with 4-in. polyvinyl chloride casings. All joints were connected with polyvinyl chloride glue.

[b] Information on ground surface elevation at well sites is not available.

[c] Not applicable. These wells will not be sampled, so well volumes were not calculated.

TABLE 3.11 J-Field Monitoring Wells That Will Not Be Sampled during the RI

Well Number	Reason for Not Sampling
TH6	Wells are located in upgradient areas near other, better constructed wells. Sampling of these wells would duplicate efforts.
TH2, TH4, TH5, TH11	Wells are filled with sand, probably because of casing failure.
TH9	This well is now located offshore because of shoreline erosion. The grout seal is missing.
JF42, JF72, JF92, JF102, JF112	The screens of these wells are partially blocked by grout, as evidenced by the extremely high pH of the water. These wells also require several days after purging for sufficient water to accumulate for sampling. Sampling for organic compounds under these conditions will not yield any useful data.

Monitoring well completion records for the USATHAMA and Princeton Aqua Science wells should be reviewed and the remaining wells inspected to determine if they are usable. The wells that are found to be usable should be redeveloped in order to eliminate excess silt. Depending upon these results, a decision should be made either to continue using the wells or to abandon them in accordance with Maryland state well abandonment regulations. If any existing wells are abandoned, they should be replaced if the locations are critical for the groundwater monitoring program.

Because the USGS has installed four additional wells on J-Field (two in the RPDG AOC and two south and southeast of the RCP AOC), it is recommended that only one additional well be installed at J-Field as part of the RI activities. This additional well should be southeast of the TBP AOC near the marsh area, directly downgradient of the pits (Figure 3.16). The exact location for this well will be selected on the basis of the results of the ground-penetrating radar survey and electromagnetic geophysical data. The well construction protocol discussed in Section 3.4.2 will be used. Details of the installation of the proposed monitoring well (well 173) will be documented in a technical update and submitted to the DSHE.

According to USGS data, the top of the confining clay layer slopes down to the east-southeast, in the direction of the marsh. Because of this slope, DNAPLs, if present in a free liquid phase, would have a tendency to spread out in a "pancake-like" form and flow down along the top of the clay layer. To determine if this movement is occurring, the well will be constructed so the capped well screen will rest a few inches below the base of the aquifer. The boring will be drilled down to the confining layer (penetrating it only a few inches) to allow the top of the screen cap to be just at the top of the confining layer (Figure 3.17). If the well is properly installed, very little sediment will accumulate in the well, and it will trap DNAPLs if they are present along the flow path. This information will help in future monitoring and in cleanup activities.

3.4.2 Monitoring Well Construction Specifications and Instructions[3]

The monitoring well to be installed at J-Field will be placed in a downgradient location near the TBP to collect DNAPL. The well will be constructed and developed consistent with the provisions of USATHAMA's *Geotechnical Requirements for Drilling, Monitor Wells, Data Acquisition, and Reports* (USATHAMA 1987a) and with the COE's generic RI/FS work plan for the APG-Edgewood Area, including SOP 019 (Monitoring Well Installation) (COE 1993).

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[3] In this discussion, it is implicitly assumed that UXO/CWA surveys will be conducted at the appropriate periods.

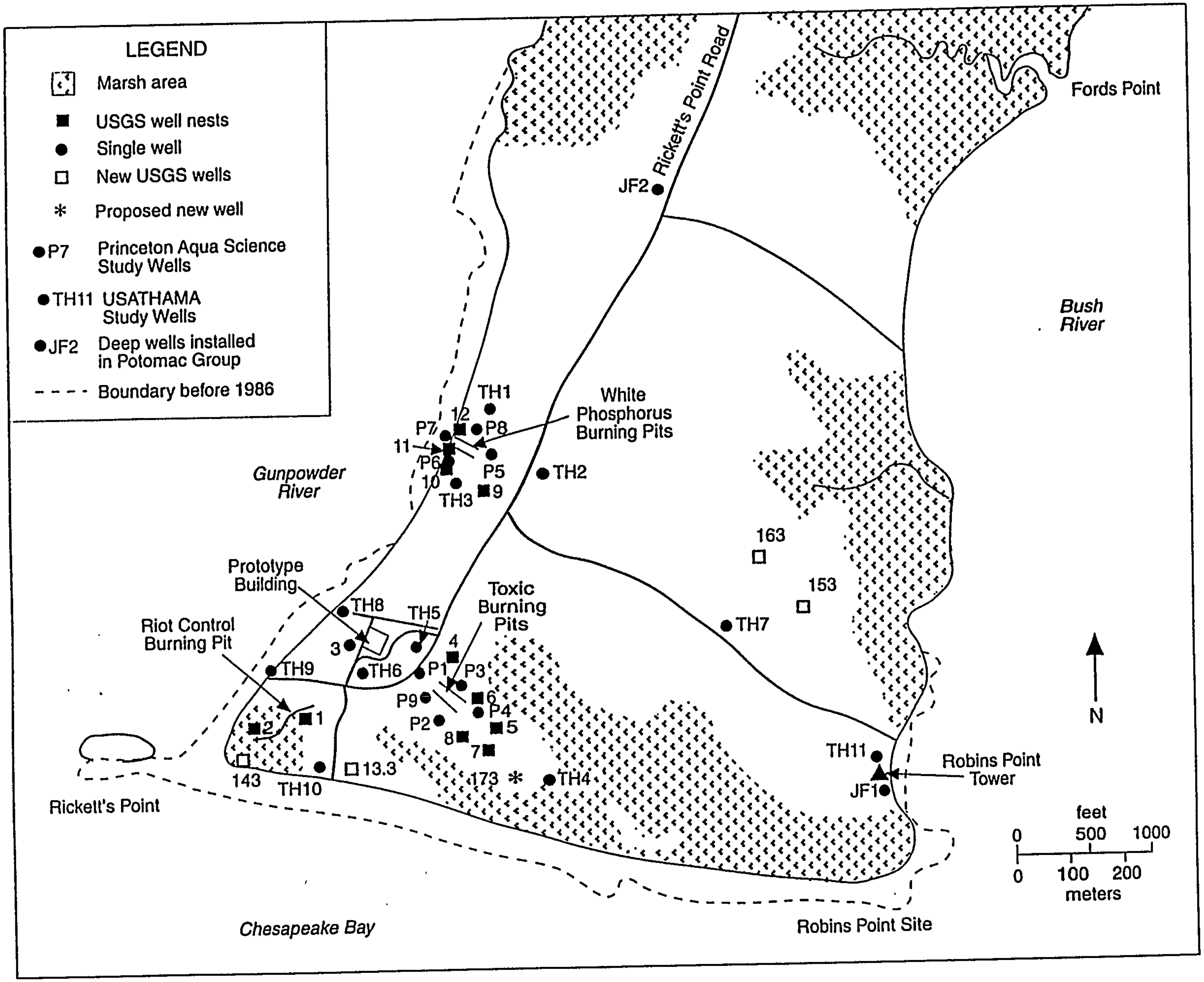

FIGURE 3.16 Approximate Locations of Existing Monitoring Wells and Proposed New Monitoring Well (Well 173) at J-Field (Source: Adapted from Hughes 1993)

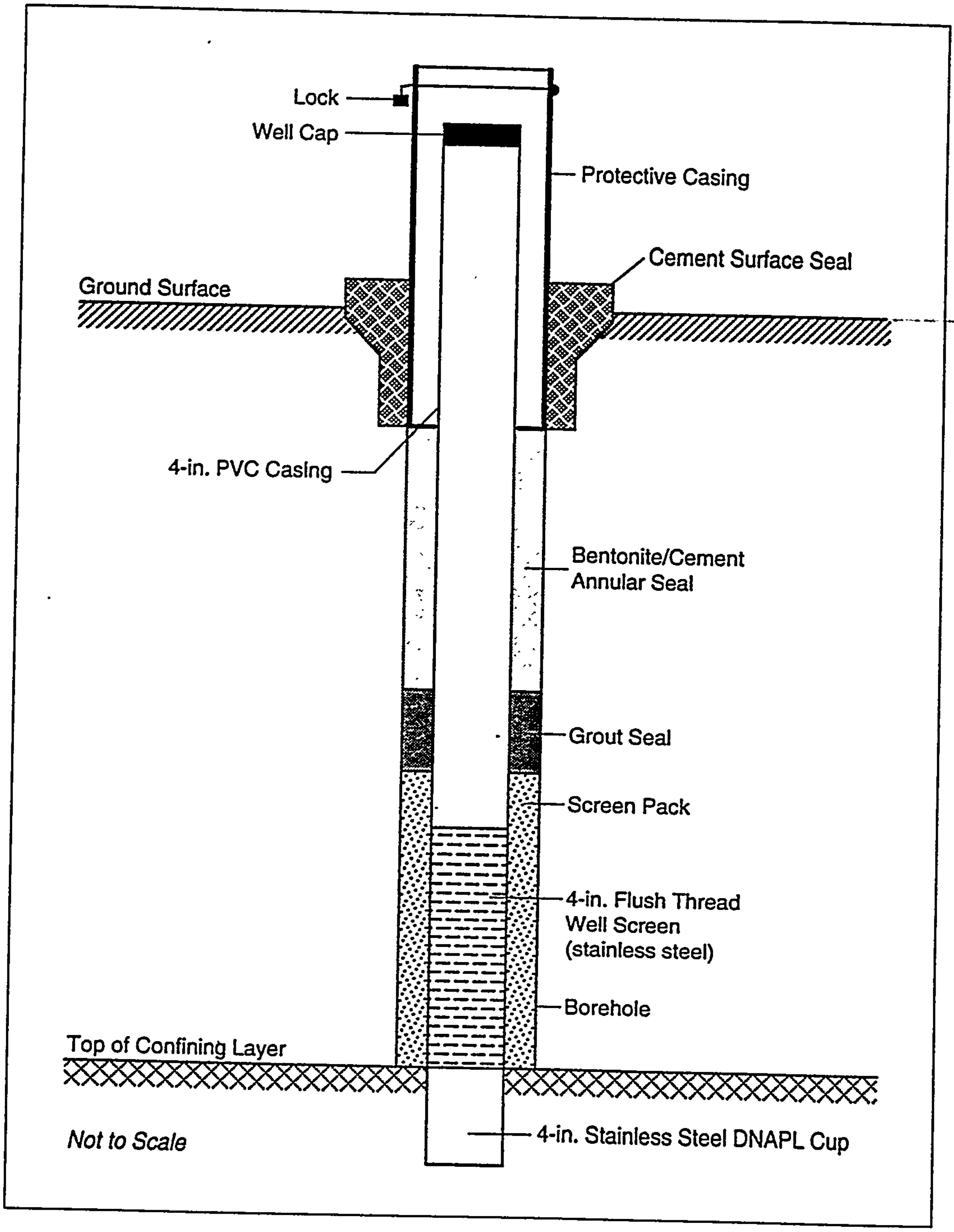

FIGURE 3.17 Generalized Construction Details for the Proposed Monitoring Well

3.4.2.1 Unexploded Ordnance Clearance[4]

Before any boring or well installation begins, the work site will be surveyed and cleared of all surface UXO. A subcontractor will conduct these operations under the guidance of Army personnel. In those areas where the Health and Safety Plan (HASP) indicates the need for surface and surface surveys, the procedures will generally be as indicated below.

Work sites will be visually inspected to locate surface UXO. All UXO and hazardous ordnance residue located on the work site will be identified, if possible, and catalogued. An access path will then be routed around the item.

In addition to visual inspection, a magnetometer survey adequate to a depth of 4 ft will be conducted within a 50-ft radius of each drill site marker before drilling operations are started. After the work site has been determined to be clear of UXO, the drilling crew will start drilling. Drilling operations will be stopped at 2, 4, 6, 8, and 10 ft to allow downhole monitoring with a ferrous metal detector.

For downhole monitoring to be performed, the drill crew will insert a PVC casing into the borehole and remove the auger. The drilling rig will then be moved a minimum of 20 ft from the borehole. The probe will then be lowered into the PVC casing to the bottom of the hole to monitor for presence UXO. If the hole is clear of UXO, the crew will then remove the PVC casing and continue drilling to the next level. If realignment over the hole is unsuccessful, the boring will be properly abandoned and a new boring will be started nearby.

If the survey indicates the presence of UXO, further drilling at that location will be suspended, the hole will be properly abandoned (according to SOP 028, Well and Boring Abandonment) (COE 1993), and a new location will be selected.

3.4.2.2 Construction Procedure

The new monitoring well will be installed through a hollow-stem auger. The preferred choice for well casing is 4-in.-diameter stainless steel. The screen aperture size will be determined from formation grain size analysis performed on cuttings. If corrosive groundwater conditions are present (characterized by either pH <4.5, dissolved oxygen >2 ppm, odor of hydrogen sulfide, dissolved solids >1,000 ppm, carbon dioxide 50 ppm, or halides >1,000 ppm), teflon will be used for the well casing and screen.

Materials used for well construction will be subject to the approval of the project manager and will be free of toxic chemicals such as lead, copper, and organic solvents. Lubricants will not be used. Bentonite, kaolinite, and cement sealers will be approved by the contracting officer before their delivery to the site. The source, manufacturer, and contents of the sealer will be recorded. The source of water used for equipment washing, drilling, well installation, and grouting will be approved by the contracting officer before site activities

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[4] This subsection has been taken from a report by the COE (1992).

begin. The water will be derived from an EPA-approved source and will be transported in a decontaminated plastic tank.

The installation of the well will begin within 12 hours of borehole completion. The installation process will not be interrupted until the well has been fully cased and grouted and the auger removed. Exceptions include personal injury, equipment breakdown, or sudden inclement weather. All contact equipment will be steam cleaned before well installation. Pipe labels will be removed by sanding — no solvents will be used. The well screen will be placed at the bottom of the borehole. Silt traps will not be used.

The bottom cap will be set 4 in. into the confining unit so that the bottom of the well screen will be flush with the top of the leaky confining unit. The well screen will be 5 ft long. After the screen and casing are emplaced, the annulus will be backfilled with a filter (screen) pack of clean sand. The filter pack will extend at least 2 ft above the screen. The grain size of the filter pack will be determined in the field and will be 3 to 5 times the 50% size of the aquifer material. The screen size will be chosen to retain at least 90% of the filter pack material. A bentonite seal, no more than 3 ft thick, will be placed around the casing from the top of the filter pack. A bentonite/cement grout will then be placed from the top of the bentonite seal to within 1 ft of the ground surface. A 6-in.-diameter steel riser pipe will be positioned around the casing, resting on the grout layer. The riser pipe will extend 2.5 ft above the ground surface and 2.5 in. above the top of the well casing. The area between the well casing and the riser will then be filled with bentonite to within 1 ft of the top of the casing. Concrete will be poured into the top of the hole outside of the riser and will be fashioned into a 2-ft-diameter circular cap sloping away from the base of the well. The riser cap will have a cap that can be locked with a standard padlock. Three or four steel posts (each 4 ft from the well, set 2-3 ft into the ground, and extending at least 3 ft above the ground surface) will be installed to protect the riser. A geologist will be present at the drill rig to record well installation procedures, prepare boring logs, and record sampling data.

The field geologist will record the following relevant data in the field log during boring and well installation:

- Start and completion dates and work shift changes during installation;
- Physical characteristics and thickness of each lithologic layer;
- Depth to each distinct soil or lithologic layer;
- Depth to free water and saturated water conditions;
- Well construction details, such as depth of grout, bentonite seal, filter pack and screen;
- Physical and chemical characteristics of each sample; and
- Any problems encountered during drilling, such as unrecovered tools in the hole.

Drilling of the borehole will proceed in distinct increments as allowed by the UXO/CWA survey. Construction details are shown in Figure 3.17 and are summarized below.

Before well development, the static water level will be measured from the top of the casing and recorded. The top of the casing will serve as the standard reference point for all subsequent water depth measurements. The well will be developed by pump purging no sooner than 48 hours after completion of the well. Either a surface or a submersible pump will be used, depending on the depth to the water table. Clean tubing and contact pump parts will be used. The well will be purged until the water is clear to the unaided eye. At a minimum, five times the well volume will be purged.

3.4.3 Groundwater Sampling

Groundwater is a major pathway for contaminant migration. Therefore, a comprehensive groundwater monitoring program will be implemented at J-Field. The focus of the Stage I RI activities for groundwater will be on understanding the nature and extent of contamination in the surficial aquifer. The objective is to relate contamination in groundwater to source areas (e.g., the TBP) and to understand the contaminant migration patterns.

Data will be collected with methods and procedures detailed by the COE (1993) and in the QAPjP. The level of QA/QC for sampling and analysis will be analytical levels III and IV. Specific details of level III and IV requirements are outlined in Table A.1 of the J-Field RI Work Plan. The findings from this phase of the investigation will be evaluated to determine the need for additional work. The decision on the types and locations of any additional wells and samples will be based on conclusions resulting from this phase.

3.4.3.1 Sampling Rationale

A variety of organic and inorganic materials have been disposed of or used at J-Field during its operation. The principal migration pathway for any contaminants that have been subsequently released or leached would be first to the surrounding soils and then vertically to the groundwater. These contaminants would eventually migrate to the marsh areas, rivers, and bay. Because previous sampling results indicate organic and inorganic compounds in the groundwater and sediment, the following activities are recommended.

Groundwater from 52 of the monitoring wells will be sampled and analyzed for VOCs, semivolatile compounds, pesticides/PCBs, CWA degradation products, explosives and related compounds, cyanide, water quality parameters, major ions, radioactivity, phosphate, sulfate, and total and dissolved metals. Field analysis should include measuring temperature, pH, specific conductance, redox, dissolved oxygen, and turbidity. Sampling of the groundwater should verify previous analytical results and help determine if contamination has increased. If possible, the boring used for the installation of the new monitoring well will be used as one of the subsurface soil sampling locations previously discussed. During drilling for the new well, soil samples will be collected at 2.5-ft intervals and will be analyzed for the Stage I analytical suite. Groundwater samples will be collected in accordance with SOPs 008, 009, 010, 012, 013, 015, 016, 036, and 037 (COE 1993).

3.4.3.2 Periodic Groundwater Monitoring

The objective of a groundwater monitoring program at J-Field is to provide an ongoing check on the movement of contaminants in the groundwater. The data yielded by such a program are useful in determining the effectiveness of cleanup actions. These data also serve as a check on the predictions of contaminant movement made by modeling studies. The remedial investigation is expected to yield much new information. Analysis of these new data, combined with the existing data, may indicate changes that should be made in the monitoring program. The types of changes that might result include the numbers and locations of monitoring wells, monitoring frequency, and analytical categories used.

The monitoring program involves collecting groundwater samples on a yearly basis. As new information is collected, it may be appropriate to amend the groundwater monitoring program to analyze for select parameters and the CLPAS on a more or less frequent basis. Appropriate amendments to the yearly monitoring program will be proposed in a technical update to the EPA, approved by APG's EMD. If changes to the monitoring program are necessary before completion of three quarters of sampling, these changes will be documented in an EMD-approved technical update to EPA Region III after review and approval by the APG Directorate of Safety, Health, and Environment.

3.4.4 Groundwater-Level Measurements

The aquifers beneath J-Field are fairly flat and poorly defined. It is extremely important to determine the groundwater flow direction and gradient at J-Field in order to evaluate tidal influence on the aquifers. Before well sampling or purging, water levels will be measured to the nearest 0.01 ft with an electronic device. These measurements will be recorded in a bound notebook. During the sampling period, water levels will also be measured in wells that are not being sampled.

The USGS currently has water-level recorders installed on 23 monitoring wells. To help further define the hydrogeologic framework, the water-level recorder network will be maintained and water levels will be measured quarterly in all wells.

Groundwater-level measurements will be conducted using SOP-010 (Water Level and Well-Depth Measurements) (COE 1993).

3.5 TIDE-LEVEL MEASUREMENTS

A tide-measuring device will be installed in the Chesapeake Bay, approximately 200-300 yd east of Robins Point. The location will be near (or at) the site of the former tide gauge operated by the USGS, with coordinates at approximately 39° 18' 2" North, 76° 16' 51" West. The gauge location will be in an area with a water depth of at least 5 ft below MSL. If possible, the previous gauge mooring posts will be used to mount the gauge. If the existing moorings prove inadequate, a new gauge mounting platform will be constructed.

The gauge will measure tide fluctuations of ±0.01 ft at 15-minute intervals. The data obtained will be coordinated with the water table measurements collected from onshore monitoring wells to determine the impact of any tidal-induced compressional loading on the local groundwater aquifers. This information will assist in determining groundwater flow velocity at J-Field.

4 SAMPLE PROCESSING

4.1 SAMPLE HANDLING

All procedures regarding sample handling, such as those dealing with preservation, containers, and holding times, are presented in Section 5 (Sampling) of the QAPjP. Chain-of-custody (CC) procedures are outlined in Section 6 (Sample Custody) of the QAPjP.

4.2 SAMPLE ANALYSIS

All field and laboratory analytical procedures (including sample preparation) to be used for the RI at J-Field are presented in Section 8 (Analytical Procedures) of the QAPjP, and instrument calibration procedures are addressed in Section 7 (Calibration Procedures and Frequency) of the QAPjP. Data management procedures are discussed in Section 9 (Data Validation, Reduction, and Reporting) of the QAPjP, and records management, including management of technical data, is discussed in Section 6 (Records Management) of this FSP.

4.3 SAMPLE DOCUMENTATION

To ensure compliance with quality assurance (QA) and CC standards, appropriate documentation procedures must be followed for each sample. The protocols for recording sampling information in logbooks are given in Section 13.1 (Sampling Records) of the QAPjP, SOP 003 (Field Logbook), and SOP 016 (surface water, groundwater, and Soil/Sediment Logbooks), prepared by the COE (1993). Requirements for laboratory sample documentation are given in Section 13.2 (Laboratory Records) of the QAPjP. Proper custody procedures require that samples be handled by a minimum number of people. Proper record keeping requires that detailed field sampling logs, CC forms, and sample labels be prepared and maintained. All entries must be legible and in permanent blue or black ink.

Field sampling logs will include (at a minimum) the following information for each sample or sample container as specified in SOP 003 (COE 1993):

1. Project or installation for which the sample is being collected;
2. Sampling date and time;
3. Sampling location (borehole or well identification) or source;
4. Field sample number (a unique number should be assigned to each container if several analytical samples are being taken from the same source);
5. Analyses required for the contents of each container;

6. Field data applicable to the sample (e.g., pH, conductivity); and

7. Name of sampler.

Depending on the specific sample type or sampling technique, the following additional information may also be required for some samples:

- Sampling depth, measured from the top of the well casing for established wells and from ground level for bores;

- Sampling technique; and

- Preservative used (if applicable).

Information entered on the field CC form (which accompanies each sample container) must exactly match the information entered in the field sampling log. In addition, each sample label (which is attached to the sample container) must include sufficient matching information to verify each sample against the CC record. As a minimum, the information specified in items 3, 4, 5, and 7 above must be included. Details of CC procedures are presented in Sections 6 and 13 of the QAPjP.

4.4 SAMPLE SCREENING, PACKAGING, AND SHIPMENT

4.4.1 Sample Screening

Before they are shipped to an off-site laboratory for analysis, soil and sediment samples will be screened for CWA contamination by personnel from the Chemical Research, Development, and Engineering Center (CRDEC) at APG. Results of the screening will be interpreted as positive if CWA contamination is present in the sample, and negative if CWA concentrations are below the detection limit of the screening process. Samples that are positive will remain with the CRDEC. Samples that are negative will be released for shipment and analysis.

4.4.2 Sample Packaging and Shipment

Samples must be packaged and classified for shipment in compliance with current U.S. Department of Transportation and commercial carrier regulations (EPA 1988). All required government and commercial carrier shipping papers must be filled out in accordance with these regulations. Specific requirements for the packaging and shipment of samples are given in Section 6.3 (Transport of Samples) of the QAPjP and in SOP-004 (Sample Packing and Shipping) (COE 1993).

5 SAMPLING PROCEDURES AND EQUIPMENT AND HANDLING OF INVESTIGATION-DERIVED WASTE

5.1 SAMPLING PROCEDURES AND EQUIPMENT

The methods and equipment to be used in the collection of environmental media at J-Field are discussed in the relevant SOPs listed in Table 5.1 and are described in Appendix A of the QAPjP (Volume 2 of this report) and the *Work Plan for CERCLA Remedial Investigation/Feasibility Study* (COE 1993). The SOPs (COE 1993) are updated periodically and are accessible to all contractors through the Internet. All sampling will be conducted in accordance with the protocols for worker safety established in the Health and Safety Plan for J-Field. Levels of personal protection required, safety procedures, and the locations of contamination-reduction zones will also be as specified in the Health and Safety Plan. Sample preservation, labeling, chain-of-custody, identification, packing, and transport will be as specified in the QAPjP.

5.2 EQUIPMENT DECONTAMINATION

The procedures for decontaminating equipment are outlined in this section and SOP 005 (COE 1993). All sampling equipment (including bailers, pumps, shovels, dredges, hand trowels, scoops, measuring instruments, plastic tarps, and bottles) will be taken to a designated area in the contamination-reduction corridor for decontamination. Reusable equipment (such as bailers, pumps, and scoops) will be transported from the location of use back to the decontamination area in clean, dedicated plastic bags after use at each sample location. Sample bottles will also be transported in separate, clean plastic bags. Disposable equipment and personal protective clothing will be segregated and bagged for transport and disposal.

At the decontamination area, reusable equipment will be hand-washed in the following sequence:

- Thorough brush-cleaning with a phosphate-free soap (such as Alconox) and, if deemed necessary, appropriate CWA decontamination solutions;
- Tap-water rinse;
- Deionized-water rinse; and
- Methanol rinse and air-dry (certain equipment, such as electrodes on monitoring devices, may require slightly different procedures as recommended by the manufacturer).

After cleaning, the equipment will then be sealed in clean, dedicated plastic bags in preparation for transport back into the field. The outside of filled sample bottles will undergo a similar wash procedure without the methanol rinse. The filled sample bottles will then be sealed and packed for shipment to the analytical laboratory.

TABLE 5.1 Identification Numbers and Titles of Relevant Standard Operating Procedures for J-Field[a]

SOP No.	Title
U.S. Army Corps of Engineers SOPs[b]	
001	Sample Labels
002	Chain-of-Custody Form
003	Field Logbook
004	Sample Packing and Shipping
005	Decontamination
006	Use of the IRDMS Network
007	Surface Water Sampling Procedures
008	pH Measurement
009	Temperature Measurements
010	Water Level and Well-Depth Measurements
011	Photoionization Detector (HNu Model P1-101)
012	Specific Conductance Measurements
013	Collection of Monitoring Well Samples
014	Collection of Production Well Samples
015	Document Control System
016	Surface Water, Groundwater, and Soil/Sediment Field Logbooks
017	Ground Penetrating Radar Survey
018	Electromagnetic Induction (Terrain Conductivity) Surveys
019	Monitoring Well Installation
020	Active Soil Gas Sampling
021	Sediment Sampling
022	Benthic Tissue Sampling
023	Organic Vapor Analyzer (Foxboro 128 GC)
024	Photoionization Detector (Microtip HL-200)
025	Soil Sampling
026	Active Soil Gas Analysis
027	Passive Soil Gas Survey
028	Well and Boring Abandonment
029	Extraction Wells
030	Radioactivity Surveys
031	Sample Container Cleaning
032	Piezometer Installation
033[c]	Slug Tests
034	"Orphan or Unclaimed" Wells
035	Agent Screening
036	Turbidity Measurements
037	Dissolved Oxygen Measurements
038	Redox Potential Measurements
039	Sample Preservation
040	Confined Space Entry
041	Sludge Sampling Procedures
042[c]	Disposal of Environmental Well Development/Purge Water

TABLE 5.1 (Cont.)

SOP No.	Title
043[c]	Hydrolab Multiparameter Water Quality Monitoring Instrument
044[c]	Assessment of Existing Wells Using Downhole Camera
045[c]	Assessment of Tidal Effects on Groundwater
Argonne National Laboratory Supplemental SOPs[d]	
S001	Field Screening of Metals in Soil by X-Ray Fluorescence
S002	Immunoassay Field Screening Method for Rapid PCB, PEH, and PAH Analysis of Soil
S003	Microbial Assessment Using Mickit
S004	Surface Soil Sampling for Radiological Testing
S005	Emflux Passive Soil Gas Surveys

[a] The SOPs listed here are periodically updated.

[b] Source: COE (1993).

[c] Denotes SOP in draft.

[d] Developed by Argonne National Laboratory for J-Field RI.

Sampling equipment that is difficult to hand-clean (e.g., augers, split spoons, and drilling equipment) will be steam-cleaned before being rinsed in deionized water. Gross cleaning (removal of large, visible debris) of this equipment will be done in the field in order to minimize the transport of potential contaminants through site access points. The collection and disposal of decontamination rinsewater and solid waste is described in Section 5.3.

5.3 STORAGE AND DISPOSAL OF INVESTIGATION-DERIVED WASTE

A staging area that meets APG approval will be established in a location near J-Field for the temporary storage of investigation-derived waste. Solid wastes such as contaminated protective clothing and disposable sampling equipment generated during field sampling activities will be staged in the designated area in 55-gal drums. The wastes will be classified for disposal as required by APG. Soil and sediment samples that are not sent from the site to a laboratory for analysis will be composited into a secure drum in the staging area and sampled as required by APG. Used sample-collection bottles will be rinsed and disposed of along with the other investigation-derived wastes. Waste materials will be removed from the staging area and shipped for final disposal in accord with written approval from APG.

Rinse water will be collected and disposed of as decontamination rinse water. Liquid wastes from the drilling, purging, and development of wells and from decontamination of equipment will be segregated and stored in 55-gal drums or mobile tanks before being tested and disposed of as directed by APG. Decontamination wastewaters containing methanol rinse will be segregated from other wastewaters and may be disposed of differently.

Solid wastes discovered during site survey activities that contain UXO or explosives-related compounds in sufficient concentrations that they may be explosive will be treated and disposed of according to APG regulations by an authorized subcontractor or APG personnel.

6 RECORDS MANAGEMENT

This section establishes the general guidelines to be followed in managing all project records, including technical data sets. The specific methods and details of protecting records will be implemented through use of SOPs and good management practices, as outlined in the *Work Plan for CERCLA Remedial Investigation/Feasibility Study* (COE 1993) and the QAPjP.

6.1 PROJECT LOGBOOKS

Bound logbooks will be used for all record keeping, both in the field and in the laboratory. Requirements for recording of sampling and field investigation data are presented in SOP-003 (Field Logbook) and SOP-016 (Surface Water, Groundwater, and Soil/Sediment Logbooks) (COE 1993). The bound logbooks will provide a chronological sequence of data collection. Each logbook will contain a unique document control number. Field logbooks will be submitted to ANL's Document Control Center when complete. Laboratory logbooks will be maintained by the analytical laboratory. These books will be checked during routine laboratory audits conducted by ANL's quality assurance (QA) officer (see QAPjP, Section 11). At the end of the project, all project data files and logbooks will be transferred to the AEC.

6.2 TECHNICAL DATA

Figure 6.1 illustrates the data flow for the J-Field RI project. Details for each step in the flow diagram and responsible project personnel are as follows:

1a. Data Receipt and Log-In by Procurement Officer

- Record date of data package receipt on the data transmittal form,
- Check data package for completeness and consistency with contract terms, and
- Forward data package with transmittal form to data manager for database entry.

1b. Data Submittal to Installation Restoration Data Management System (IRDMS)

- Submit data to IRDMS directly from laboratory.

2. Data Entry and Check by Data Manager

- Assign data package file number for tracking purposes,
- Enter data into database (include data package file number),
- Check entries (QA officer),

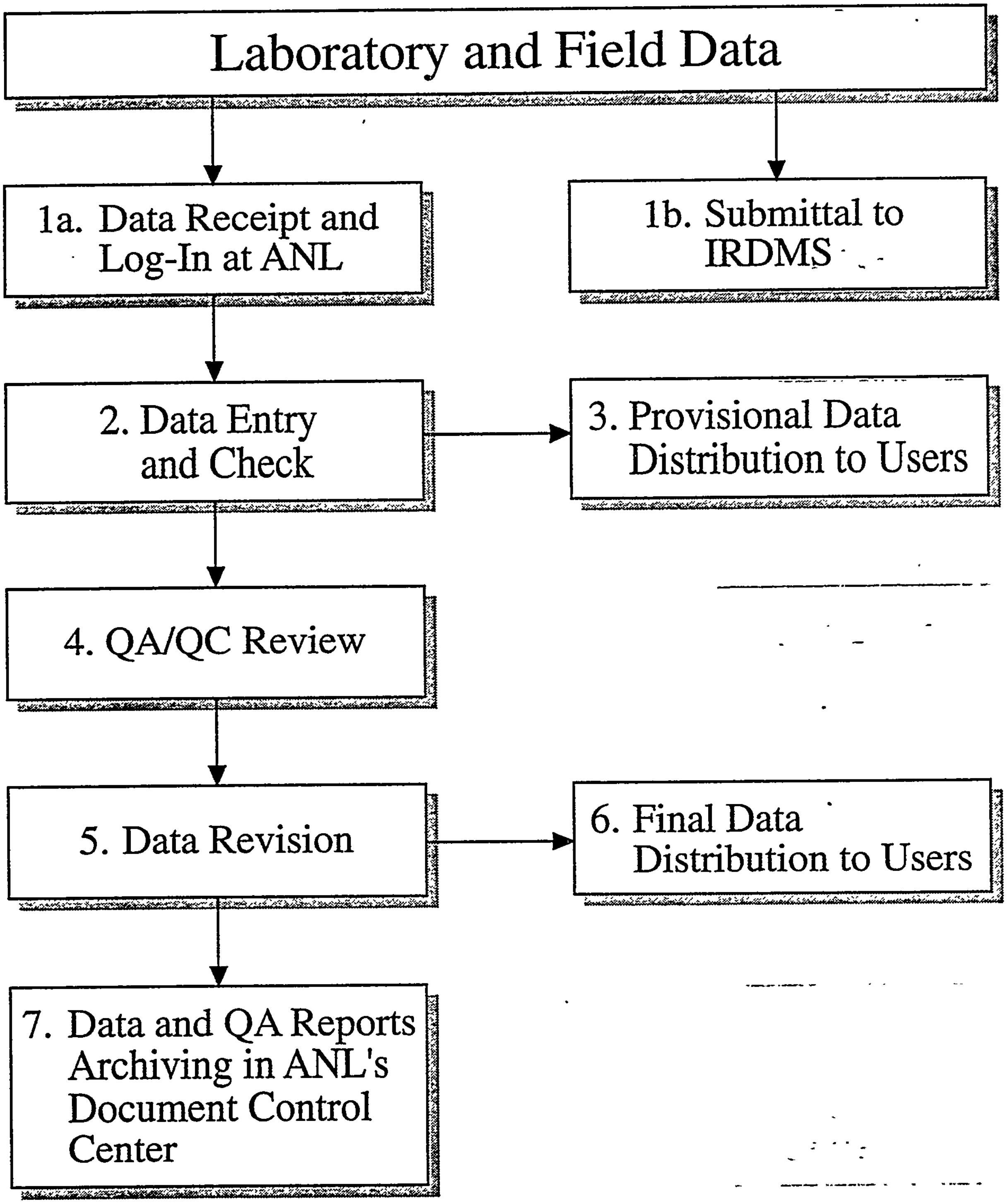

FIGURE 6.1 Overview of Data Flow in the J-Field RI Project

- Prepare provisional data summary tables for distribution, and
- Forward data package to QA/QC reviewers as designated by the QA officer.

3. Data (Provisional) Distribution by Data Manager
    - Distribute provisional data summary tables to all users, and
    - Record date of data distribution.
4. QA/QC Review by QA Officer (or Designee)
    - Check QC procedures and data,
    - Highlight errors and provide new flags based on review,
    - Prepare a report to file detailing results of review,
    - Forward corrected data tables to data manager for database update, and
    - Return data package to data manager for archiving.
5. Data Revision by Data Manager
    - Update database on the basis of corrections made by QA officer, and
    - Record date of data revision.
6. Data (Final) Distribution by Data Manager
    - Distribute final data summary tables to all users, and
    - Record date of data distribution.
7. Data and QA Reports Archiving by Data Manager
    - File hardcopy data in ANL's Document Control Center, and
    - Update and maintain index of hard copy data files.

All correspondence relating to data management (including issuance of hard copy data sets to DSHE and other contractors) will be handled by ANL's project data manager.

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8 LIST OF PREPARERS

This Field Sampling Plan was prepared for the U.S. Army Directorate of Safety, Health, and Environment by the Environmental Assessment Division of Argonne National Laboratory (ANL). The following ANL staff have contributed to the preparation of this sampling plan.

Name	Education/Experience	Contribution
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Paul Benioff	Ph.D., nuclear chemistry; 17 years experience in theoretical chemistry; 16 years experience in environmental assessment; lead author.	Section 2 Environmental Conditions at J-Field Section 3 Sampling Activities
Randall Biang	M.S., geology; 11 years experience in groundwater and hazardous waste investigations.	Section 2 Environmental Conditions at J-Field Section 3 Sampling Activities
David Dolak	M.S., environmental science; 10 years experience in environmental assessment including sample collection and laboratory analysis.	Section 3 Sampling Activities Section 5 Sampling Procedures and Equipment and Handling of Investigation-Derived Waste
Christopher Dunn	Ph.D., plant ecology; 13 years experience in ecological research and assessment.	Section 2 Environmental Conditions at J-Field
Terri Patton	M.S., geology; 6 years experience in radiochemical analysis; 5 years experience in environmental assessment.	Section 1 Introduction Section 2 Environmental Conditions at J-Field Section 3 Sampling Activities Section 6 Records Management
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Name	Education/Experience	Contribution
Cheong-Yip Yuen	Ph.D., geology (hydrogeology and environmental geology); 6 years experience in hydrogeological analysis; 12 years experience in process geomorphology.	Section 2 Environmental Conditions at J-Field Section 3 Sampling Activities

APPENDIX A:

J-FIELD-RELATED DOCUMENTS REVIEWED FOR THE FIELD SAMPLING PLAN

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J-FIELD-RELATED DOCUMENTS REVIEWED FOR THE FIELD SAMPLING PLAN

1. *Installation Assessment of Aberdeen Proving Ground — Records Evaluation Report No. 101,* Department of the Army, Chemical Demilitarization and Installation Restoration Program, Aberdeen, Md., Sept. 1976.

2. *Installation Assessment of Aberdeen Proving Ground — Aberdeen Area Report No. 301,* USATHAMA, Aberdeen, Md., Feb. 1981.

3. *Environmental Survey of the Edgewood Area of Aberdeen Proving Ground, Maryland,* USATHAMA, Aberdeen, Md., Jan. 1983.

4. *RCRA Facility Assessment, Edgewood Area, Aberdeen Proving Ground, MD,* Assessment No. 39-26-0490-90, U.S. Army Environmental Hygiene Agency, Waste Disposal Engineering Division, Nov. 1989.

   A report documenting historic activities related to solid waste management at the Edgewood Area of Aberdeen Proving Ground that may have resulted in the release of hazardous materials to the environment. Included are some data collected from previous investigations at J-Field and data collected during the RFA.

5. *Sampling and Analysis Plan for the Investigation of Ground-Water Contamination at J-Field, Aberdeen Proving Ground, Maryland,* Draft Report, U.S. Geological Survey, Reston, Va., 1991.

6. *Baseline Risk Assessment for Eight Selected Study Areas at Aberdeen Proving Ground, Draft Document - J-Field,* RI/FS Contract No. DAAA15-88-D-0009, USATHAMA, Aberdeen, Md., Jan. 1991.

   A draft report evaluating the potential impacts on human health and the environment associated with J-Field in the absence of remedial actions. Sampling data collected in 1988 and 1990 by the USGS were used for the evaluation.

7. *Hydrogeology and Soil-Gas Analyses at J-Field, Aberdeen Proving Ground, Maryland,* U.S. Geological Survey, Towson, Md., 1991.

   An interim report that presents the results of the USGS hydrogeologic investigation and soil-gas analyses at J-Field. The report includes information on exploratory boreholes drilled and observation wells installed by USGS, as well as descriptions of lithology, slug tests, water-level measurements, and marine-seismic reflection profiles.

8. *Phase II Workplan and Field Sampling Plan Update for the Remedial Investigation at J-Field, Aberdeen Proving Ground, Maryland,* U.S. Geological Survey, Towson, Md., 1991.

   A work plan defining the objectives of the continued hydrological assessment conducted by the USGS. The report includes information on the physical setting of J-Field and the results of the initial hydrogeologic investigation and soil-gas survey.

9. *Characterization and Interim Remediation of J-Field at Edgewood Area, Aberdeen Proving Ground, Maryland,* Draft Report, Contract No. DACA87-90-D-0031, Roy F. Weston, Baltimore, Md., Feb. 1992.

   A report describing a work plan for the characterization of chemical hazards associated with the burning pits, erosion control, and drum removal and disposal.

10. *Risk and Biological Impact Assessment at U.S. Army Aberdeen Proving Ground, Maryland,* Draft Document, Total Environmental Program Support Contract No. DAAA15-91-D-0014, ICF Kaiser Engineers, Fairfax, Va., March 1992.

    A report describing a work plan for conducting a risk and biological impact assessment at the Aberdeen Proving Ground.

11. Letter from W. Brian Hughes, USGS, to John Wrobel, DSHE, U.S. Army, June 19, 1992.

    A letter that compiles the results of all the environmental sampling conducted by the USGS at J-Field. The letter includes soil sampling data not previously reported.

APPENDIX B:

IDENTIFICATION OF AND SAMPLING PLAN FOR POTENTIAL AREAS OF CONCERN AT J-FIELD, ABERDEEN PROVING GROUND, MARYLAND

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IDENTIFICATION OF AND SAMPLING PLAN FOR POTENTIAL AREAS OF CONCERN AT J-FIELD, ABERDEEN PROVING GROUND, MARYLAND

B.1 INTRODUCTION

This appendix describes the methodology used to identify the potential areas of concern (PAOCs) at J-Field, documents the PAOCs on the basis of historical photograph analysis, and reports the results of the PAOC inspections performed April 12-15, 1994, and May 11, 1994. Sampling planned for these areas is also presented.

The methodology used to select the PAOCs is described in Section B.2. The PAOCs are documented and the site inspection results presented in Section B.3. The PAOCs are divided into three groups. One group contains sites that are not associated with the eight AOCs, the second group includes sites associated with the identified AOCs, and the third group includes all craters at J-Field. The PAOCs in the first group could become new AOCs in the future if sampling and analysis indicated contamination were present. The PAOCs in the second group will be incorporated into their corresponding AOCs for study in the Remedial Investigation. The third group, fieldwide craters, will be addressed in the Ecological Risk Assessment Work Plan.

B.2 METHODOLOGY FOR IDENTIFYING PAOCs

The PAOCs were designated on the basis of information from two sources: (1) the 1986 RFA (Nemeth 1989), which includes a review of archival information and personnel interviews; and (2) analysis of historical aerial photographs. The photographic analysis involved a brief review of aerial photographs dated 1951, 1957, 1960, 1970, and 1981 (Nemeth 1989) and a detailed analysis of aerial photographs dated 1965 and 1968 (U.S. Army 1965; USGS 1968). The identified PAOCs include areas that show man-made features (such as clearing areas, geometric patterns, and ground scarring), and structures (such as buildings, trenches, storage areas, and roads) on aerial photographs. Their locations are shown in Figure B.1.

The PAOCs identified were inspected in the field April 12-15, 1994, and May 11, 1994. Large-scale (approximately 1 in.:400 ft) aerial photographs from 1965 were used in the field. Features that may reflect previous human activities such as soil piles, metal, and other man-made debris; structure ruins; bomb craters; road tracks; and shallow depressions of regular shape were recorded. The condition of vegetation within and around a PAOC was also documented. On the basis of these features and aerial photographic interpretation, an attempt was made (when possible) to determine the nature of the past activities on each PAOC.

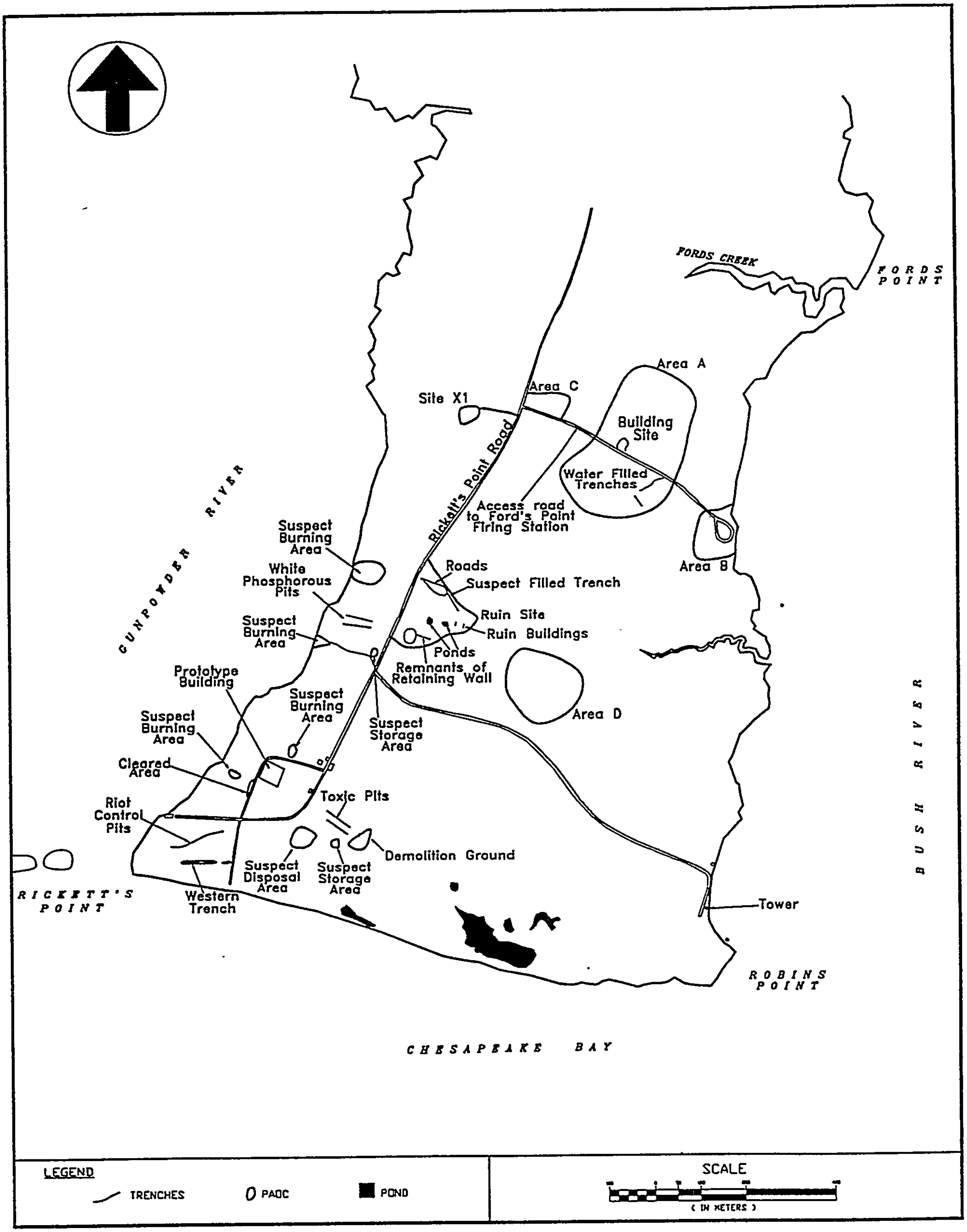

FIGURE B.1 Locations of PAOCs at J-Field

B.3 FIELD INSPECTION RESULTS

A total of 17 PAOCs have been inspected. They are Site X1, Areas A to D, two suspected storage areas associated with the Toxic Burning Pits (TBP) area and the White Phosphorous Burning Pits (WPP) area, four suspected burning areas (two near the WPP and two near the Prototype Building), one suspected filled trench (near the South Beach Trench area), one clearing near the southwest corner of the Prototype Building, one suspected disposal area (southwest of the TBP area), the craters of J-Field, one demolition area (southeast of the TBP area), and one ruins site (east of the WPP area). The locations and features of these PAOCs are shown in Figure B.1 and described in the following sections.

For discussion purposes the PAOCs are separated into three groups: those not associated with AOCs (Section B.3.1), those that are (Section B.3.2), and craters (Section B.3.3). Within each group, the PAOCs are described sequentially based on their locations, from north to south.

B.3.1 PAOCs Not Associated with AOCs

B.3.1.1 Site X1

Site X1 is in the northwestern part of J-Field, about 300 ft southwest of the intersection of Rickett's Point Road and the access road to the Ford's Point Firing Position. In 1965 aerial photographs, the site was a cleared area with a size of about 120 by 100 ft. An access road starting from Rickett's Point Road ended at the site. The access road bed is still discernable in the field today.

The site includes two ruins subsites about 100 ft apart. Collapsed concrete columns are present on the ground at each subsite. Both subsites are surrounded by a ridge of soil piles. The vegetation is much younger within the subsites than in the surrounding areas. A brick wall foundation is visible on the ground in the eastern subsite. A small drum emerges among a soil pile in the western ruin. No bomb craters are found near this site.

Three very shallow depressions with ponded water were identified. All are near the access road. The first shallow depression is about 100 ft from the entrance of the access road and is perpendicular to the road. The second and third depressions are parallel to the access road and are near the first one. Each depression seems to be rectangular and about 6 ft wide. They may represent filled trenches. Site X1 has been present since as early as 1951 (Nemeth 1989). Its use is not known.

B.3.1.2 Area A

Located in the northern part of J-Field, Area A is characterized by grids of linear features and two water-filled trenches, as they appeared on aerial photographs. The access road to the Ford's Point Firing Station dissects the central part of the site. When inspected in the field, the site was swampy. The grid pattern shown on aerial photographs is caused by grids of drainage commonly used to drain wetlands in this region.

One S-shaped trench and one straight trench are present within the drainage grid. The S-shaped trench is located immediately adjacent to the road and is separated from the straight trench by a dirt pile. Both trenches are about 6-7 ft wide. No scrap metal has been found nearby on the ground surface. The past use of the trenches is unclear.

About 400 ft west of the S-shaped trench is an old building site. A small shack appears there in 1965 aerial photographs. The ground now is scattered with a few glass bottles and ceramic sherds. Soil piles surround the site. A prominent, straight, long drainage about 3 ft wide extends from behind the site to the swamp north of J-Field. This drainage is readily noticeable in aerial photographs.

B.3.1.3 Area B (Ford's Point Firing Station)

Area B is a large open area at the eastern end of an access road in the northern part of J-Field and near the Bush River. It is also referred to Ford's Point Firing Station. Aerial photographs show that the site has existed since as early as 1951. The site is covered with reed grass (*Phragmites*). Concrete slabs are piled up near the shore of the Bush River, probably protecting the shore from erosion. Near the southern part of the site a pile of concrete chunks embedded with hollow pipes is present. Soil mounds are present near the western boundary of the site. Two small scrap drums were found on the ground surface near the soil mounds. The past use of the site is not known.

B.3.1.4 Area C

Area C is a ruin site near the entrance of the access road to Ford's Point Firing Station. Aerial photographs from 1965 show two buildings near the intersection of the access road and Rickett's Point Road, and a wall near the eastern part of the site. The buildings were destroyed before 1968, as indicated in later aerial photographs. In the field, remnants of a standing concrete wall and bricks are left on the ground surface. Bomb craters are visible near the site. The destroyed buildings probably were used for access control to the Ford's Point Firing Station, while the concrete wall in the eastern part of the site was probably a test site for bombing structures.

B.3.1.5 Ruins Site Across Road from WPP

A ruins site located across Rickett's Point Road from the WPP includes two building ruins, two connected artificial ponds, four retaining wall structures, and a suspected filled trench. These features are discernable in the 1965 aerial photographs. The western part of the site, where the two building ruins are located, was flooded when the site was inspected.

The site was used for munitions testing in World War II. Bomb craters are common, especially near the four retaining wall structures. Probably due to bombing, only remnants of buttressed columns and partially destroyed steel-reinforced walls remain in the field. No visible metal scrap has been found on the ground surface. The ruin buildings are in the eastern part of the site. One is a steel-reinforced concrete building, and the other is a steel-reinforced brick building. Circular-shaped scars are common on the building's outside walls. Two small ponds connected by a ditch are near the southern part of the site. One of the ponds is rectangular in shape, the other is irregularly shaped. The past use of the ponds is not known.

A suspected filled trench, about 7-8 ft wide, was identified in an area about 80 ft southeast of the ruin buildings. It is partially ponded with water. The suspected filled trench extends southeast for more than 100 ft. Traces of road bed are discernable near its end. The roads connect to Rickett's Point Road. A steel tube with a cylinder built inside was found next to a pile of soil between the filled trench and the two building ruins. The past use of the trench is not clear.

A dark-toned area appears in the southwestern part of the site in the 1965 aerial photographs. This area was inspected in the field and was found to be flat and covered with vegetation that is younger than in the surrounding area. No scrap metal was found on the ground surface. The previous use of this area is unknown.

B.3.1.6 Area D

Area D, located about 400 ft east of the ruins site, is a flooded swamp area. The area has a dark tone in aerial photographs and is dotted with many craters. No road extends to this site. The site probably was used for targeting.

B.3.2 PAOCs Associated with AOCs

B.3.2.1 Storage Area of WPP

The suspected storage area, about 30 by 20 ft, is in the southeastern corner of the WPP AOC and about 40 ft west of Rickett's Point Road. Some materials are shown on the ground surface in the 1965 aerial photographs. The storage area was observed in the field to be surrounded by piles of soil.

B.3.2.2 Suspected Burning Area near Northwestern Corner of WPP

This site is in the northwestern corner of the WPP AOC and is covered with reed grass. The 1965 aerial photographs show three suspected burning areas clustered together on this site. Each area was circular in shape, with a diameter about 30 ft, and appeared as a dark-toned area in the aerial photographs. Mounds of soil were observed in the field to be piled near its northern boundary. A few pieces of scrap metal were scattered nearby. The specific past use of the site is not known.

B.3.2.3 Suspected Burning Area near Southwestern Corner of WPP

This area appeared as a demolition area in aerial photographs. By the shore of Gunpowder River and at the southwestern corner of the WPP AOC, the area is covered by abundant shells of small arms, grenade caps, 50-caliber shells, and melted glass. Away from the shore, most of the area is covered by reeds (*Phragmites*). Judging from field observations, this site likely was used for small ammunition demolition.

B.3.2.4 Suspected Burning Area near Northeastern Corner of Prototype Building

This area appeared in the 1965 aerial photographs as an oval-shaped clearing with three small structures in its western portion. The area is covered with grasses today. The three structures probably were grills. Only one of them, with a size of 3 by 3 ft, is still in the field. Pieces of silver-like melted metals and charcoals are still visible in the grill. The original clearing area is free from metallic objects. The previous use of the site is unknown.

B.3.2.5 Clearing near Southwestern Corner of Prototype Building

This area was shown as a clearing in aerial photographs as early as 1951. No scrap metal was found near the site when it was inspected. There is no evidence to suggest that management or disposal of wastes was carried out at this site.

B.3.2.6 Suspected Burning Area near Southwestern Portion of Prototype Building

The area appears as a demolition ground in aerial photographs. The site is about 200 ft west of the Prototype Building and near the edge of the woods. Its southern boundary is marked by piles of soil, and its northern boundary is marked by tall reeds and shallow ponded water. Very few trees grow on the site. A rusty empty drum and a belt-shaped piece of scrap metal were found on the ground surface.

B.3.2.7 Western Trench of South Beach Trench Area

This suspected trench is filled, and it is located about 40 ft west of the current South Beach Trench. In aerial photographs, the western trench is oriented east-west and extends more than 300 ft. Some waste was observed in its central and eastern portions. The central portion of the trench was once accessible by a road from the south. The filled trench is still discernable in the field. Small drums and cans are scattered in the woods nearby.

B.3.2.8 Storage Area of TBP Area

Located near the southeastern corner of the TBP area and by the edge of the woods, the storage area is a fenced area about 30 by 30 ft. In the 1965 aerial photographs, drums were shown being unloaded from a truck and moved through a track to the storage area. This area probably was used for temporary storage before wastes were disposed in the TBP area.

B.3.2.9 Suspected Disposal Area near Southwestern Portion of TBP Area

Located in the southwestern portion of the TBP area, this site is shown cleared of nearly all vegetation in late 1950s aerial photographs. In 1965 aerial photographs, soil in the western part of the site is pushed out to the south into the marsh. In the field, the site is covered with reed grass with a few old trees. Near its northern edge, a square pit, about 4 by 4 ft and made of steel, emerges from the ground. The pit is filled with sand. No scrap metals, except for a barbed wire next to an old tree, were seen on the ground surface. The specific use of the site is unknown.

B.3.2.10 Demolition Area near Southeastern Portion of TBP Area

Documented in the RFA (Nemeth 1989), this site was used for demolition of high-explosive munitions. The site was active in as early as 1965, as seen in aerial photographs. Piles of scrap metals and soils are common on the ground near the site, especially near the marsh.

B.3.3 Craters

Numerous craters are distributed across J-Field. The craters are visible in large-scale historical aerial photographs and in the field. Many of these craters fill with water in the spring.

B.4 SAMPLING PLAN FOR POTENTIAL AREAS OF CONCERN

B.4.1 Site X1

B.4.1.1 Target Areas

Two building ruins and three potential filled trenches are the target areas on the site.

B.4.1.2 Existing Data

No soil or groundwater data are available for this site.

B.4.1.3 Data Evaluation and Data Gap

The use of this site is not known. There is a need to know whether the soil near building ruins is contaminated and to confirm if the suspected filled trenches exist.

B.4.1.4 Proposed Sampling Plan

The target areas will be screened for metals by a portable XRF unit in the field, upon the issuance of a radiation permit from the U.S. Army. The surface soil in the identified hot spots will be sampled.

Six surface soil samples (0-6 in.) will be collected from the hot spots to be identified and from other areas at the building ruins.

The suspected trenches will be explored by magnetic, GPR, and EM surveys. If a trench is confirmed, boring soil samples will be collected for that trench. The chemical parameters to be analyzed depend on the geophysics data. Potential analytes include TAL metals and TCL VOCs. If no trench is found, two surface samples will be collected for each suspected area. The surface samples will be analyzed for TAL metals.

B.4.1.5 Objectives of the Sampling Plan

The objectives of the sampling plan are (1) to determine if the soil near the building ruins is contaminated or not, (2) to confirm if the suspected trenches exist, and (3) to determine if the trenches (if they exist) are contaminated.

B.4.1.6 Selection of the Chemical Parameters and Rationale

Metals are common contaminants at J-Field, and they are relatively immobile. If an area is contaminated, metal contaminants are likely to be detected in surface soil.

B.4.2 Area A

B.4.2.1 Target Areas

One S-shaped trench and one straight trench filled with water are the target areas.

B.4.2.2 Existing Data

No data was collected in Area A.

B.4.2.3 Data Evaluation and Data Gap

The installation of drainage grids like those in Area A is a common practice. The drainage grids are not likely to be contaminated; however, the past use of the two trenches is unknown. One possible use was for the decontamination of vehicles used in the Ford's Point Firing Station. It is uncertain whether the trenches are contaminated.

B.4.2.4 Proposed Sampling Plan

Three sediment samples will be collected from each trench. The samples will be analyzed for metals and VOCs. If contamination is found, additional sediment samples will be collected for the analysis for more chemical parameters.

B.4.2.5 Objective of the Sampling Plan

The objective is to test if the trenches are contaminated.

B.4.2.6 Selection of the Chemical Parameters and Rationale

Metals are common contaminants at J-Field, while VOCs include common chemicals for decontamination. Both are likely to be absorbed onto the organics in sediments.

B.4.3 Area B (Ford's Point Firing Station)

B.4.3.1 Target Area

The entire Area B is the target area.

B.4.3.2 Existing Data

There is no existing data collected in Area B.

B.4.3.3 Data Evaluation and Data Gap

The area probably was used for a firing position. Information on other uses of the site is not available. As concrete chunks and soil mounds are present on the site, potential contamination is possible.

B.4.3.4 Proposed Sampling Plan

The target area will be screened for metals by a portable XRF unit in the field, upon the issuance of a radiation permit from the U.S. Army. The surface soil in the identified hot spots will be sampled.

A total of ten surface soil samples (0-6 in.) will be collected from the hot spots to be identified and from other areas at the site. The locations of the samples will be chosen near the soil mounds, concrete chunks, and other areas within the site. The samples will be analyzed for TAL metals. If contamination is found, additional samples will be collected to characterize the nature and extent of the contamination.

B.4.3.5 Objective of the Sampling Plan

The objective of the sampling plan is to collect exploratory samples to determine if the site is contaminated.

B.4.3.6 Selection of Chemical Parameters and Rationale

Metals are the most widespread and common contaminants at J-Field. If the site is contaminated, the presence of metal contaminants is likely.

B.4.4 Area C

B.4.4.1 Target Areas

The building ruins and bomb craters are the target areas of the site.

B.4.4.2 Existing Data

No environmental data have been collected on Area C.

B.4.4.3 Data Evaluation and Data Gap

The buildings probably were used for access control to the Ford's Point Firing Station and are not likely to be contaminated. The bomb craters will be addressed in the Ecological Risk Assessment Work Plan.

B.4.4.4 Proposed Sampling Plan

Four surface soil samples will be collected near the building ruins.

B.4.4.5 Objective of the Sampling Plan

The objective of the sampling plan is to verify that the building ruins are not contaminated.

B.4.4.6 Selection of the Chemical Parameters and Rationale

Heavy metals are the most common contaminants at J-Field. If the site is contaminated, the presence of heavy metals is likely.

B.4.5 Ruins Site Across the Road From WPP

B.4.5.1 Target Areas

The target areas of this site include two ponds, two building ruins, one suspected filled trench, and an area in the southwestern part of the site.

B.4.5.2 Existing Data

Ten locations within the two ponds were selected when the ponds were dry for XRF analysis for metals. Slightly elevated levels of zinc, copper, and lead were found in some samples. About five soil gas samples were collected near the suspect trench, and no volatile contaminants were found. Data for the other parts of the site are not available.

B.4.5.3 Data Evaluation and Data Gap

Based on the XRF data, the ponds are slightly contaminated. However, surface soils from the building ruins, the suspected trench, and the area in the southwestern part of the site need to be sampled.

B.4.5.4 Proposed Sampling Plan

The target areas will be screened for metals by a portable XRF unit, upon the issuance of a radiation permit from the U.S. Army. The surface soil in the identified hot spots will be sampled.

Six surface soil samples (0-6 in.) will be collected from each of the two building ruins and the area in the southwestern part of the site. Eight sediment samples will be collected from the bottom (0-6 in.) of the ponds. The surface soil and the sediment samples will be analyzed for TAL metals. Exploratory EM, GPR, and magnetic surveys will be conducted near the suspected trench. If the trench is not confirmed (the trench may be a road bed), no samples will be collected in that area.

B.4.5.5 Objectives of the Sampling Plan

The objectives of the sampling plan are (1) to determine if there is any contamination in the ponds, the southwestern part of the site, and the ruin buildings; and (2) to determine if the suspected trench exists.

B.4.5.6 Selection of the Chemical Parameters and Rationale

Metals are the most widespread and common contaminants at J-Field. If the site is contaminated, the presence of metal contaminants is likely. Explosives are not included because they have probably degraded. The site has been abandoned for more than 30 years.

B.4.6 Area D

B.4.6.1 Target Areas

The bomb craters are the target areas of this site.

B.4.6.2 Existing Data

No data have been collected.

B.4.6.3 Data Evaluation and Data Gap

The site probably was used as a bomb testing area. It is unknown whether the craters are contaminated.

B.4.6.4 Proposed Sampling Plan

There is no sampling plan for this site. However, the craters in the site will be sampled as part of the fieldwide crater study (see Ecological Risk Assessment Work Plan).

B.4.6.5 Objective of the Sampling Plan

The objective of the fieldwide crater study is to explore whether the craters are contaminated.

B.4.6.6 Selection of the Chemical Parameters and Rationale

Because there is no sampling plan for this site, a selection of chemical parameters is not applicable.

B.4.7 Craters

B.4.7.1 Target Areas

The target areas include all bomb craters at J-Field.

B.4.7.2 Existing Data

Limited data on the possibility of contamination near the bomb craters are available.

B.4.7.3 Data Evaluation and Data Gap

As there are numerous bomb craters at J-Field, it would be reasonable to include all craters in a PAOC for study. The impact of the craters on the environment is not known.

B.4.7.4 Proposed Sampling Plan

Thirty sediment samples will be collected from the bottom (0-6 in.) of 30 randomly chosen bomb craters for the analysis for TAL metals. The design of the sampling will be detailed in the Ecological Risk Assessment Work Plan.

B.4.7.5 Objective of the Sampling Plan

The objective is to explore whether the craters have been contaminated.

B.4.7.6 Selection of the Chemical Parameters and Rationale

Heavy metals are the most common contaminants at J-Field. If the craters are contaminated, the presence of heavy metals is likely. Explosives are not included because they have probably degraded.

B.5 REFERENCES

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