White Phosphorus Pits

Focused Feasibility Study

Final

August 2007

Distribution Restriction
Statement Approved For Public Release
Distribution is Unlimited
 # 6809-B-6

U.S. Army Garrison
Aberdeen Proving Ground, Maryland

Final

Focused Feasibility Study for the White Phosphorus Pits, Aberdeen Proving Ground, Maryland

Prepared by B. Davies and L. Martino

Environmental Science Division
Argonne National Laboratory, 9700 South Cass Avenue, Argonne, Illinois 60439

August 2007

Work sponsored by the U.S. Army Garrison, Aberdeen Proving Ground, Maryland

CONTENTS

CONTENTS (CONT.)

CONTENTS (CONT.)

CONTENTS (CONT.)

FIGURES

FIGURES (CONT.)

FIGURES (CONT.)

TABLES

TABLES (CONT.)

TABLES (CONT.)

NOTATION

The following is a list of abbreviations and acronyms, chemicals, and units of measure used in this document. Some acronyms used only in tables are defined in the respective tables.

ABBREVIATIONS AND ACRONYMS

ADD	applied daily dose
AEC	U.S. Army Environmental Center
ANL	Argonne National Laboratory
AOC	area of concern
APG	Aberdeen Proving Ground
ARAR	applicable relevant and appropriate requirement
ASTM	American Society for Testing and Materials
AVS	acid-volatile sulfide
AWQC	ambient water quality criteria
BAF	bioaccumulation factor
BERA	baseline ecological risk assessment
BGS	below ground surface
BTAG	Biological Technical Assistance Group (EPA Region III)
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	*Code of Federal Regulations*
CLP	Contract Laboratory Program
COPC	contaminant of potential concern
COPEC	contaminant of potential ecological concern
CSM	chemical surety material
CWA	chemical warfare agent
DOD	U.S. Department of Defense
DSHE	Directorate of Safety, Health & Environment
EA	EA Engineering Science and Technology, Inc.
EPA	U.S. Environmental Protection Agency
ERA	ecological risk assessment
ERL	Effects Range-Low
ERT	environmental response team
FETAX	frog embryo teratogenesis assay-Xenopus
FFA	Federal Facility Agreement
FFS	focused feasibility study
FS	feasibility study
FSP	Field Sampling Plan

GC	gas chromatography
GIS	geographic information system
GWSE	groundwater surface elevation
HHRA	human health risk assessment
HI	hazard index
HQ	hazard quotient
IMP	Installation Management Plan
LUC	land-use control
LUCIP	Land Use Control Implementation Plan
MDE	Maryland Department of the Environment
MDL	method detection limit
MRM	Military Range Maintenance
MSL	mean sea level
NCP	National Contingency Plan
ND	not detected
NOAA	National Oceanic and Atmospheric Administration
OE	ordnance and explosives
O&M	operation and maintenance
OSHA	Occupational Safety and Health Administration
PAOC	potential area of concern
PCOEC	potential contaminant of ecological concern
QAPP	Quality Assurance Project Plan
RACER	Remedial Action Cost Engineering and Requirement System
RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RfC	reference concentration
RfD	reference dose
RI	remedial investigation
ROD	record of decision
RPD	relative percent difference
SEM	simultaneously extracted metals
SEV	screening ecotoxicity value
SF	slope factor

TAL	Target Analyte List
TBCs	to be considered requirements
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TEU	Technical Escort Unit
UCL	upper confidence limit
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
UXO	unexploded ordnance
WPP	White Phosphorus Burning Pits
XRF	X-ray fluorescence

CHEMICAL SYMBOLS AND ABBREVIATIONS

As	arsenic
BHC	lindane
BNA	base-neutral and acid-extractable organic compound
Cd	cadmium
CO_2	carbon dioxide
Cr	chromium
Cu	copper
DBT	di-n-butylphthalate
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DM	adamsite (phenylarsazine chloride)
GB	sarin (nerve agent), isopropylmethylphoshponofluoridate
GD	soman (nerve agent), pinacolylmethylphosphonofluoridate
HD	mustard
Hg	mercury
HMX	cyclotetramethylene tetranitrate
PAH	polynuclear aromatic hydrocarbon
Pb	lead
PCB	polychlorinated biphenyl
PCE	tetrachloroethene

RDX	hexahydro-1,3,5-trinitro-1,3,4-triazine
Sb	antimony
SVOC	semivolatile organic compound
TCE	trichloroethene
TOC	total organic carbon
TOX	total organic halides
VOC	volatile organic compound
VX	O-ethyl S-(2-diisopropylaminoethyl) methylphosphonothioate
WP	white phosphorus
Zn	zinc

UNITS OF MEASURE

°C	degree(s) Celsius
cm	centimeter(s)
d	day(s)
dL	deciliter(s)
°F	degree(s) Fahrenheit
ft	foot (feet)
ft^2	square foot (feet)
gal	gallon(s)
ha	hectare(s)
in.	inch(es)
kg	kilogram(s)
L	liter(s)
lb	pound(s)
m	meter(s)
m^2	square meter(s)
m^3	cubic meter(s)
µg	microgram(s)
mg	milligram(s)
mi	mile(s)
min	minute(s)
ng	nanogram(s)
pCi	picocurie(s)
ppm	part(s) per million

1 INTRODUCTION

1.1 BACKGROUND

The White Phosphorus Burning Pits (WPP) Area of Concern (AOC) is a site of about 5.5 acres (2.2 ha) located in the J-Field Study Area, in the Edgewood Area of Aberdeen Proving Ground (APG), Maryland (Figure 1.1). Considerable information about the WPP exists as a result of efforts to characterize the hazards associated with J-Field. Contamination in the J-Field Study Area was first detected during an environmental survey of the APG Edgewood Area conducted in 1977 and 1978 (Nemeth et al. 1983) by the U.S. Army Toxic and Hazardous Materials Agency (USATHAMA; predecessor to the U.S. Army Environmental Center). As part of a subsequent USATHAMA environmental survey, 11 wells were installed and sampled at J-Field (three of them at the WPP) (Nemeth 1989). Contamination was also detected in 1983 during a munitions disposal survey conducted by Princeton Aqua Science (1984). The Princeton Aqua Science investigation involved installing and sampling nine wells (four at the WPP) and collecting and analyzing surficial and deep composite soil samples (including samples from the WPP area). In 1986, the U.S. Environmental Protection Agency (EPA) issued a Resource Conservation and Recovery Act (RCRA) Permit (MD3-21-002-1355) requiring a post-wide RCRA Facility Assessment (RFA) and a hydrogeologic assessment of J-Field. In 1987, the U.S. Geological Survey (USGS) began a two-phase hydrogeologic assessment in which data were collected to model groundwater flow at J-Field. Soil-gas investigations were conducted, several well clusters were installed (four at the WPP), a groundwater flow model was developed, and groundwater and surface water monitoring programs were established that continue today. The results of the USGS study were published by Hughes (1993).

While APG was investigating J-Field as part of a RCRA Corrective Action, the Edgewood Area was added to the National Priorities List on February 21, 1990. Because of that listing, a Remedial Investigation/Feasibility Study (RI/FS) was required for the entire Edgewood Area pursuant to Modification 2 of the RCRA Permit and a March 1990 Federal Facility Agreement (FFA) between EPA Region III and the U.S. Department of the Army. Pursuant to the FFA, 15 areas at J-Field, including eight previously identified AOCs and seven potential areas of concern (PAOCs) outside the AOCs, have been investigated. The J-Field AOCs and PAOCs are shown in Figure 1.2.

A number of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)-related activities were performed to address the issues associated with these AOCs and PAOCs, including the inactive portions of the WPP AOC at J-Field (Benioff et al. 1995a,b; Hlohowskyj et al. 2000; Yuen et al. 1999; Weston 2001a). A number of CERLCA decision documents have been signed to address remedial actions in the J-Field Study Area. Previous removal and remedial actions have been implemented to address the J-Field Soil Operable Unit. Remedial actions under the most recent Record of Decision address the surficial aquifer, the confined aquifer at the former Toxic Burning Pits AOC, and remaining soil areas except for limited areas that remain active in the J-Field Study Area, which, at the time, included portions of the WPP and the Robins Point Demolition Ground (*J-Field Study Area Record of Decision, Final Remedial Action* [APG 2001]).

Until 2001, the WPP AOC was considered an active emergency disposal facility that was used periodically for disposal of ordnance and explosives (OE) by open detonation. Since the early 1980s, APG has coordinated with environmental regulators and received permission for use of the site on a case-by-case basis. The existing pits and areas potentially affected by emergency disposal operations were excluded from complete evaluation in the RI/FS (Yuen et al. 1999; Hlohowskyj et al. 2000). Investigation of these areas was largely deferred until the Army discontinued use of the WPP. The RI/FS focused mainly on the suspected storage area and the southwestern and northwestern corners of the AOC. However, some chemical, toxicological, and ecological data were collected from surface soil near the pits, from the Southern Pit, and from the ditch and impoundment associated with the Northern Pit. On the basis of the analysis of those data, an ecological risk assessment (ERA) for the WPP AOC was developed and included in the J-Field ERA (Hlohowskyj et al. 2000), and a human health risk assessment (HHRA) was performed (Ripplinger et al. 1998).

Now that the WPP AOC is closed to emergency disposal operations, the Directorate of Safety, Health and Environment (DSHE) elected to complete the RI/FS for the WPP AOC. Additional sampling activities were conducted at the WPP during 2004 and 2005 to complete the contamination assessment. An updated ERA was also completed at the WPP AOC. The results of these activities are reported in the final RI/ERA report (Martino et al. 2006). An HHRA utilizing the 2004/2005 investigation data was prepared by EA Engineering, Science and Technology, Inc., and finalized in March 2006 (EA 2006).

The RI performed in 2004/2005 utilized the historical site data to focus on areas of the site previously exhibiting elevated contaminant concentrations and areas not previously investigated. Samples were collected from site soil, groundwater, surface water, and sediment. The sample results were evaluated in the ERA and HHRA reports (Martino et al. 2006 and EA 2006). The ERA concludes that contaminant concentrations at the WPP AOC are unlikely to affect the ecological sustainability of any of the species utilizing the habitats at the AOC. This conclusion is based on the fact that the WPP AOC encompasses a small area within J-Field, and only a small portion of that area is likely to contain contaminants at levels that may elicit effects on ecological receptors. The HHRA evaluated current-use scenarios for site workers and adolescent trespassers and likely future use by commercial and construction workers. The HHRA also evaluated the future site use as residential. Of the likely (i.e., all but the residential-use scenario) current and future-use scenarios, no unacceptable carcinogenic and non-carcinogenic risks were modeled. The only scenario with modeled risks in excess of the 1×10^{-6} cancer risk (but still within the acceptable range of 10^{-4} to 10^{-6}) were to future commercial workers for arsenic in soil and tricloroethene (TCE) in groundwater. The primary risk drivers for potential future residential use by adults were found to be TCE and iron in groundwater. The primary risk drivers for children in a residential use scenario were found to be lead in near-surface soils and iron, TCE, and perchlorate in groundwater.

1.2 PURPOSE AND NEED FOR DECISION

The purpose of this focused feasibility study (FFS) is to evaluate remedial options for addressing contamination at the WPP AOC. Although complete soil and groundwater exposure pathways are not likely to exist under current conditions, DSHE has requested that Argonne National Laboratory evaluate the potential remedial options available to reduce the likelihood of exposure under future hypothetical use of the site.

The overall objective of the FFS is to identify long-term environmental actions to reduce the potential for future risks to human health and the environment posed by contamination at the WPP site. The results of the HHRA indicate that groundwater does pose some risk to potential future commercial workers and/or residential users largely because of elevated concentrations of TCE found in a small area of the site. The main TCE exposure pathways were inhalation and ingestion. However, the EPA has stated in its comments on the draft HHRA, "… there is no plume that would require remediation" (EA 2006). Therefore, this FFS does not address active groundwater remediation at the WPP AOC. The authors of the FFS do recognize that if land use were to change at the WPP AOC, it may be necessary to formulate groundwater use restrictions for the site.

The HHRA focused on current-use receptors, including site workers and adolescent trespassers. While future use of the site is unknown, it is located on an active military post that could be utilized at any time. Therefore, the HHRA also focused on the most likely future-use receptors being commercial and construction workers. Assessment of the soil, sediment, and surface water sample results did not indicate any unacceptable risk posed to receptors by these media. The HHRA also addressed the future-use scenario of the site becoming residential. This residential-use scenario is deemed to be unlikely given J-Field's location on an active range and previous history as a disposal site. Under this scenario, site surface soils could pose an unacceptable risk to children for lead. Although humans are not adversely impacted by site contaminants at this time, the purpose of APG's remedial action program is to preclude the potential for such impacts in the future by implementing long-term environmental restoration decisions. One such decision involves determining whether the potential for impacts from exposure to surface soil warrants remediation of contaminated soil not otherwise threatening human health.

1.3 ORGANIZATION OF THE REPORT

This FFS has been prepared to provide sufficient information to support a decision regarding an appropriate remedy to address contamination in the surface soil at the WPP AOC. The report is organized as follows:

- Chapter 1 presents an introduction, including a brief background of environmental studies conducted at the site and the purpose and organization of the FFS report.

- Chapter 2 details the site background, including its history, environmental setting, nature and extent of contamination, and the results of the human health and ecological risk evaluations, which take into account the conceptual site models and identify contaminants of potential concern.

- Chapter 3 identifies the remedial action objectives, including preliminary cleanup levels and the area of attainment; it also provides a discussion of applicable or relevant and appropriate requirements (ARARs) and to-be-considered requirements (TBCs).

- Chapter 4 describes the identification and screening of alternatives for addressing contaminated surface soil.

- Chapter 5 presents an initial evaluation of possible surface soil remedial alternatives, including their effectiveness, implementability, and estimated cost.

- Chapter 6 describes the selected final remedial alternatives for surface soil and provides a detailed evaluation of these alternatives.

- Chapter 7 presents a comparative analysis of the surface soil alternatives.

- Chapter 8 lists the references cited in Chapters 1 through 7 of the report.

Figures and tables, numbered according to chapter, are provided in two separate sections following the text. Supporting information is provided in Appendices A and B. Appendix A is a table summarizing preliminary identification of ARARs and TBCs for the remediation activities at the WPP AOC. Appendix B describes the methodology used to estimate costs associated with each remedial alternative (presented in the detailed analyses in Chapters 5 and 6). Costs presented for all alternatives were estimated by using the Remedial Action Cost Engineering and Requirement System (RACER) (Earth Tech 2007).

2 SITE BACKGROUND

2.1 SITE DESCRIPTION

The WPP AOC is a 5.5-acre (2.2-ha) site located in the J-Field Study Area, Aberdeen Proving Ground, Maryland. J-Field occupies approximately 460 acres (186.2 ha) on the southern tip of the Gunpowder Neck Peninsula and is bordered by tidal estuaries on three sides — the Gunpowder River to the west, the Chesapeake Bay to the south, and the Bush River to the east (Figure 1.2). The WPP is nearly flat, with a maximum relief of about 8 ft (2.4 m), and contains a mixture of freshwater marshes, forest, and an open managed grassy area.

The WPP AOC consists of a large grassy area measuring about 540 by 440 ft (164.6 by 134.1 m). The grassy area is north and west of Rickett's Point Road inside of the treeline shown in Figure 2.1. The grassy area is bordered to the north, south, and east by stands of tulip poplar trees or mixed deciduous hardwoods and some forested wetlands dominated by sweetgum and red maple, with willow oak, black gum, swamp chestnut oak, and sycamore frequently dominating wetter sites.

The most prominent surface features at the WPP AOC are two large trenches or pits that are referred to here as the "Northern Pit" and the "Southern Pit." The two pits are oriented roughly east/west (Figure 2.1). Currently, the Northern Pit is approximately 150 ft (45.7 m) long and the Southern Pit is approximately 225 ft (68.6 m) long. A ditch from the Northern Pit extends north toward a bermed depression constructed to hold any surface water runoff. The Southern Pit ends to the west at what is assumed to be a "pushout area" where material previously was pushed out of the pit. During wet weather, water collects in the pits and the bermed depression, even though surface runoff does not enter the pits.

The Gunpowder River borders the site to the west. Since the area around the WPP began being used for military testing and waste handling, wave erosion has caused the loss of substantial portions of the shoreline. However, since the mid-1990s, shoreline loss has been curtailed with the construction of a shoreline stabilization system.

2.2 ENVIRONMENTAL SETTING

2.2.1 Climate

The climate in the area of APG is temperate and moderately humid and is moderated by the presence of the Chesapeake Bay. The average annual precipitation of 45 in. (114.3 cm) is distributed relatively uniformly during the year. The average annual temperature is about 54°F (12.2°C).

2.2.2 Geology

J-Field is in the Atlantic Coastal Plain physiographic province. The stratigraphy of J-Field consists of the Talbot Formation and Quaternary/Pleistocene sediments of fluvial, estuarine, and marine origin, underlain by Cretaceous sediments of fluvial origin. The Talbot Formation, consisting of interbedded sands, gravels, and silty clays, covers the entire J-Field area and varies in thickness from 40 to 160 ft (12.2 to 48.8 m) (Hughes 1993). The underlying Cretaceous deposits, referred to collectively as the Potomac Group, can be subdivided into three formations, listed here in ascending order: Patuxent, Arundel, and Patapsco (Clark 1910; Brenner 1963; Hansen 1968; Glaser 1969; Crowley et al. 1976), as referenced in Powars (1997). The Cretaceous deposits in the J-Field area consist of interbedded fine-grained quartz sand and massive clay. In the vicinity of the WPP, the Cretaceous deposits can be found at a depth of approximately 100 ft (30.5 m) below ground surface. In the eastern portion of the J-Field site, the Cretaceous deposits are found at depths of 160 ft (48.8 m) below ground surface. The pattern of the erosion of the Cretaceous deposits and the fact that Talbot Formation fluvial and estuarine deposits overlay the Cretaceous deposits indicate that a major stream system, such as an ancestral Susquehanna River, once existed in the J-Field area (Hughes 1993; Powars 1997).

The majority of the WPP site is underlain by Sassafras loam, a deep, well-drained soil formed in old marine sediments containing moderate amounts of silt and clay. The upper 2 to 3 ft (0.6 to 0.9 m) of the subsoil is a light brown, sandy clay loam that is slightly sticky when wet. The lower subsoil is a dark-brown, loose, loamy sand. The soil is moderately permeable, with a medium to high available water capacity. The soil is susceptible to erosion along steep grades.

Elkton silt loam is the dominant hydric soil throughout much of the center of J-Field and can also be found at the WPP site. Elkton silt loam is a deep, poorly drained, level soil formed in old deposits of clayey marine sediment. The surface horizon consists of a dark gray-brown silt loam about 7 in. (17.8 cm) thick. The subsoil, which ranges between 34 and 60 in. (86.4 and 152.4 cm) thick, is a gray, silty clay with yellow-brown mottles. The soil is very sticky and plastic when wet (USDA 1927, 1975).

2.2.3 Surface Water

Surface water is typically present in the bermed depression that receives drainage from the Northern Pit. In addition, woodland marshes exist north and south of the open field area at the WPP. The estuarine reach of the Gunpowder River is located along the western side of the WPP. Ephemeral surface water can also be found in relict detonation craters and other depressions at the WPP.

2.2.4 Groundwater

The four major hydrostratigraphic units that occur at J-Field are classified, in descending order, as (1) the surficial aquifer, (2) the leaky confining unit, (3) a first confined aquifer, and (4) a semiconfined to confined aquifer unit (referred to hereafter as the Potomac Group aquifer).

The upper three units exist in the Pleistocene sediments of the Talbot Formation. The lower unit is in the Cretaceous sediments of the Patapsco Formation (Hughes 1993).

2.2.4.1 Surficial Aquifer

The surficial aquifer has been extensively investigated at the nearby TBP AOC, and similar conditions likely exist in the surficial aquifer at the WPP AOC. The surficial aquifer at the TBP AOC consists of low-permeability fine sand and clayey silt that are highly variable in texture and clay content. Borehole geophysics, including gamma and electrical resistivity logs, reveal that silty clay lenses exist throughout the surficial aquifer (Weston 2001b).

Hydraulic conductivity was measured in several wells at the WPP by Hughes (1993). The measured values of horizontal hydraulic conductivity in the surficial aquifer ranged from 0.29 to 0.69 ft/d (0.09 to 0.2 m/d) (Table 2.1).

2.2.4.2 Leaky Confining Unit

The leaky confining unit consists of silty, sandy clay and organic matter. The unit is approximately 40 ft (12.2 m) thick at the WPP, with a surface elevation of approximately 25 ft (7.6 m) below mean sea level (MSL). The unit thickens to the east and slopes toward the east. The hydraulic conductivities of this unit, measured in wells throughout J-Field, range from less than 0.01 to 0.20 ft/d (0.003 to 0.06 m/d), with a median value of 0.05 ft/d (0.015 m/d).

2.2.4.3 Confined Aquifer

The confined aquifer consists of gravelly sand and clay and corresponds to the base unit of the Quaternary/Pleistocene (Talbot) sediments. At the WPP, the top of the confined aquifer is 60 ft (18.3) below MSL, and the unit is 50 ft (15.2 m) thick. Hydraulic conductivity was measured at two wells completed in the confined aquifer in the WPP (wells JF9-1 and JF11-1) and was found to range from 3.16 to 508 ft/d (approximately 1 to 155 m/d) (Table 2.1).

2.2.4.4 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. The surface elevation of the Potomac Group aquifer is at about 157 ft (48 m) below MSL in the vicinity of the WPP. The thickness of the aquifer is uncertain, but it may be up to 800 ft (244 m) at the WPP (Hughes 1993).

2.2.4.5 Groundwater Flow Direction

The steepest hydraulic gradients in the surficial aquifer at J-Field were found near the former TBP and WPP (Hughes 1993). Because the closest production well in this aquifer is about 4 mi to the west (across the Gunpowder River), pumping does not affect the groundwater flow system at the WPP AOC. The major influences on the flow system at J-Field are recharge, evapotranspiration, and tidal fluctuations. Hydrographs of wells screened in the confined aquifer show rapid, short-term water-level responses to tidal changes (Donnelly and Tenbus 1998). Recharge is mainly through rainfall, and the system discharges into the marshes and the Gunpowder River. Some recharge from the Gunpowder River may occur during droughts (Hughes 1993). In general, groundwater flows from the topographic high near and along Rickett’s Point Road to the Gunpowder River to the west. Figure 2.2 shows the groundwater surface elevations for the WPP in May 1995.

2.2.5 Ecology

APG is located within the northern portion of the Middle Atlantic Coastal Plain ecoregion, which extends from southern New Jersey to eastern Georgia (Omernik and Gallant 1989). The predominant land uses in the ecoregion are woodland and forest. The low elevations and relatively flat topography of the Atlantic Coastal Plain support the development of extensive tidal marshes and wet-mesic forest. Tidal marshes occur along most of the eastern and southern shorelines of J-Field and intermittently along the Gunpowder River shoreline. These marshes are dominated primarily by common reed and cattail; associates commonly include false nettle, sensitive fern, Olney-threesquare, and rose-mallow. Woody species found frequently along the upland margins include wax myrtle and groundsel bush.

The majority of J-Field is forested. Drier upland areas support occasional stands of tulip trees or mixed deciduous hardwoods, including Spanish oak, hickory, and scarlet oak, with an open understory. Persimmon, black locust, and black cherry also occur frequently throughout much of the forested areas, along with holly, Japanese honeysuckle, and Virginia creeper. Lower elevations, including forested wetlands, support extensive areas dominated by sweetgum and red maple, with willow oak, black gum, swamp chestnut oak, and sycamore frequently dominating wetter sites. The understory is frequently open, with greenbrier and highbush blueberry increasing into lower and wetter areas. Seasonal forested wetlands are scattered throughout J-Field and range from small crater-like depressions (many with 2- to 3-ft [0.6 to 0.9 m] water depths) to large tracts of several acres with relatively shallow water depths. These wetlands are primarily sites of groundwater discharge with little surface flow. A large forested and scrub-shrub wetland is located in the central portion of J-Field, extending from the Gunpowder River on the west to the tidal marsh along the Chesapeake Bay on the east. Surface water in this wetland flows east to west.

Vegetation communities in and around the WPP AOC were characterized by dominant species during a general walkover of the site (Hlohowskyj et al. 2000). Conditions may have changed since the walkover survey was performed. In the forested area south of the AOC, the transition from marsh to forest is abrupt. The marsh has a clear and distinct edge. It is dominated by common reed in the interior and common reed, grounsel bush, and false nettle toward the margins. The dominant trees within the forested area are sweetgum and red maple. The marsh north of the AOC is also dominated by common reed, grounsel bush, and false nettle. When the walkover survey was performed, the southern portion of the marsh was bordered by the open, mowed grasses that make up most of the vegetation of the AOC. This area was periodically mowed when the site was active and is vegetated with upland grasses and forbs, including broom sedge, velvet grass, purple-top grass, sweet vernal grass, switchgrass, gamma grass, and bracted plantain. The site is no longer mowed. The remainder of the marsh is bordered by forest dominated by willow oak, sweetgum, and highbush berry, which form an abrupt edge.

Another wetland (the bermed depression) occurs between the pits and northern marsh. This wetland is approximately rectangular and covers 0.02 acre (0.01 ha). It appears to have been excavated to receive excess surface water from the Northern Pit. Surface water is present throughout the growing season. The wetland supports an emergent vegetation community around the margin dominated by narrow-leaf cattail and a community in the interior dominated by duckweed and cattail. A narrow band of marsh dominated by common reed lines the Gunpowder River shoreline west and south of the pits.

Wildlife species at J-Field include the bald eagle (a designated federal threatened species), osprey (several nesting pairs), white-tailed deer, red fox, and flying squirrel. No bald eagle nests or nesting pairs have been observed at the WPP AOC. Eastern box turtles and black racers are common in the forested areas throughout J-Field. The many reptile and amphibian species that use the seasonal wetlands as breeding sites include spotted turtle, painted turtle, snapping turtle, and red-spotted newt. Waterfowl also commonly forage in these wetlands (Hlohowskyj et al. 2000).

2.2.6 Land Use

J-Field was used for military purposes as early as 1917; however, the site became more actively used from the World War II era into the late 1970s. Historical site usage is only partially documented. In general, site activities included the testing of high explosives and chemical munitions, the testing of conventional munitions on structures and buildings, thermal (through open burning) and chemical decontamination of chemical munitions, open detonation, and disposal. Materials disposed at J-Field included chemical warfare agents (CWAs), CWA decontamination solutions, riot control agents, white phosphorus (WP), chlorinated solvents, and other wastes generated by research laboratories, process laboratories, pilot plants, and machine and maintenance shops.

The organizational history files of the Edgewood Arsenal were reviewed to determine the early history of the Edgewood Area. Organizational files of the Technical Escort Unit (TEU) were examined because the TEU has historically been, and continues to be, responsible for disposal operations at J-Field. The organizational history files of Edgewood Arsenal for 1917 to 1942 and the organizational history files of the Chemical Warfare Center for 1942 to 1946 provide no information about the types or quantities of materials handled at the J-Field site in general, or those handled at the WPP AOC in particular. TEU records for the years spanning

1942 to 1995 become more informative with respect to the WPP in the 1980s (Martino et al. 2006). This is primarily because APG implemented the use of what is referred to as "disposal vouchers" around 1980.[1] Disposal vouchers included a description of the items, disposal field, and disposal method. As a result, the disposal vouchers can be used to determine that the WPP site was used primarily for the disposal of ordnance-related materials, including fuzes, grenades, bombs, bursters, rockets, mortar rounds, artillery rounds, and explosives either containing or contaminated with WP. In addition, archival records indicate that small quantities of a wide variety of what appear to be laboratory chemicals were disposed of by open burning and/or open detonation in the WPP, including shock-sensitive items like ethers, peroxides, azides, and perchlorates.

In addition, TEU files include Explosive Ordnance Incident Reports about events involving the discovery, reporting, identification, and disposal of ordnance on the APG. As a result, it is possible to determine that a variety of WP-containing OE were handled in the WPP. Records (the APG Emergency Response Log) indicate that the WPP was last used on June 27, 2001, for the disposal of a 4.2-in. (10.7-cm) WP-filled mortar round.

2.2.7 Military Range Maintenance and the WPP Reforestation Grove

As noted previously, the WPP AOC is located on J-Field, an active military testing range on APG. In the past, periodic range maintenance activities have included shoreline stabilization, along with removal of UXO and scrap metal. Range maintenance activities have also included repair of primary and secondary roads that affect access to the WPP AOC and other areas of J-Field. Although not considered part of the remedy selected for the WPP AOC, these ongoing activities are anticipated to continue and are expected to be compatible with the remedial activities selected for the WPP AOC.

In April 2007, a military range maintenance (MRM) activity was conducted to establish a reforestation grove as a mitigative measure for the nearby Robbins Point Demolition Ground. Approximately 1,500 trees were planted over a five-acre area at the WPP in support of APG's Chesapeake Bay Critical Area program.

2.3 PREVIOUS INVESTIGATIONS

The WPP AOC has been the subject of previous environmental studies performed in the 1970s, 1980s, and 1990s, with the most recent study occurring in the late 1990s (Table 2.2). Fundamental elements of the past studies, including technical approach, sample collection strategies, sample collection techniques, analytical methods, and data interpretation, may differ from the best practices employed presently in site characterization studies. However, information from past studies has proven to be useful for the development and refinement of the site conceptual model, the identification of contaminants of potential concern, the development of

---

[1] Examples include APG (1983a–c).

data quality objectives, and the crafting of the sampling plan. In the interest of completeness, the information developed as a result of these past studies is summarized here. The study results are presented in the following paragraphs, grouped by medium, with a summary of the investigation results for each medium included. Additional information regarding these previous investigations can be found in the references cited in Table 2.2.

2.3.1 Soil Gas

During the hydrologic assessment conducted by the USGS, 35 locations at the WPP were sampled for TCE and tetrachloroethene (perchloroethene, or PCE), combined hydrocarbons, and simple aromatics. The highest relative flux values of contamination were found north of the pits and west along the shore of the Gunpowder River. Isolated areas of contamination also were found to the south. These results suggest that contamination sources existed north, west, and south of the burn pits.

This USGS soil-gas measurement effort was followed by an EMFLUX® soil-gas survey in the spring of 1994 (Prasad and Martino 1995). That survey was conducted to detect volatile organic compounds (VOCs) on the EPA's Target Compound List (TCL) for EPA's Contract Laboratory Program (CLP) (EPA 1990a). Forty locations (sample point numbers 163 to 202 in Figure 2.3) surrounding the pits were sampled. Results from this 1994 sampling effort suggest that the burn pits represent a source of chlorinated organic contamination. As depicted in the 1995 report, TCE is absent from the eastern portions of the pit (Figure 2.3). TCE was detected at six sample locations at emission rates ranging from 0.7 to 37.8 ng/m^2/min. The highest emission rate for this compound was found at sample point 187, located at the western edge of the Southern Pit.

Emissions of PCE were recorded at nine sample locations. The highest emission rate (12.3 ng/m^2/min) was measured at sample point 187 (which also exhibited the highest TCE emission rate. Five of the nine detections of PCE were found at sample points along the edges of the pits (Figure 2.4) (Prasad and Martino 1995).

Benzene and toluene were also detected in the passive soil-gas monitors, although at isolated locations at the WPP. Benzene was detected at monitoring points 178, 184, and 189 at emission flux rates of 0.9, 5.2, and 1.2 ng/m^2/min, respectively. Toluene was detected at monitoring points 169 and 180 at emission flux rates of 0.9 and 0.5 ng/m^2/min, respectively (Prasad and Martino 1995).

Passive soil-gas measurement results obtained by the USGS suggest the presence of VOC contamination sources south, west, and north of the burn pits. Except for the area near well TH3, the 1995 passive soil-gas measurements revealed the complete absence of chlorinated ethanes and ethenes south of the burn pits. The presence of chlorinated VOC contamination west and north of the burn pits, as measured by the USGS, was substantiated by the results of the 1995 passive soil-gas monitoring. The presence of "simple aromatics," as measured by the USGS south of the burn pits, was somewhat substantiated by the benzene and toluene results documented by the 1995 study.

2.3.2 Soil

In 1983, soil samples were collected from four monitoring well boreholes at the WPP (locations P5, P6, P7, and P8 in Figure 2.5). One composite sample from each borehole was analyzed for metals, phosphorus, gas chromatography (GC) purgeables, GC pesticides/ polychlorinated biphenyls (PCBs), GC herbicides, cyanide, and phenol. The compositing procedure used is described as follows:

> Soil samples collected from each borehole at five (5)-foot intervals were then composited into a single sample for analysis. The GC purgeables, GC pesticides/PCBs, and GC herbicides were not detected at a detection limit of 0.005 ppm. Cyanide was not detected. Samples from other boreholes showed essentially no unusually elevated metal contamination (Princeton Aqua Science 1984).

The analytical results for the composite sample collected from each boring are provided in Table 2.3. Composite JWP-1, JWP-2, JWP-3, and JWP-4 were collected from the boring locations that became monitoring wells P5, P8, P6, and P7, respectively (Figure 2.5) (Princeton Aqua Science 1984).

Composite samples collected from the burn pits at the WPP were analyzed for the same suite of compounds. The results show significant levels of lead (up to 2,960 mg/kg) and zinc (up to 2,720 mg/kg) in the composite samples (Table 2.4). High concentrations of petroleum hydrocarbons (up to 5,800 mg/kg) were also detected (Princeton Aqua Science 1984).

As part of the 1986 RFA, surface soil samples were collected at two locations near the WPP (J31 and J32 in Figure 2.6). The samples were analyzed for metals, extractable metals, and explosive-related compounds. Soil sample J31 contained 14.1 mg/kg and 255 mg/kg of arsenic and lead, respectively. Soil sample J32 contained 12.3 mg/kg and 184 mg/kg of arsenic and lead, respectively. However, neither of the samples contained contaminants at concentrations that exceeded the RCRA extraction procedure toxicity test limits for the metals analyzed (including lead, with a limit of 5.0 mg/L) (Nemeth 1989) (Table 2.5).

The USGS collected soil samples (at approximately 1-ft [0.3-m] depths) from nine locations in the WPP area (Figure 2.7). The samples were analyzed for metals, VOCs, and semivolatile organic compounds (SVOCs). No VOCs or explosive-related compounds analyzed as part of the SVOC suite (2,6-dinitrotoluene, 2,4-dinitrotoluene, and nitrobenzene) were detected.

Arsenic, chromium, copper, and lead were detected at all of the sites sampled. The USGS reported that arsenic, chromium, and copper concentrations detected were not indicative of the presence of a contamination source. Lead concentrations were reported as being slightly enriched; that is, slightly higher than concentrations that would be expected based on average crustal abundances. The USGS further reported that trace-metal concentrations were highest in the area between the disposal pits and the Gunpowder River. Di-n-butylphthalate (DBT) was the only organic compound detected by the USGS in soil (Phelan 1998).

Soil samples were also collected in the WPP area by Weston in October 1992 (Weston 1994). 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 (Figure 2.8). Table 2.6 summarizes the analytical results for the parameters detected in some of these samples.

In 1994, Argonne National Laboratory performed in-situ x-ray fluorescence (XRF) analyses of soil in the Southern Pit and in areas adjacent to the Southern Pit. The Northern Pit was not sampled because it was periodically used for emergency disposal operations (Prasad and Martino 1995) (Figure 2.9). The study team used a field-portable Spectrace 9000 XRF[2] analyzer to screen metals in the field. XRF results are summarized in Table 2.7. The manufacturer of the XRF unit used reported that an element reading of less than three times the associated standard deviation is considered to be below the detection limit of the instrument. Results between 3 and 10 standard deviations can be interpreted less definitively; that is, the element may be present but the concentration reported is semi-quantitative (TN Technologies 1992). EPA Method 6200 (EPA 1996a), "Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment," Section 9.6, gives the same interpretation. The XRF results indicate that zinc and lead concentrations were somewhat elevated in the Southern Pit (XRFWPP10, 11, and 12) and in areas downslope from the burn pits (XRFWPP2 and 3).

Soil samples were collected in the WPP AOC in March 1994 as part of the RI. Samples were collected and analyzed for CWAs from three borings south and adjacent to the Southern Pit prior to March 1994 to prepare for more extensive sampling within the burn pits. No CWAs were detected (Norris and Borland 1993). Soil samples were also collected at 0- to 6-in. and 6- to 12-in. intervals[3] from open field areas adjacent to the burn pits (Figure 2.10). These samples were analyzed for the CLP Target Analyte List inorganics and TCL VOCs and SVOCs. In addition, soil samples were analyzed in the field for PCBs, polynuclear aromatic hydrocarbons (PAHs), and total petroleum hydrocarbons by using immunoassay test methods. Immunoassay test results are summarized in Table 2.8.

PAHs and petroleum hydrocarbons were not detected by using the immunoassay test kits. PCBs were detected at concentrations between 1 and 10 ppm in sample CLPW9 (0 to 6 in.) and at greater than 10 ppm in sample CLPW12 (0 to 6 in.).

Soil samples from the 6- to 12-in. interval at locations CLPW12, CLPW13, CLPW14, CLPW8, and CLPW9 were analyzed for TCL VOCs. No VOCs were detected at these locations. Soil samples from the 0- to 6-in. and 6- to 12-in. intervals were analyzed for Target Analyte List inorganics. Results for this CLPW series of samples, which were validated as part of the J-Field RI/FS, are summarized in Table 2.9.

---

[2] Mention of specific items of equipment by brand name is not intended as an endorsement of those brands. The information is merely provided to present a complete description of the processes used.

[3] Metric equivalents of sampling depth intervals used throughout the text of this report are: 0–3 in. = 0–7.6 cm, 0–6 in. = 0–15.2 cm, 6–12 in. = 15.2–30.5 cm, 0–1 ft = 0–0.3 m, 1–2 ft = 0.3–0.6 m, 2–3 ft = 0.6–0.9 m, 2–4 ft = 0.6–1.2 m, and 4–6 ft = 1.2–1.8 m.

Soon after the CLPW series of samples was collected, it was determined that because of the active nature of the WPP, efforts should focus on inactive portions of the WPP used for waste disposal in the past. As a result, soil samples (the WP series) were collected from the Northwest Burn Area, the Southwest Burn Area, and the Suspect Storage Area. Samples were collected at 0- to 6-in. and 6- to 12-in. intervals and at depths up to 2 ft in the Suspect Storage Area (Figure 2.5). The Northwestern Suspect Burning Area, the Suspect Storage Area, and the Southwestern Suspect Burning Area have already been assessed in the J-Field RI (Yuen et al. 1999). The sample results are included in Table 2.10.

The range of concentrations found in soil samples collected during previous investigations at the WPP AOC is reported in Table 2.11.

2.3.3 Sediment and Surface Water

Sediment samples were collected from several locations near the WPP in 1982. These samples were analyzed for WP only. No WP was detected, but results were referred to as being qualitative in nature (Nemeth et al. 1983).

Surface water samples were collected from the WPP area in 1986 (Nemeth 1989) Sampling locations are shown in Figure 2.6. As noted in Table 2.2, these samples were analyzed for metals, explosive-related compounds, gross alpha and beta, VOCs, base-neutral and acid-extractable organic compounds (BNAs) (i.e., SVOCs), pesticides, and PCBs. The results are summarized in Table 2.12.

Nearshore surface water samples were collected in 1988 by the USGS (Figure 2.11). In 1988, filtered and unfiltered surface water samples were analyzed for water quality parameters, metals, and a few organic compounds. The metals data showed the presence of lead (at concentrations ranging from not detected [ND] to 28 μg/L) and zinc (50 to 133 μg/L) at locations 1 through 4. Lead and zinc concentrations at the other locations ranged from ND to 2.7 and 48 μg/L, respectively. Mercury and nickel concentrations were slightly elevated at location 1 (0.54 and 34 μg/L, respectively). No elevated concentrations of arsenic, barium, or chromium were found (USGS 1991).

Acetone, toluene, phenol, total organic carbon (TOC), and total organic halides (TOX) were also analyzed in the filtered and unfiltered surface water samples. Phenol (ND to 52 μg/L), TOC (4,000 to 7,000 μg/L), and TOX (22 to 30 μg/L) were detected in the unfiltered samples only. The presence of acetone in some of the samples may represent laboratory contamination. Toluene (3.1 μg/L) was found at location 1 (Phelan et al. 1996). In August 1992, the EPA Environmental Response Team collected nearshore surface water and sediment samples at 17 locations around the peninsula — in the Gunpowder River and in the Chesapeake Bay (EPA 1993a). However, these sample locations were somewhat distant from the WPP. For example, the sample closest to the WPP was collected offshore about 500 ft (152 m) west of the WPP. Therefore, the EPA results are not reported here. In 1993, ICF Kaiser Engineers performed as ecological stress survey, which included collection of sediment samples from the Gunpowder River. However, the closest sediment sample location during that study was about 500 ft offshore west of the WPP. For this reason, the results from the ICF Kaiser survey are not reported here (Neubauer et al. 1994).

The USGS sampled the bermed depression in 1993 (sample point 3 in Figure 2.12). No VOCs, SVOCs, pesticides, or explosive-related compounds were detected.

In 1994, as part of the J-Field RI, two surface water samples were collected near the pits at the WPP AOC: WPP-A and WPP-C (Figure 2.13). The samples were analyzed for VOCs, SVOCs, metals, TOX, PCBs, pesticides, chemical surety material (CSM), CSM degradation products, and explosives-related compounds. No sediment samples were collected. VOCs, SVOCs, PCBs, pesticides, and CSM/CSM degradation products were not detected. As summarized in Table 2.13, several metals, including chromium, iron, lead, and zinc, were detected at levels above background concentrations. The explosive RDX (hexahydro-1,3,5-trinitro-1,3,4-triazine) was detected in both samples at 1.7 μg/L in WPP-A and 1.2 μg/L in WPP-C.

The presence of surface water at the two suspect burning areas is transient. In 1995, as part of the J-Field RI, four surface water samples were collected where surface water was available for sampling at the WPP AOC — two from the marsh near the Northwestern Suspect Burning Area (WPSW2 and WPSW3), one offshore and adjacent to the Southwestern Suspect Burning Area (WPSW4), and one to the south of the Southwestern Suspect Burning Area (WPSW5) (Figure 2.13). The samples were analyzed for metals, cyanide, CSM/CSM degradation products, and explosives-related compounds. No sediment samples were collected. Table 2.13 summarizes the metals results. Metals exceeding the calculated background included iron, lead, and zinc. Cyanide, explosive-related compounds, and CSM/CSM degradation products were not detected.

2.3.4 Groundwater

In 1977, three monitoring wells (TH1 through TH3; Figure 2.5) were installed at the WPP AOC as part of an environmental contamination survey conducted by USATHAMA (Nemeth et al. 1983). The wells were 16 to 18 ft (4.9 to 5.5 m) deep and screened in the surficial aquifer. Water samples collected from the wells in 1977 were analyzed for indicator chemicals, VOCs, metals, WP, mustard degradation products, cholinesterase inhibitors, and BNA organic compounds.

A mustard degradation product reported to be 1,3-dithiane (6 μg/L) was found in well TH1 near the Northwestern Suspect Burning Area (Figure 2.5). Investigators may have misreported 1,4-dithiane, a CWA-related compound, as 1,3-dithiane here because 1,4-dithiane is one of the typical compounds analyzed. Aliphatic and aromatic organic compounds were found at levels of up to 200 μg/L in most of the well samples (Nemeth et al. 1983).

In 1983, four additional wells were installed around the WPP AOC (P5 through P8 in Figure 2.5) as part of a munitions disposal study (Princeton Aqua Science 1984). The wells were 17 to 20 ft (5.5 to 6.1 m) deep and screened with 15-ft-long (4.6 m) 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.

In 1986, groundwater samples collected from wells P5 through P8 as part of the RFA (Nemeth 1989) were analyzed for indicator parameters, VOCs, SVOCs, metals, explosive-related compounds, radioactivity, and thiodiglycol. Sulfate, total dissolved solids, and TCE (560 μg/L in well P7) were the only materials that were found at elevated concentrations.

In 1988 and 1989, the USGS installed 12 additional monitoring wells at the WPP AOC (Sonntag 1991; Hughes 1993). Three nested wells were installed at four different locations (JF9 through JF12 in Figure 2.5). At each site, the three wells were screened in the confined aquifer (JFX-1 series), leaky confining unit (JFX-2 series), and surficial aquifer (JFX-3 series) of the Talbot Formation. The groundwater samples collected from these wells in a 1990 sampling effort were analyzed for VOCs, SVOCs, metals, other inorganic parameters, organosulfur, explosive-related compounds, and radioactivity. Wells were selected on the basis of their proximity to potential disposal areas for these materials (USGS 1991). Low levels of VOCs were detected in one well, P7, which contained TCE at 40 μg/L and chloromethane at 2.8 μg/L. Cyanide was detected at a concentration of 7.0 μg/L in well P6. The explosive compound RDX was detected in well JF10-3 at a concentration of 0.576 μg/L. Well JF12-2 had detectable concentrations of 2,6-dinitrotoluene (2.26 μg/L) and RDX (1.07 μg/L). No other contamination was detected in these groundwater samples during the 1990 sampling episode (Phelan et al. 1996).

In 1993, groundwater samples from 13 monitoring wells around the WPP were analyzed for VOCs, metals, general chemistry, and explosive-related compounds. TCE was detected in well P7 (310 μg/L). RDX was detected in wells JF11-3 (5.4 μg/L) and P7 (4.7 μg/L). HMX (cyclotetramethylene tetranitrate) was detected in well JF10-3 (10 μg/L) and well JF12-3 (4.4 μg/L) (Phelan et al. 1996).

In 1994, groundwater samples from 13 monitoring wells around the WPP AOC were analyzed for VOCs, SVOCs, metals, pesticides, general chemistry, explosive-related compounds, and CWA degradation compounds. The only VOC detected was TCE (86 μg/L in well P7). The only CWA-related compound detected was thiodiglycol (38.8 μg/L in well JF10-3) (Yuen et al. 1999).

2.3.5 Ecological Risk Assessment

In the late 1990s, a baseline ecological risk assessment (BERA) was performed for J-Field (Hlohowskyj et al. 2000). The circa-2000 BERA (hereafter "BERA 2000") included an ERA for the WPP AOC that conformed to current EPA guidance (EPA 1997). However, at the time the BERA 2000 was performed, areas used for ongoing emergency OE disposal operations at the WPP AOC (in particular, the Northern Pit) were excluded from detailed study. The emergency OE disposal operations have now ceased, but operations occurring since the samples used for the BERA 2000 were collected may have resulted in site conditions that differ from those that were previously evaluated. This section presents a brief summary of the conclusions of the BERA 2000 that pertained to the WPP AOC. A more detailed discussion of the BERA 2000 pertaining to the WPP AOC is presented in the RI/ERA report (Martino et al. 2006).

On the basis of the results of toxicity tests, phytoplankton growth may be at risk from surface water in the small pond that receives runoff from the Northern Pit at the WPP AOC. However, qualitative observations indicate an apparently healthy aquatic community in the pond, suggesting that the toxicity tests for phytoplankton (*Raphidocelis subcapitata,* formerly *Selenastrum*) production may have been overly sensitive to other environmental conditions in the pond water, not just contaminant levels. For example, the brownish/reddish coloration of the water indicates that tannic conditions are present and that similar conditions are found throughout J-Field. In addition, the toxicity of ambient surface water to *R. subcapitata* in the BERA 2000 was based on a comparison between the laboratory control and ambient media, not on a comparison with a field reference site. Thus, the conclusion that there was a reduction in growth because of ambient water may be a conservative conclusion (i.e., growth may actually have been comparable to growth under suitable reference conditions). An overall summary of the risk characterization for each trophic level of the aquatic ecosystem at the WPP AOC is presented in Table 2.14.

Also on the basis of the results of toxicity tests, Hlohowskyj et al. 2000 concluded that the growth and reproduction of old-field herbaceous vegetation was potentially at risk from metals in soils at the Suspect Pushout Area and the Northern Pit. Media-derived hazard quotient (HQ) risk estimates indicated that the growth of herbaceous vegetation could be affected by chromium and lead, and that reproduction of herbaceous vegetation may be at risk from zinc in the soils from the Suspect Pushout Area and pits. On the basis of toxicity tests, it was concluded that the growth of soil-dwelling macroinvertebrates was potentially at risk from metals in soils at the Suspect Pushout Area. Dose modeling indicated that the growth, survival, and/or reproduction of mammalian primary consumers could be at risk from antimony and lead in the soils from the Northwestern and Southwestern Suspect Burning Areas and the Suspect Storage Area. The growth, survival, and/or reproduction of avian secondary consumers could be affected by cadmium, chromium, iron, lead, and zinc in the soils from these same areas. Summaries of the overall risk characterization developed by Hlohowskyj et al. (2000) for each trophic level of the terrestrial ecosystem at the WPP AOC are presented in Tables 2.15 through 2.17.

2.3.6 Human Health Risk Assessment

A HHRA for J-Field (Ripplinger et al. 1998) was prepared in conjunction with the RI conducted by Argonne National Laboratory (Yuen et al. 1999). Human health effects associated with site-related chemicals in soil and surface water for the inactive areas of the WPP were evaluated as part of the HHRA. Groundwater data collected at the WPP were not quantitatively evaluated in the HHRA because of the absence of a complete exposure pathway (Ripplinger et al. 1998).

For all of the environmental media evaluated in the HHRA, the maximum concentrations of detected chemicals were compared with the EPA Region III risk-based concentrations (RBCs) that were published at the time of the study. (For additional information regarding the nature of the statistical comparison, see Ripplinger et al. [1998]). Any inorganic constituents detected at concentrations above the RBCs were retained for statistical comparison with background inorganic chemical concentrations (background data used were from ICF Kaiser Engineers [1995]). Inorganic constituents exceeding both RBCs and reference concentrations were considered contaminants of potential concern (COPCs) and were retained for evaluation in the HHRA. In addition, organic chemicals detected at concentrations above the RBCs were designated COPCs.

Although a number of inorganic constituents were detected in soil at the WPP, only arsenic exceeded its RBC (3.8 mg/kg industrial). Arsenic was detected at the WPP at concentrations ranging from 0.352 to 5.34 mg/kg. Because arsenic also exceeded reference concentrations, it was designated a COPC. Organic compounds detected in surface soil and subsurface soil at the WPP were below the industrial soil RBCs.

Several inorganic constituents were detected in surface water at concentrations above the tap water RBCs. Lead, which was detected at levels above reference concentrations, and antimony and beryllium, which were not detected in the reference samples, were designated COPCs. In addition, six explosive-related compounds detected at concentrations above the tap water RBCs were selected as COPCs: 1,3 dinitrobenzene, 2-amino-4,6-dinitrotoluene, 4-amino-2,6-dinitrotoluene, nitrobenzene, RDX, and 1,3,5-trinitrobenzene.

Under current land-use conditions, incidental ingestion and dermal absorption of chemicals in surface soil by a demolition worker were selected as exposure pathways for quantitative evaluation in the HHRA. A number of complete exposure pathways under future-land-use scenarios were selected for quantitative evaluation:

- Incidental ingestion and dermal absorption of chemicals in surface soil by an industrial worker;
- Incidental ingestion and dermal absorption of chemicals in surface soil by a trespasser; and
- Dermal absorption of chemicals in surface water by a trespasser.

To ensure that risks were unlikely to be underestimated, the “reasonably most exposed” case was evaluated in the HHRA. Average daily doses and lifetime average daily doses were estimated on the basis of exposure point concentrations and assumptions used to characterize exposure to COPCs at the site. Those dose values were then compared against toxicity criteria to calculate risks associated with the exposures. For noncarcinogenic chemicals, a hazard index (HI) less than 1 indicates that adverse noncarcinogenic health effects would not be expected. For carcinogenic chemicals, the resulting risk estimates were the upper-bound excess lifetime cancer risks. Cancer risk estimates were compared with the EPA-recommended targeted risk range of 1×10^{-6} to 1×10^{-4}.

For a current-land-use scenario, the HHRA determined that for the WPP, the cumulative HIs were below 1, indicating that noncarcinogenic effects would not be expected to occur. In addition, the HHRA determined that the risk estimates for carcinogenic chemicals for the WPP AOC fell below the recommended risk range of 1×10^{-6} to 1×10^{-4}.

Under future-land-use scenarios, risks were calculated for industrial workers and trespassers. Risks to industrial workers from incidental ingestion and dermal absorption of chemicals were at the lower end of the target risk range, while total HIs for the WPP were less than 1, indicating that noncarcinogenic effects would not be expected to occur. Risks to a trespasser for total excess lifetime cancer (assuming ingestion and dermal contact with soil and/or dermal contact with surface water) fell within or below the target risk range. Total HIs for trespassers for the WPP were less than 1. Trespasser exposure to beryllium in surface water at the WPP was associated with the highest risks, in this case, 1×10^{-5}.

As reported in the HHRA, lead was also identified as a COPC for surface water in the WPP AOC. However, because toxicity criteria were not available for lead in surface water, an appropriate evaluation was not possible.

2.4 CURRENT INVESTIGATION ACTIVITIES

Additional environmental data were collected by Argonne National Laboratory during 2004/2005 to support the characterization of the WPP AOC. Data collection activities included the following:

1. In-situ XRF measurements of metal concentrations in soil at locations within the Northern Pit and in area grids adjacent to and outside of the burn pits,

2. Collection of surface and subsurface soil samples for chemical analyses,

3. Collection of sediment samples from the Gunpowder River shoreline for XRF measurements and chemical analyses, and

4. Collection of surface water and groundwater samples for chemical analyses.

All field activities were performed in accordance with the methods outlined in the WPP Field Sampling Plan (Martino and Hayse 2003) and the Quality Assurance Project Plan (Kimmell et al. 2003). Besides supplementing the existing chemical characterization, Argonne National Laboratory also conducted additional ecological effects assessments for surface water, sediment, and soil at the WPP AOC (Martino et al. 2006). Updated human health risk assessments were also performed by EA Engineering, Science and Technology, Inc. (EA 2006). The additional toxicity tests, using environmental media gathered from the WPP AOC, were performed following an approved sampling plan (Hayse and Martino 2004). Discussions of these investigation activities are included in the following sections.

2.4.1 Soil

Soil at the WPP was evaluated by using a combination of in-situ XRF measurements and conventional intrusive sampling/off-site analysis methods. Locations with elevated XRF results for inorganic contaminants of potential ecological concern (COPECs) identified by Hlohowskyj et al. (2000) — lead and zinc — were used to aid in the selection of intrusive sample collection locations. Areas with elevated concentrations of those metals were given priority as soil sample collection sites.

2.4.1.1 Soil XRF Measurement Results

In-situ XRF measurements of the Southern Pit and some other areas at the WPP had been performed in the past (Prasad and Martino 1995). These 1995 results were taken into consideration for this 2004/2005 investigation. However, no XRF measurements had ever been performed in the Northern Pit or in most of the open grassy areas adjacent to the burn pits. As part of the 2004/2005 investigation activities, in-situ XRF measurements of metal concentrations in soil were performed at locations within the Northern Pit and in area "grids" adjacent to and outside of the burn pits (Figure 2.14). Grid 1 encompasses an area most likely to have been impacted by the "pushout" material periodically removed from the burn pits. Grids 2 and 3 encompass areas where ground scarring visible in archival aerial photographs suggests that OE disposal by open detonation occurred in the past.

Figures 2.15 through 2.17 show the XRF measurement locations for Grids 1, 2, and 3, respectively.

The potential existence of a buried trench in the vicinity of Grid 2 (see Figure 2.2) is discussed in Yuen et al. (1999). Environmental geophysics analyses yielded mixed results with regard to this "Suspect Filled Trench." A magnetic survey of the WPP revealed an east-west line of localized anomalies north of the Northern Pit that could be indicative of an additional buried trench. However, no such linear feature was revealed in the companion conductivity survey of the same area, and a ground-penetrating radar survey of the area did not reveal the presence of an additional buried trench (Daudt et al. 1994). In part to address the potential presence of a buried trench, XRF sample locations in Grid 2 are located near the suspected location of the buried trench.

XRF measurement locations from within the Northern Pit were established along a transect on the center line of the pit and at locations on the sidewall of the pit. XRF measurement locations for the Northern Pit and the locations of XRF measurement performed in the past on the Southern Pit are depicted in Figure 2.18. EPA Method 6200 was used for the XRF analyses (EPA 1996a).

2.4.1.2 Burn Pit Sampling and Analysis

The burn pits are a potential source of contamination. The XRF measurement results for the Northern and Southern Pits were used to select locations for the collection of intrusive soil samples. XRF measurements for lead and zinc, identified in the BERA 2000 (Hlohowskyj et al. 2000) as COPECs, were used to aid in the selection of boring locations. Burn pit and sidewall locations with elevated concentrations of those metals were given priority as soil sample collection sites.

Burn pit boring samples were collected from seven locations (four in the Northern Pit and three in the Southern Pit), and sidewall samples were collected from eight locations: four in each pit (Figure 2.19). Boring samples were collected at three intervals: 0 to 1 ft, 1 to 2 ft, and 2 to 4 ft. Sidewall samples were collected at a 0- to 1-ft interval. In response to EPA comments, the center boring sample location in each pit was advanced to 6 ft so that an additional interval (4 to 6 ft) could be sampled at that deeper interval. The noted intervals have been selected for sampling in order to characterize the soil horizon where biological activity is expected to occur and to assess the degree to which open burning/open detonation activities have resulted in the release of COPECs into both surficial and deep soil horizons within the burn pits.

Analytes for the locations and intervals sampled in the burn pits are summarized in Table 2.18 for the Southern Pit and in Table 2.19 for the Northern Pit.

In addition to the conventional COPCs analyzed, all samples from the burn pits collected from intervals greater than the 0- to 1-ft interval were analyzed for the chemical warfare agents sarin (GB), soman (GD), mustard (HD), and O-ethyl S-(2-diisopropylaminoethyl) methyl-phosphonothioate (VX). No CWAs were detected in any soil samples collected from the WPP site.

2.4.1.3 Soil Sampling/Analysis Outside of the Burn Pits

Outside of the burn pit areas, samples were collected from one interval, 0-1 ft below ground surface, at 26 locations (Figure 2.20). Soil samples were collected from five locations in Grid 1, seven locations in Grid 2, and eight locations in Grid 3. Six additional soil samples from areas outside of Grids 1, 2, and 3 but adjacent to the burn pits were also sampled in response to EPA comments on the April 2003 draft version of the Field Sampling Plan (locations SO-8, SO-9, SO-10, SO-16, SO-17, and SO-18). Also in response to EPA (Varva 2003) comments on the April 2003 Draft Field Sampling Plan, an additional soil boring (location PO-1) was advanced to a depth of 4 ft in an area of shoreline that appears to have been filled with material from the disposal trenches. Samples were collected from three intervals in this “pushout” area: 0 to 1 ft, 1 to 2 ft, and 2 to 4 ft.

Eight samples from outside the burn pits were also analyzed for OE-related compounds (nitrobenzene, nitrotoluene, aromatics, nitramine, perchlorate, and CWA degradation compounds). These included two locations in Grids 1, 2, and 3, and two of the six locations recommended by the EPA in comments on the April 2003 Draft Field Sampling Plan

(Figure 2.20). The OE-related compounds were added to the analytical suite because the WPP was used for the emergency disposal of ordnance and explosives originating from APG that may have contained these compounds. Analytes for the locations and intervals sampled outside of the burn pits are summarized in Table 2.20.

The results of the 2004 XRF field measurements of soils at the WPP are reported in Table 2.21. At Grid 1, the concentration of lead ranged between 17 and 328 mg/kg, and the concentration of zinc ranged between 104 and 988 mg/kg. At Grid 2, lead and zinc concentrations ranged from 4 to 149 mg/kg and 3 to 617 mg/kg, respectively. At Grid 3, lead and zinc concentrations ranged from 8 to 38 mg/kg and 24 to 141 mg/kg, respectively. The burn pit XRF field measurements ranged between 14 and 4,078 mg/kg for lead and 44 and 3,262 mg/kg for zinc.

As discussed in the WPP Sampling Design for the Collection of Media for Toxicological Testing (hereafter "WPP Sampling Design") (Hayse and Martino 2004), a number of metals, pesticides, and SVOCs present in surface soil samples collected from the site have been retained for further evaluation as part of the ecological risk assessment (hereafter "retained COPECs"). Given the importance of the retained COPECs, summarized in Table 2.22, discussion of soil analytical results for the Northern Pit, the Southern Pit, and non-burn-pit soil samples will concentrate on the retained COPECs.

2.4.1.4 Burn Pit Soil Sampling Results

A number of retained COPECs were detected at site-wide maximum concentrations in the Northern Pit, including acenapththylene, antimony, benzo(k)fluoranthene, fluoranthene, and zinc (Table 2.23). Two of the retained COPECs, benzo(g,h,i)perylene and PCBs, were not detected in the Northern Pit. Except for sample locations NP-3 and NP-4 (Figure 2.19), the highest concentrations of the retained COPECs were detected in samples from the sidewalls of the Northern Pit. The PAHs anthracene, benzo(b)fluoranthene, and chrysene were detected at maximum concentrations in the Northern Pit at sample location NP-4.

No perchlorate or CWA degradation compounds were detected in soil samples from the Northern Pit. The only explosive-related compound detected in the Northern Pit was nitrobenzene, detected at a concentration of 48 μg/kg in sample NP-8-WALL. VOCs were detected in the Northern Pit; the maximum concentration detected was 48 μg/kg for the common laboratory contaminant methylene chloride. Other common laboratory contaminants detected included acetone, carbon disulfide, and toluene. The maximum concentrations of other VOCs detected but not considered to be common laboratory contaminants were benzene (9.4 μg/kg), chloromethane (3 μg/kg), and TCE (4.3 μg/kg). Lead and zinc were detected in the Northern Pit soil samples with maximum concentrations of 7,900 mg/kg (NP-6-WALL) and 5,110 mg/kg (NP-7-WALL), respectively. In addition to the dieldrin detected and summarized in Table 2.23, 4,4-dichlorodiphenyldichloroethane (4,4-DDD), 4,4-dichlorodiphenyldichloroethylene (4,4-DDE), and 4,4-dichlorodiphenyltrichloroethane (4,4-DDT) were detected at maximum concentrations of 2.2 μg/kg, 7.7 μg/kg, and 2 μg/kg, respectively, in the Northern Pit. Also detected in the Northern Pit: γ-chlordane, endrin aldehyde, and α-BHC at concentrations of 0.26 μg/kg, 0.25 μg/kg, and 0.19 μg/kg, respectively.

A number of retained PAH COPECs were detected at site-wide maximum concentrations in the Southern Pit, including anthracene, benzo(b)fluoranthene, benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,i)perylene, chrysene, and phenanthrene (Table 2.24). Other retained COPECs detected at site-wide maximum concentrations in the Southern Pit include barium, chromium, copper, dieldrin, and PCB-1254. The maximum site-wide concentrations of PAH compounds and PCB-1254 were detected in samples from the sidewall of the Southern Pit. The maximum concentrations of metal compounds in the Southern Pit were found in sidewall samples or in samples collected from borings in the center line of the Southern Pit. The maximum site-wide concentration of dieldrin (6.8 μg/kg) was detected in center line boring SP-2.

No explosive-related compounds, CWA degradation compounds, or perchlorate were detected in soil samples from the Southern Pit. VOCs were detected in the Southern Pit, with a maximum detected concentration of 49 μg/kg for the common laboratory contaminant acetone. Other common laboratory contaminants detected were 2-butanone, carbon disulfide, methylene chloride, and toluene. Other VOCs detected, but not considered common laboratory contaminants, included 1-hexanone (5.8 μg/kg), cis-1,2-dichloroethene (7.9 μg/kg), chloromethane (3.8 μg/kg), TCE (5.4 μg/kg), and methylcyclohexane (8.5 μg/kg). In addition to the dieldrin detected and summarized in Table 2.24, 4,4-DDE and 4,4-DDT were detected at maximum concentrations of 3.3 μg/kg and 3.8 μg/kg, respectively, in the Southern Pit.

2.4.1.5 Non-Burn-Pit Soil Sampling Results

No CWA degradation compounds or explosive-related compounds were detected in soil samples collected outside of the burn pits. A number of retained COPECs were detected at site-wide maximum concentrations in the non-burn-pit samples, including lead, mercury, nickel, selenium, and thallium (Table 2.25). In general, the maximum concentrations of contaminants in non-burn-pit samples were detected in areas near the burn pits, such as adjacent to the long sides of the burn pits and/or in the burn pit residual pushout area. The highest concentration of lead detected during soil sampling (13,400 mg/kg) was found at sampling location SO-3 adjacent to the Northern Pit (Figure 2.20).

2.4.2 Sediment

Prior to the collection of sediment samples from the Gunpowder River shoreline, the U.S. Army TEU performed an OE survey (U.S. Army TEU, 2003). During that survey, it was determined that OE-related scrap metal was present along the shoreline. In particular, the area immediately west of the burn pits and delineated in Figure 2.21 had dense concentrations of scrap metal and, potentially, some unexploded ordnance. The delineation in the figure was performed at low tide on March 16, 2004, at approximately 10:00 a.m. TEU has been involved in an ongoing scrap removal program from within the delineated area. Some of the scrap metal present is OE-related. Approximately 1,000 lb (454 kg) of OE-related scrap metal and 300 lb (136 kg) of miscellaneous scrap metal have been removed. The OE-related scrap metal removed was M14 and M16 primer adapters for 100-series bomb fuzes. These fuze adapters showed evidence of having been subject to a burn. The energetics associated with these adapters (when unused) contained a net explosive weight of <2 g per item, as follows: mercury fulminate pellet (<1 g) and tetryl (0.9 g for M14 adapters and 1.4 g for M16 adapters).

2.4.2.1 Sediment XRF Measurement Results

Sediment from 25 locations along the Gunpowder River shoreline was collected and analyzed by using a field-portable XRF unit. As noted in Figure 2.21, some of the locations sampled were in the footprint of the OE-related scrap metal delineation. Results for the zinc and lead XRF measurements are reported in Table 2.26.

2.4.2.2 Sediment Sampling and Analysis

Sediment results with the five highest zinc and lead XRF concentrations are highlighted in Table 2.26. These five locations in the Gunpowder River and two additional locations, one in the drainage ditch that drains the Northern Pit and one in the bermed depression, were subsequently sampled and submitted for off-site analyses. The sediment sampling locations are shown in Figure 2.22; the analytes for each location are given in Table 2.27.

2.4.2.3 Sediment Sampling Results

Characterization of sediments at the WPP is based on the analysis of seven sediment samples collected at the site. For estuarine sediment, intrusive sampling sites were selected on the basis of XRF analytical results from 25 locations along the Gunpowder River shoreline. In general, intrusive sediment samples were collected from the locations that had shown elevated XRF readings for lead and/or zinc. As noted in the WPP Sampling Design (Hayse and Martino 2004), the concentrations of arsenic, copper, lead, zinc, and benzyl butyl phthalate exceeded the available screening ecotoxicity values (SEVs) for sediment (Table 2.28). Although sediment-specific SEVs for aluminum, barium, beryllium, cobalt, iron, magnesium, manganese, nitrobenzene, thallium, vanadium, 1,1-biphenyl, and benzaldehyde were not available, maximum results for these compounds are included in Table 2.28.

White Phosphorus reacts rapidly with oxygen, easily igniting at temperatures 10 to 15°F above room temperature. As a result, the compound rapidly reacts in oxygenated media, such as surface soil and surface water, converting into less harmful compounds. However, WP can be found in the sediment or water features near facilities that use the compound (ATSDR 1997). Noteworthy is the fact that no WP was detected in the sediment samples collected from the WPP AOC. Furthermore, no perchlorate or CWA-related compounds were detected in sediment samples. Other than nitrobenzene, no explosive-related compounds were detected in sediment samples. Nitrobenzene was detected at SED6 (Figure 2.22) at a concentration of 110 µg/kg.

Nitrobenzene was also detected at an estimated concentration (i.e., between the detection limit and the quantitation limit) at two locations: SED2 (38 µg/kg) and SED3 (77 µg/kg).

2.4.3 Surface Water Sampling

Surface water samples (unfiltered) were collected at five locations from the Gunpowder River estuary and from the bermed depression that receives runoff from the Northern Pit (Figure 2.23). These unfiltered surface water samples were analyzed for the suite of analytes summarized in Table 2.29.

No chemical warfare agent degradation compounds, explosive-related compounds, WP, or perchlorate were detected in the surface water samples. Concentrations of aluminum, iron, and lead exceeded the available SEVs (Table 2.30). SEVs for chloromethane and magnesium were not available, so an HQ could not be calculated for these analyses.

Concentrations of total aluminum ranging from 94.3 to 1,480 µg/L were detected in the five surface water samples collected from the WPP AOC. The offshore sampling locations (Figure 2.23) yielded the highest concentrations, with 1,060, 1,480, and 1,150 µg/L detected in samples from locations WPSW8, WPSW9, and WPSW10, respectively. Concentrations of iron measured in surface water from the WPP ranged from 1,690 to 5,630 µg/L. The three locations with the highest concentrations were WPSW6, WPSW7, and WPSW9 (2,110, 5,630, and 2,420 µg/L, respectively). The concentrations of lead in surface water ranged from 1.7 to 24.1 µg/L. Ambient surface water concentrations of lead at WPSW8, WPSW9, and WPSW10 in the Gunpowder River were 20.1, 24.1, and 8.9 µg/L, respectively.

2.4.4 Groundwater Sampling

Selected monitoring wells at the WPP were sampled in March 2004. The subset of the monitoring wells sampled at the WPP is listed in Table 2.31 with the order sampled and the suite of analytes for each well. Groundwater surface elevations (GWSEs) from wells screened in the surficial aquifer were collected on March 1, 2004, and were used to generate the GWSE contour map in Figure 2.24. GWSEs from wells screened in the confined aquifer were collected on March 1, 2004, and were used to generate the GWSE contour map in Figure 2.25.

For the March 2004 sampling event, no WP, cyanide, CWA degradation compounds, or explosive-related compounds were detected in the monitoring wells sampled for those compounds. These results represented a marked change; in the past, as described in Section 2.3.4, the explosive-related compounds RDX and HMX were detected in surficial aquifer wells at the site.

Metals detected in the monitoring wells sampled are summarized in Table 2.32. The data qualifiers (lab flags and validation flags) used in Tables 2.23–2.25, 2.28, 2.30, and 2.32–2.34 are defined in Table 2.35.

Only a limited number of VOCs were detected in the monitoring wells sampled at the WPP and in rinse blank and trip blank samples associated with the March 2004 sampling event (Table 2.33). Several common laboratory solvents were detected in the monitoring wells sampled, including 2-butanone, toluene, and methylene chloride. Only one well screened in the confined aquifer (JF9-1) contained detectable concentrations of a VOC, with dichlorodifluoromethane detected at 0.58 μg/L. Of the surficial aquifer wells, well JF10-3 contained detectable concentrations of bromoform, chloroform, and TCE at 5.10, 5.10, and 4 μg/L, respectively. Well JF10-3 also exhibited a high (11.0) pH. The sample from well JF10-3 was re-analyzed as a diluted sample to meet quality control specifications for a subset of the VOCs in the analytical suite. As a result of the re-analyses, bromoform and chloroform were detected at higher concentrations of 55.0 and 36.0 μg/L, respectively. TCE was not detected (at or above the detection limit of 5 μg/L) in the diluted sample from well JF10-3, which is why TCE results for the diluted sample are not included in Table 2.33.

As shown in Table 2.34, TCE was detected at concentrations of 10 and 11 μg/L in surficial aquifer well P7 (the sample ID "04A-P17" is an alias for a blind duplicate sample of well P7). This result is comparable to TCE detections of between 40 and 560 μg/L in well P7 from 1986 to 1994. In the March 2004 sampling episode, perchlorate was detected in wells P8 and TH1 at concentrations of 28 and 1 μg/L, respectively. Perchlorate was absent from all other monitoring wells sampled.

2.4.5 Investigation Summary

Sampling/analyses were performed as specified in the approved WPP Sampling Plan (Martino and Hayse 2003) to characterize site-related contaminants in soil, surface water, sediment, and groundwater. By using the retained COPECs from the WPP Sampling Design (Hayse and Martino 2004), Table 2.35 compares the maximum concentration of analytes in the ecologically important sample interval (0- to 1-ft below ground surface) from the 2004 study with soil sample results from previous studies. Contaminant concentrations detected in the biased samples collected in 2004 were higher than the maximum concentrations reported for previous studies. The soil sampling locations where maximum concentrations of retained COPECs were detected in the 0- to 1-ft below-ground-surface interval were evaluated further as part of the ecological risk refinement process (Martino et al. 2006). A subset of the retained COPCs was also evaluated as part of the HHRA (EA 2006). Similarly, sediment and surface water results were evaluated further as part of the ecological risk refinement and HHRA. Groundwater was not evaluated as part of the ecological risk refinement but was evaluated as part of the HHRA.

2.5 2006 HUMAN HEALTH RISK ASSESSMENT

EA Engineering, Science and Technology, Inc. performed an HHRA for the WPP AOC, which was finalized in March 2006 (EA 2006). The 2006 HHRA is a supplement to the previous J-Field HHRA (Ripplinger et al. 1998). Data included in the assessment were obtained from the investigation efforts in 2004 at the WPP AOC. Only the recent data were used because the previous open detonation activities were likely to have changed site conditions (EA 2006). The

2006 HHRA evaluated data from 45 surface soil, 19 subsurface soil, 15 groundwater, 8 sediment, and 6 surface water samples (see previous sections).

2.5.1 Risk Assessment Methodology

The 2006 HHRA evaluated potential sources of contamination and routes of migration and was based on current and future site uses. Noncarcinogenic and carcinogenic risks were evaluated by using EPA guidance (EPA 1989a) and the approach outlined in the approved work plan (EA 2005). The HHRA methodology involved four steps, each of which is described in the paragraphs that follow:

1. Hazard identification,

2. Exposure assessment,

3. Toxicity assessment, and

4. Risk characterization.

In the hazard identification, environmental monitoring data were evaluated, COPCs were selected for inclusion throughout the remainder of the risk assessment, and the rationale for their selection was documented. The human population or groups of individuals potentially exposed to COPCs (i.e., potential human receptors were identified). From the many potential pathways of exposure, pathways applicable to potential receptors at the site were identified (e.g., ingestion, inhalation) and included in a human health conceptual site model for the WPP AOC. The conceptual site model, adapted from the HHRA (EA 2006), is shown as Figure 2.26.

In the exposure assessment, concentrations of COPCs in relevant media (e.g., soil, water, air) were converted into systematic doses, taking into account the rates of contact and absorption rates of each COPC. The magnitude, frequency, and duration of these exposures were then integrated to obtain estimates of daily intakes over a specified period of time.

In the toxicity assessment, the relationship between extent of exposure and extent of toxic injury or disease was estimated for each COPC. Chemical-specific toxicity values, such as cancer slope factors for carcinogenic compounds and reference doses or reference concentrations for noncarcinogens, were presented along with a discussion of their scientific basis and derivation.

The risk characterization integrated the results of the toxicity assessment and the exposure assessment to derive quantitative estimates of human health risk, including risks of carcinogenic and noncarcinogenic effects. The major uncertainties and limitations associated with the estimates of risk and their potential ramifications were included in the risk characterization. The 2006 HHRA results are briefly summarized in the following sections.

2.5.2 2006 HHRA Conceptual Site Model

A generalized conceptual site model was initially developed to identify contaminant source areas, potential release and transport mechanisms, environmental media of concern, and potential human receptors and routes of exposure for the WPP AOC (Figure 2.26). This conceptual site model was developed on the basis of the current understanding of the site and took into account available monitoring and characterization data.

Current-use receptors include site workers and adolescent trespassers. While the future use of the site is unknown, it is located on an active military post that could be utilized at any time. Consequently, likely future-use receptors include construction and commercial workers. There are no residential areas on or in the vicinity of the WPP AOC. The site is located downrange, access is limited, and future residential use is unlikely. However, the HHRA did assess the hypothetical future residential use for adults and children (EA 2006).

Media of concern include surface soil (applicable to the current-use site worker and adolescent trespasser), total soil, and dispersion of soil particulates into air (applicable to potential future commercial workers and construction workers). Based on the site's location adjacent to the Gunpowder River, surface water and sediment are the potential media of concern in current-use site worker and adolescent trespasser exposure scenarios. It was assumed that construction workers could come into contact with groundwater during future construction activities at the WPP AOC. Finally, inhalation of volatiles in air that may migrate from groundwater into buildings was identified as a potential exposure pathway, so air is included as a medium of concern. Hypothetical future residential users could come into contact with total soil, particulates, groundwater, surface water, and sediment.

Under current use, site worker and adolescent trespasser exposure was assumed via the incidental ingestion of and dermal contact with surface soil, sediment, and surface water at the site. The future-use commercial worker was assumed to have incidental ingestion of and dermal contact with total soil. Commercial worker exposure to volatiles in indoor air emanating from the shallow groundwater was also assumed. The future-use construction worker was assumed to have incidental ingestion of and dermal contact with total soil and shallow groundwater. Hypothetical future residential users were assumed to have exposure via ingestion and dermal contact with total soil; inhalation of particulates; ingestion of and dermal contact with surface water, sediment, and groundwater; and inhalation of VOCs emanating from shower water or infiltrating into buildings.

2.5.3 Risk Characterization Results

After completion of the hazard identification and exposure and toxicity assessment steps of the HHRA process, a risk characterization was performed for the WPP AOC. In this step, the toxicity values were combined with the chemical intakes for the receptor populations to qualitatively estimate both carcinogenic and noncarcinogenic risks. Risks were estimated for each receptor of concern. For most contaminants evaluated, potential carcinogenic and/or noncarcinogenic human health risks were evaluated in accordance with EPA guidance (EPA

1989a). The evaluation of lead was an exception. According to the EPA, lead is classified as a probable human carcinogen (EPA 1999). However, there is no EPA value for use as a slope factor in quantifying carcinogenic risks. In the absence of any EPA-published toxicity values for lead, it is currently not possible to perform a quantitative risk estimate for lead exposures using standard EPA methodology. The current EPA guidance sets forth an interim soil cleanup level for total lead of 400 ppm (EPA 1989b). The exposure models used in the HHRA followed *Recommendations of the Technical Review Workgroup for Lead, An Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil* (EPA 1996b) and the Integrated Exposure Uptake Biokinetic (IEUBK) Model for Lead in Children (EPA 2002). The lead models are used to model blood lead levels — the indicator of excess lead exposure in humans — for exposure to lead in soil and groundwater. Modeled blood level results are compared with the established cutoff value or acceptable blood lead threshold of 10 μg/dL. The risk characterization results for each subgroup are presented below.

2.5.3.1 Adolescent Trespasser Results

The adolescent trespasser cumulative HI across all pathways is 0.10. For surface soil, the HI is 0.03, the surface water cumulative HI is 0.06, and the cumulative HI for sediment is 0.01. There are no noncarcinogenic COPCs with HQs exceeding the threshold of 1.0; therefore, there are no unacceptable noncarcinogenic risks estimated for the adolescent trespasser receptor.

Carcinogenic risks for the adolescent trespasser scenario are 4.8×10^{-7}, lower than the EPA acceptable risk range of 10^{-4} to 10^{-6}. Acceptable carcinogenic risks are estimated for the current-use adolescent trespasser receptor.

2.5.3.2 Site Worker Results

The site worker cumulative HI across all pathways is 0.03. There are no noncarcinogenic COPCs with HQs exceeding the threshold of 1.0; therefore, there are no unacceptable noncarcinogenic risks estimated for the site worker.

Carcinogenic risks for the site scenario are 6.4×10^{-7}, lower than the EPA acceptable risk range of 10^{-4} to 10^{-6}. Acceptable carcinogenic risks are estimated for the current-use site worker.

2.5.3.3 Future Commercial Worker Results

The commercial worker cumulative HI across all pathways is 0.03. No noncarcinogenic COPCs had HQs exceeding the threshold of 1.0; therefore, there are no unacceptable noncarcinogenic risks estimated for the future-use commercial worker.

Carcinogenic risks for the site scenario are 6.4×10^{-6}, which is within the EPA acceptable risk range of 10^{-4} to 10^{-6}. Two COPCs exceed the 1×10^{-6} cancer risk: arsenic (1.4 ×

10^{-6}) and TCE (5×10^{-6}). The risk from arsenic derives from ingestion and dermal contact with total soil, and the risk from TCE derives from modeled volatilization through the building floor.

2.5.3.4 Future Construction Worker Results

The construction worker cumulative HI across all pathways is 0.28. No noncarcinogenic COPCs had HQs exceeding the threshold of 1.0; therefore, there are no unacceptable noncarcinogenic risks estimated for the construction worker receptor.

Carcinogenic risks for the construction worker scenario are 4.6×10^{-7}, which is lower than the EPA acceptable risk range of 10^{-4} to 10^{-6}. Acceptable carcinogenic risks are estimated for the future-use construction worker.

2.5.3.5 Worker Lead Evaluation

The EPA has developed a model to predict blood-lead levels in adult workers (EPA 1996b). The model was run to assess current site workers and potential future commercial and construction workers. Model default parameters were used to predict blood lead impacts to the most susceptible subgroup (female workers and their unborn children) from exposure at the site. For future commercial and construction workers, the model predicts 95 percentile fetal blood-lead levels of 7.77 and 9.91 μg/dL, respectively. This is below the 10 μg/dL threshold; therefore, lead is not a concern for future workers at the WPP AOC based on the EPA model for total soil. The current site worker exposure scenario for lead in surface soil was modeled based on exposure limited to 50 days/year. The model predicts 95 percentile fetal blood-lead levels of 9.91 μg/dL. This is below the 10 μg/dL threshold. Consequently, lead is not a concern for current female site workers based on the EPA model for surface soil.

2.5.3.6 Hypothetical Future Resident Results

There are no residential areas on or in the vicinity of the WPP AOC. The site is located downrange, access is limited, and future residential use is very unlikely based on the past uses of J-Field. However, the HHRA did assess the hypothetical future residential use for adults and children (Appendix D, EA 2006). The results for future residential use were similar to those for future commercial workers, with risks associated with arsenic in soil and TCE in groundwater. Cancer risks above the EPA acceptable risk range of 10^{-4} were due to inhalation of TCE during showering by residential adults. However, as noted in the response to comments included in the March 2006 version of the HHRA, it has been determined that, because there is no groundwater plume at the site, there is no “real” risk. However, we recognize that if land use were to change, land use controls to restrict the use of groundwater would likely be necessary. The noncarcinogenic risks to residential adults and children from exposure to groundwater also had an HQ > 1, again largely due to TCE. The blood lead models (EPA 1996b and EPA 2002) were also run for the hypothetical future resident scenario. The model predicts 95 percentile fetal blood-lead levels greater than the 10 μg/dL threshold; therefore, lead in total soil at the WPP AOC is a concern for the hypothetical future child resident scenario.

2.6 ECOLOGICAL RISK ASSESSMENT

An ERA was performed for the WPP AOC to update the BERA 2000 (Hlohowskyj et al. 2000). Chemical data used for the ERA were based on the most recent analyses of soil, surface water, and sediment samples, which were collected from the WPP AOC during the spring and summer of 2004. Analyses were conducted for VOCs, PAHs, SVOCs, inorganic metals, CWA degradation compounds, pesticides, PCBs, explosive-related compounds, and perchlorate.

The updated ERA was based on chemical analyses from 49 soil samples collected from the WPP AOC. Only results of analyses for samples collected from depths of 0 to 2 ft were used in the ERA in order to characterize the soil horizon where biological activity is expected to occur. More specifically, analytes in samples collected from the 0- to 1-ft and 1- to 2-ft intervals were evaluated to determine statistical minimum, maximum, mean, and detection frequency. Soil samples were collected from seven locations (four in the Northern Pit and three in the Southern Pit), and sidewall samples were collected from eight locations (four in each pit) (Figure 2.19). Samples were also collected from 26 locations outside of the burn pits (Figure 2.20). These samples were collected from five locations in Grid 1, seven locations in Grid 2, and eight locations in Grid 3 (Figure 2.14). Six additional soil samples from areas adjacent to the burn pits (but outside of Grids 1, 2, and 3) and one additional sample from an area of shoreline that appeared to have been filled in with soil that may have originated in the pits were also analyzed in response to EPA comments on the April 2003 draft version of the Field Sampling Plan.

Unfiltered surface water samples were collected from five locations in the WPP AOC, including three samples from the estuarine Gunpowder River, one sample from the ditch that drains the Northern Pit, and one sample from the bermed depression that receives runoff from the Northern Pit. Surface water sampling locations are shown in Figure 2.23. All surface water samples were analyzed for VOCs, WP, metals, CWA degradation compounds, perchlorate, and explosive-related compounds (Table 2.29).

Sediments at the WPP were characterized on the basis of seven sediment samples collected at the site (Figure 2.22). Sites for intrusive sampling of estuarine sediment were selected on the basis of XRF analyses of sediment collected from 25 locations along the Gunpowder River shoreline. In general, locations with elevated XRF results for lead and/or zinc were targeted for the collection of intrusive sediment samples. The samples were analyzed for VOCs, WP, SVOCs, metals and other inorganic elements, CWA degradation compounds, perchlorates, and explosive-related compounds, as listed in Table 2.27.

Additional ecological effects assessments were conducted for surface water, sediment, and soil at the WPP AOC as part of the ERA. These additional toxicity tests, conducted using environmental media gathered from the WPP AOC, were performed in accordance with the approved WPP Sampling Design (Hayse and Martino 2004). The updated ERA results are briefly summarized in the following sections. The full updated ERA is included in the RI/ERA report (Martino et al. 2006).

2.6.1 Screening Ecological Risk Assessment

The screening-level ERA for the WPP AOC was based on and consistent with Steps 1 and 2 and the beginning of Step 3 of EPA's eight-step Ecological Risk Assessment Guidance for Superfund (EPA 1997). Step 1 is to develop a site conceptual model. Step 2 is to prepare a screening-level exposure estimate for each site contaminant at each assessment endpoint identified in Step 1. The beginning of Step 3 involves further refining the list of chemical constituents by considering additional criteria.

2.6.1.1 Conceptual Site Model

In Step 1, a conceptual site model is developed that describes the known or expected relationships between site COPECs and ecological resources at the WPP. The conceptual site model identifies the source areas, fate and transport mechanisms, assessment endpoints, representative ecological receptors, and complete exposure pathways for the site. Among the factors considered are contaminant sources, mechanisms for contaminant release to the environment, environmental transport of contaminants, point-of-receptor contact (exposure point) with contaminated media, and exposure route to the exposure point (Hope 1995).

As identified in the WPP Sampling Plan (Martino and Hayse 2003), the exposure pathways, assessment endpoints, and ecological receptors identified for the WPP AOC in the BERA 2000 (Hlohowskyj et al. 2000) are still considered applicable. Consequently, the conceptual site model presented in the BERA 2000 was the basis for the evaluation of the WPP AOC (Figure 2.27). The soils in the Northern and Southern Pits, the Suspect Pushout Area, and the Northwestern and Southwestern Suspect Burn Areas are believed to be the primary potential contaminant sources at the WPP AOC. Contaminants from these areas could be transported and made available to biota by surface runoff, infiltration and percolation, and gaseous emission. Secondary contaminant sources, resulting primarily from surface runoff of contaminated soils, include sediment and ephemeral surface water in the pits and in the depressed portion of the bermed area.

2.6.1.2 Screening-Level Exposure Estimate

In Step 2, a screening-level exposure estimate for each site contaminant is developed for each assessment endpoint identified in Step 1, and risks are estimated by comparing the exposure estimates to chemical-specific screening values. Risk-based screening for potential contaminants and exposure routes of concern is intended to make the ERA more efficient by focusing on the most significant contaminants and exposure pathways as early as possible. To accomplish this goal, the highest measured or estimated on-site contaminant concentration for each environmental medium is used as the estimate of exposure. This practice is intended to ensure that all potential chemical threats to ecological resources are considered (EPA 1997). Completion of Step 2 generates a preliminary list of COPECs — site-associated chemicals that potentially pose unacceptable risks to the assessment endpoints.

The screening exposure estimate and risk characterization in Step 2 were conducted in two ways. The first involved calculation of HQs for the detected constituents in each medium by comparing maximum concentrations of constituents in soil, sediment, and surface water to conservative medium-specific screening benchmarks accepted by EPA Region III (EPA 1995; EPA 2005 [freshwater screening values can be found at http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fw/screenbench.htm]). Ecological screening values used for soil, sediment and surface water, together with supporting references, are summarized in Appendix C of the QAPP (Kimmell et al. 2003). These benchmark concentrations are considered to be protective of organisms that dwell in or have close contact with media from the site.

The second part of the screening consisted of modeling food-chain exposures to constituents for an assortment of mammalian and avian fauna. In this part of the screening process, a conceptual food chain model was developed that identified contaminant sources, exposure routes, and food chain (or web) relationships for each receptor. Mathematical equations to predict contaminant uptake, expressed as an applied daily dose, were then developed according to EPA guidance (EPA 1993b) and/or mathematical approaches published in the scientific literature. Bioaccumulation factors (BAFs) obtained from the literature were used to estimate concentrations of constituents in prey items. The daily doses of chemical constituents were calculated by using the maximum measured or estimated media concentrations, and the modeled doses were then compared with available dose-based screening benchmarks for the organisms considered.

For purposes of the preliminary screening, a constituent was carried forward to the refinement screening step when any of the available concentration-based or dose-based SEVs was exceeded. Of the constituents detected at the WPP AOC, five organic compounds were present at levels below the available SEVs in both concentration- and dose-based evaluations conducted during the preliminary screen (Table 2.36). According to the preliminary screen, these five constituents (4,4-DDD, endrin aldehyde, γ-chlordane, PCB-1254, and pyrene) were present at concentrations that are considered safe for all of the assessment endpoints evaluated and were not considered further in the ERA process. The remaining constituents were considered further in the screening refinement step.

The preliminary screening process used here was a very conservative evaluation that utilized maximum detected concentrations as the exposure point concentrations, assumed that the constituents were in highly bioavailable forms, and assumed that the representative receptors utilized only the WPP AOC for feeding. Consequently, constituents that exceeded the concentration- or dose-based SEVs during the preliminary screening step may still be present at concentrations that pose acceptable risks to the ecological assessment endpoints.

2.6.1.3 Refinement of the Screening-Level Risk Characterization

Because the screening-level ERA presented here was conducted in order to update the existing BERA 2000, the initial portion of Step 3 identified in Superfund guidance (EPA 1997) was included as part of the screening process for COPECs. This additional refinement step used four principal criteria to determine whether chemical constituents should be retained as COPECs:

1. Elimination of analytes that were considered unlikely to pose ecological risks at the WPP because of site conditions that are known to limit bioavailability and potential toxicity even though maximum concentrations exceeded SEVs.

2. Elimination of analytes considered to be macronutrients.

3. Elimination of analytes that were present at concentrations within the range of measured background concentrations.

4. Elimination of analytes when reevaluation using the 95% upper confidence limit of the mean (95% UCL) concentrations resulted in HQs less than 1 when exposure concentrations and doses were compared with concentration-based or dose-based SEVs.

The outcome of the overall screening-level evaluation process was the selection of a final set of COPECs and ecological exposure pathways that warranted further analysis in the ERA. The final COPECs are those chemical constituents that exceeded SEVs under more realistic, site-specific conditions and that exceeded background concentrations. Contaminants were also retained for further evaluation in the ERA when no background concentrations or SEVs were available for comparison.

Nine inorganic constituents and 12 organic constituents were retained as COPECs following the screening refinement step (Table 2.37). Most of the retained COPECs were in soil, with eight metals and nine organics retained. In surface water, three metals (arsenic, barium, and lead) were retained as COPECs; no organic compounds were retained. One metal (zinc) and three organic compounds (acetone, benzaldehyde, and benzyl butyl phthalate) were retained as COPECs in sediments.

2.6.2 Toxicity Tests

In addition to evaluation of exposure and effects based solely on concentrations and modeled doses of COPECs and the resulting HQs, toxicity tests were conducted with soil, surface water, and sediment in order to compare the toxicities of media from the WPP AOC with those of reference locations. APG proposed and received approval to perform a number of toxicity tests using environmental media collected from discrete locations of the WPP AOC (Martino and Hayse 2003). Toxicity testing was used to provide measurements of the effects on growth, reproduction, development, and survival for a variety of surrogate organisms as a means of evaluating potential risks to some assessment endpoints. The methods and results for the toxicity tests are briefly described in the following sections. More detailed descriptions of methods and results are provided in the full report on the toxicity testing (Martino et al. 2006).

2.6.2.1 Toxicity Test Methods

Surface Water

Grab samples of surface water from the WPP AOC were collected on January 10, 12, and 14, 2005, at sample locations WPSW7 and WPSW9 (Figure 2.28). Water samples were also collected from these locations on January 10 and 14, 2005, to determine the concentrations of heavy metals and VOCs.

Toxicity tests conducted using surface water included 96-h green alga growth tests using *Raphidocelis subcapitata*; 7-day survival and reproduction tests using cladocerans (*Ceriodaphnia dubia*); 7-day survival and growth tests using the fathead minnow (*Pimephales promelas*); and 96-h frog embryo teratogenesis assays (FETAX) using *Xenopus laevis*.

Sediment

Sediment samples were collected on January 12, 2005, from sample locations SED2, SED4, SED5, and SED6 (Figure 2.28) and from a reference location on Saltpeter Creek, a tributary of the Gunpowder River. Subsamples collected from each sample location were combined and mixed to form composite medium samples for each location.

All sediment samples, with the exception of SED5, were sieved through 250-µm stainless steel mesh to remove debris, competitors, and predators. The sediment from SED5 could be sieved only through a 500-µm stainless steel mesh because of the coarse sand particles in the sample. The sediments that passed through the sieves were used in the toxicity tests.

General sediment quality, grain size, heavy metals, simultaneously extracted metals (SEM), and acid-volatile sulfide (AVS) analyses were performed on an aliquot from each composite sediment sample taken from J-Field. SVOCs and explosive-related compound concentrations were determined only for sediment taken from sample location SED6.

Five 1-L aliquots were taken from each composite sediment sample and used as replicates for the toxicity tests. Survival, growth, and reproduction of the epifaunal amphipod *Hyalella azteca* and the infaunal amphipod *Leptocheirus plumulosus* were evaluated in separate 28-day toxicity tests conducted using sediment from each collection location and from the reference location.

Soil

Soil was collected for toxicity testing on January 10–12, 2005, from 10 locations at the WPP AOC (Figure 2.29). On the basis of the previous evaluation of chemical concentrations and soil conditions, the sample collected from location SO-25 was considered to be an on-site reference sample for the toxicity testing. Prior to soil sample collection, plants and other debris were removed from an area measuring approximately 6 ft^2 (0.6 m^2) at each sampling location. The soil in each area was then turned over and mixed to a depth of approximately 6 in. with a shovel, and a 10-L composite sample was taken from each location for the lettuce seed and earthworm assays.

An additional aliquot was collected from the mixed soil at each location for chemical analyses. Heavy metal concentrations were determined in seven of the nine study soils; mercury concentration was determined in one soil sample; pesticide and PCB concentrations were analyzed in two samples; and concentrations of PAHs were analyzed in four samples. General soil quality parameters were measured in nine of the soil samples. The reference soil was analyzed for general soil quality, heavy metals (including mercury), PAHs, pesticides, and PCBs.

Ten replicated 120-h lettuce seed germination tests with *Lactuca sativa* and 10 replicated 28-day survival and bioaccumulation tests were conducted, and the earthworm *Eisenia fetida* was exposed to the collected soils. Site-specific values of bioaccumulation of chemical constituents by earthworms were evaluated by comparing the concentrations of analytes in earthworm tissues at the end of the 28-day toxicity tests with concentrations in the soil used to conduct the earthworm toxicity tests.

2.6.2.2 Results and Discussion

Surface Water

Four metals (aluminum, copper, iron, and lead) were present at concentrations that exceeded the Region III Biological Technical Assistance Group's (BTAG) screening levels and/or EPA freshwater chronic ambient water quality criteria (AWQC) in water samples used to evaluate toxicity. The concentration of copper was slightly above the chronic AWQC value in WPSW7, and the concentration of lead was greater than the chronic AWQC value in the samples from both WPSW7 and WPSW9.

The toxicity of surface water collected from the WPP pond (WPSW7) and the shoreline of the Gunpowder River (WPSW9) (Figure 2.28) with respect to the tested green alga, cladoceran, frog, or fish species was not significantly different from that observed in controls. The four types of aquatic toxicity tests conducted are considered useful for estimating chronic toxicity to the test organisms, and the EPA considers the green alga, cladoceran, and fathead minnow tests to be short-term methods for estimating the chronic toxicity of surface water (Lewis et al. 1994). The American Society for Testing and Materials (ASTM) has stated that the frog (FETAX) test might be useful in estimating chronic toxicity (ASTM 2004); the State of

California considers the FETAX test a short-term chronic test, because it covers 36 to 39 developmental stages, from stage 8 (blastulae stage) or stage 11 (gastrulae stage) up to stage 46 (free-swimming tadpole) (Fort 2005). Taken collectively, the tests indicated that surface water from these two locations was not chronically toxic to aquatic organisms.

Ambient water quality criteria are derived to be protective of 95% of the species (Stephan et al. 1985). It is possible that the four test species used in this evaluation were more tolerant to the metals than 95% of the freshwater species that should be protected. However, this is doubtful, because toxicity data for cladocerans (*C. dubia* and/or *Daphnia magna*) and the fathead minnow were used in the AWQC derivations for aluminum (EPA 1988a), copper (EPA 1985), and lead (EPA 1984). Thus, the chronic AWQC values for these COPECs are likely conservative for the site-specific water conditions at the WPP AOC. On the basis of these results, the concentrations of the COPECs in surface water at the WPP AOC pose an acceptable risk to aquatic plants, aquatic invertebrates, fish, and amphibians exposed to surface water from the WPP AOC.

Sediment

Compared with sediments from the reference location, the sediment from the WPP pond (SED6) and the sediments (SED2 and SED5) collected along the shoreline of the Gunpowder River (Figure 2.28) were not toxic to *Hyalella* or *Leptocheirus*. However, sediment from SED4 was toxic to both species. Lead appears to be the toxicant responsible for the toxicity at SED4, where the concentration was 521 mg/kg sediment (dry weight). The Region III BTAG screening level for animals exposed to lead in sediment is 46.7 mg/kg. The National Oceanic and Atmospheric Administration's (NOAA's) Effects Range-Low level for lead, which is calculated as the lower 10^{th} percentile concentration of the available sediment toxicity data identified to be toxic, is also 46.7 mg/kg (Long and Morgan 1990). The NOAA's Effects Range-Medium level for lead, which is the median concentration identified to be toxic in the reviewed sediment toxicity data, is 218 mg/kg. The concentrations of lead at SED2, SED5, and SED6, where no toxicity was indicated during testing, were 41.2, 37.0, and 30.1 mg/kg, respectively.

The SEM and AVS data do not help explain why toxicity occurred at SED4 but not at the other sites. It has been established that when SEM:AVS ratios are <1, toxic effects caused by the SEM (cadmium, copper, lead, mercury, nickel, and zinc) do not occur in anaerobic sediments (DiToro et al. 1991). Hansen et al. (1996) have shown that toxicity in both freshwater and marine sediments increases by approximately 40% when the SEM:AVS ratio is >2 and by approximately 50% when the ratio is >5. Long et al. (1998) have shown that much less toxicity occurs when the ratio is between 1 and 2. The measured SEM:AVS ratio at SED4 was 18.3. The ratios at SED2, SED5, and SED6 were 25.7, 16.7, and 4.4, respectively. Based on the SEM:AVS ratios alone, one would predict that some toxicity would also occur at SED2 and SED5, and possibly SED6. However, this was not the case at the WPP. The SEM/AVS model proposed for predicting toxicity from metal-contaminated sediments is generally applicable only to anaerobic sediments (Chapman et al. 1998). Because of the predominance of sand in the sediment samples taken at SED2, SED4, and SED5 (57.9 to 71.2%), the aerobic and anaerobic horizons in the samples could not be reliably separated. Thus, the SEM/AVS model for predicting toxicity may not be relevant for the samples evaluated.

The toxicity observed at SED4 does not appear to be related to culturing and testing conditions. The *Hyalella* and *Leptocheirus* tests met all of the overlying water quality and reference toxicant criteria specified in the test protocols during acclimation and testing, as well as the test acceptability endpoint criteria discussed above.

Organic carbon content has been shown to be important for sorption of heavy metals in sediments (Grant and Middleton 1998; Mahony et al. 1996). Sorption increases as organic carbon concentrations increase. The TOC concentration was slightly higher at SED4 (5,100 mg/kg dry weight) than at SED2 (4,200 mg/kg) and SED6 (1,200 mg/kg). Although the TOC concentration was only slightly higher at SED4, the lead concentration at SED4 was over an order of magnitude higher than at the other sites. Thus, it is doubtful that the TOC would be sufficient to reduce lead toxicity at SED4 relative to the other sites.

Sediment grain size has been shown to affect the well-being of some sediment organisms. However, *Hyalella* and *Leptocheirus* have been shown to tolerate a wide range of sediment types, and there is generally little effect on survival, growth, or reproduction when coarse-grained (sand) or fine-grained (predominantly silt/clay) sediment is used. The EPA (EPA 2001) recommends that *Leptocheirus* be tested with sediment silt/clay content between 5 and 85%. The sediment at SED4 had a silt/clay content of 33.7%, and the silt/clay content for the other locations ranged from 28.8% at SED5 to 67.2% at SED6. Thus, it is unlikely that grain size was responsible for the toxicity measured at SED4.

On the basis of these results, the concentrations of COPECs in sediments from the bermed area at the WPP AOC pose an acceptable risk to benthic invertebrates. While unacceptable risks to benthic organisms from concentrations of COPECs in sediment along the Gunpowder River shoreline do not appear to be widespread, toxicity indicates unacceptable conditions in the vicinity of sample location SED4. Based on the evaluations conducted, the toxicities observed in the samples from SED4 were attributable to elevated lead concentrations. Previous sampling of sediments from the WPP ERA found that lead concentrations did not exceed concentrations detected in background sampling. However, it appears that lead concentrations are heterogeneously distributed along the Gunpowder River shoreline, and the concentration of lead measured in sediments collected from SED4 for toxicity tests was over two times greater than the maximum concentration identified in background samples. Consequently, lead was retained as a COPEC for sediments at the WPP AOC.

Soil

The soils at the WPP were not toxic to lettuce seed germination or to the growth and survival of earthworms. Although the soils were not toxic, concentrations of all heavy metals, with the exception of arsenic, exceeded plant-screening levels in most of the soils, including the reference soil. Nevertheless, the WPP site is well-vegetated with upland grasses and forbs. Concentrations of seven of the 12 EPA priority pollutant heavy metals exceeded animal-screening levels in one or more of the experimental soils. Note that these screening values serve as a set of conservative guidelines that function as a starting point for assessing the potential for ecological risk when insufficient information is available (EPA 1995). The lack of toxicity to both lettuce and earthworms indicates that the screening values for plants and animals may indeed be conservative for the site-specific conditions in soils at the WPP AOC. According to the results of the toxicity testing, it appears that the concentrations of COPECs in soils at the WPP AOC pose acceptable risks to terrestrial plants and soil invertebrates.

Metals did not bioaccumulate significantly in earthworms at levels above background concentrations during the 28-day exposures to the WPP soils. With the exception of aluminum and cobalt, for which little or no earthworm bioaccumulation data are available, a number of studies have documented BAFs <1 for earthworms exposed to soil metal concentrations similar to those at the WPP (e.g., see Beyer and Cromartie 1987; Burton et al. 2003; Peijnenburg et al. 1999; and Sample et al. 1999). Cadmium appears to be the only exception. The 28-day BAFs for cadmium were ≤0.1 for earthworms exposed to soil samples from the WPP AOC with concentrations that ranged from 0.4 to 3.6 mg/kg (dry weight). Several investigators have found BAFs that range from a low of 0.6 to a high of 91.1 in field-collected earthworms taken from soils that contain cadmium at concentrations ranging from 0.3 to 11 mg/kg dry weight soil (Beyer and Cromartie 1987; Gish and Christensen 1973; Helmke et al. 1979; Hendriks et al. 1995; Ireland 1979; and Ramos et al. 1999). A cadmium bioaccumulation regression model by Neuhauser et al. (1995) estimated a cadmium BAF in the earthworm of 3.5 at a cadmium concentration of 0.1 mg/kg dry weight soil, while a regression model by Sample et al. (1999) predicts a BAF of 4.5 for soil containing cadmium at 0.1 mg/kg dry weight.

Twenty-eight day BAFs of 1.0, 1.2, 1.5, and 1.6 were estimated for γ-chlordane at SO-25, α-BHC at SP-7-WALL, 4,4-DDT at SO-25, and dieldrin at NP-7-WALL, respectively, from the chemical characterization data sets for pesticides at the WPP AOC. The estimated BAFs for 4,4-DDD, 4,4-DDE, and methoxychlor were all less than 1. These low BAFs are not surprising when one considers the low concentrations of pesticides detected in the WPP soils. Three of the four BAFs greater than 1 occurred in earthworms exposed to soils that had no measurable pesticide concentrations (i.e., concentration below the detection limit in the soil). The 28-day BAF of 1.6 for dieldrin at NP-7-WALL occurred in earthworms exposed to a soil concentration of only 0.31 μg/kg dry weight soil.

There appears to be a linear correlation between the concentration of chlorinated pesticides in earthworms and that in the corresponding soil (Davis 1971; Gish 1970). Although this correlation is widely accepted, recent studies have shown that these compounds undergo a time-dependent sequestration in soil that results in a decline in bioavailability without a parallel decline in measured concentration of the compounds (e.g., Alexander 1995; Morrison et al. 2000; Reid et al. 2000; Shor and Kosson 2000). Thus, as "aging" occurs, bioavailability decreases, resulting in reduced bioaccumulation. The low concentrations of pesticides and aging of the compounds in the WPP soils may be the primary reasons for the low BAFs observed for pesticides from the AOC.

The mean BAF for each COPEC was multiplied by the exposure point concentration in soil for that COPEC to estimate the tissue concentrations of COPECs in earthworms. These values were then used in the contaminant uptake models to recalculate the doses of COPECs and the resulting HQs for the representative terrestrial receptors (American robin, red-tailed hawk, white-footed mouse, eastern cottontail, red fox, and mallard). In most cases, the resulting HQs were not substantially different from values found following the refinement of the exposure assessment. The most notable difference is that, before consideration of the site-specific BAF, 4,4-DDT was identified as a COPEC for the American robin with an HQ of 1.4. Consideration of the site-specific BAF resulted in an HQ of 0.5 for the American robin. Consequently, 4,4-DDT is no longer identified as a COPEC for the WPP AOC.

The HQs for a number of other COPECs were lower, but still greater than 1. For the American robin, such COPECs included aluminum, barium, cadmium, lead, and zinc. For the mouse, dose-based HQs for aluminum, arsenic, barium, and lead were lower using the site-specific BAF estimates, but still exceeded 1. The HQ for aluminum for the red fox ranged from 3.6 to 3.1. HQs for the red-tailed hawk, the eastern cottontail, and the mallard were largely unaffected by the use of the site-specific BAF values, either because the receptor did not consume soil invertebrates (eastern cottontail and the mallard) or because the concentrations of COPECs in soil invertebrates made up a relatively small contribution to the exposure for the organism (red-tailed hawk).

On the basis of the results of the toxicity tests and bioaccumulation measurements, the concentrations of COPECs in soils at the WPP AOC appear to present acceptable risks to plants and soil invertebrates.

2.6.3 Final Ecological Risk Characterization

On the basis of the results of the ecological exposure and effects assessments, the concentrations of the COPECs in surface waters at the WPP AOC pose acceptable risks to aquatic plants, planktonic invertebrates, fish, and amphibians. While some HQs indicated a potential for risks to some aquatic organisms, site-specific evaluations using toxicity tests indicated that either the SEVs used to calculate the HQs were conservative or that the bioavailability of the COPECs under conditions specific to the WPP AOC was low enough that toxicity was not expressed.

For the most part, sediments at the WPP AOC appear to pose acceptable risks to sediment invertebrates and to semi-aquatic avian species, such as ducks, that might utilize aquatic habitats at the WPP AOC. One caveat, however, is that there may be selected small areas in the Gunpowder River just offshore of the WPP AOC where lead concentrations in the sediments may be high enough to affect the survival and growth of benthic invertebrates. Given the large amount of shoreline area along the Edgewood peninsula and the greater Gunpowder River, it is anticipated that such localized areas would not substantially affect overall invertebrate production within the local area. Consequently, the overall effects of COPECs in sediments from the WPP AOC on ecological resources are likely to be minor.

Toxicity tests with soils from the WPP AOC indicated that COPECs in soils are unlikely to affect terrestrial plants and soil invertebrates. Dose-based uptake modeling and calculation of dose-based HQs indicate a potential for negative effects on omnivorous terrestrial birds and mammals with small home ranges. Birds and mammals, such as larger carnivorous species, that would utilize habitats at the WPP AOC for a relatively small proportion of their foraging needs are likely not at risk from the concentrations of COPECs that are present at the WPP AOC. The potential risks that were identified are largely associated with the presence of elevated concentrations of heavy metals such as chromium, lead, and zinc, which may have resulted from the past activities at the WPP AOC. It should be noted, however, that the contaminant uptake models were based upon the 95% UCL concentrations, and the resulting HQs likely comprise a conservative analysis that overestimates the potential for risks from the WPP AOC. In the absence of additional information, however, it is concluded that the concentrations of heavy metals in soils at the WPP AOC, especially chromium, lead, and zinc in the immediate vicinity of the Northern and Southern Pits, pose a minor to moderate risk to some of the assessment endpoints evaluated.

Overall, the WPP AOC encompasses a small area, and only a small portion of that overall area is likely to contain contaminants at levels that may elicit effects on ecological receptors. As a result, the concentrations of COPECs at the WPP AOC are unlikely to affect ecological sustainability of any of the species that may utilize the habitats at the AOC. At most, only a small number of individuals would be likely to be affected each year by the concentrations of COPECs at the site. Consequently, the overall ecological significance of risks to any of the assessment endpoints is considered negligible.

It is worth comparing the conclusions from the BERA 2000 (Hlohowskyj et al. 2000) with those of this more current ERA (Martino et al. 2006). In the BERA 2000, potential risks were identified for the growth and germination of terrestrial plants from COPECs in soils, while no such risks were identified in the current ERA. However, the potential risks identified in this ERA were largely the same with regard to other terrestrial assessment endpoints and the assessment endpoints for aquatic biota. Both ERAs identified that omnivorous birds and small mammals might be at risk from concentrations of heavy metals at the site and similarly identified acceptable risks to higher-level terrestrial consumers. The BERA 2000 identified potential risks to green alga based on toxicity testing with surface water; the current ERA did not. The difference may be related to slightly different testing protocols: the recent testing protocol employed standardized nutrient concentrations among reference and WPP AOC surface water samples, while the previous evaluation did not. While the recent toxicity evaluation identified potential risks to benthic invertebrates from lead concentrations in sediment, these were sediments from the shoreline of the Gunpowder River, which were not evaluated in the BERA 2000.

3 REMEDIAL ACTION OBJECTIVES

3.1 OBJECTIVES AND SCOPE

The overall objectives of any proposed remedial actions at the J-Field WPP AOC are to:

- Prevent exposure to surface soil containing contaminants at concentrations above acceptable levels and

- Minimize the potential for contaminant migration to other media such as air or surface water.

The discontinuous areas of lead contamination at the WPP AOC were presented in Sections 2.3.2 and 2.4.1. These areas include the locations of surface soil samples collected in and around the Northern Pit and an area west of the Southern Pit. Lead concentrations above 400 mg/kg (highlighted in Table 3.1) were evaluated based on EPA guidance (EPA 1989b). The lead analytical results for all soil samples collected in 2004 are given in Table 3.1. Results of the HHRA, discussed in Section 2.5, indicate minimal risks to human health for current use and any likely future-use scenarios at the WPP AOC. However, evaluation of the residential future-use scenario revealed health risks to children from soil lead concentrations. The results indicated that lead exists in surface soil at concentrations up to 33 times higher than residential screening values.

Technologies that could be applied to address contaminated near-surface soil at the WPP AOC are discussed in Section 4. Figure 3.1 shows the areas to be addressed by the proposed actions. The approximate volume of soil containing contaminants at concentrations above screening levels is 125 yd^3 (95.6 m^3), assuming a thickness of 2 ft (0.6 m). This encompasses a 10-ft by 20-ft (3-m by 6-m) area surrounding sample locations SO-11 and SO-12 west of the Southern Pit and an approximately 150-ft by 10-ft (46-m by 3-m) area along the northern wall of the Northern Pit (sample locations SO-3, NP-6-WALL, NP-7-WALL, and NP-8-WALL; see Figure 3.1). The preliminary soil remediation levels developed for the surface soils at the J-Field WPP AOC (discussed in Section 3.3) were used to determine the area that should be addressed as part of the proposed remedial action.

3.2 COMPLIANCE WITH REGULATORY REQUIREMENTS

3.2.1 Applicable or Relevant and Appropriate Requirements: An Overview

Section 121 of CERCLA and provisions of the National Oil and Hazardous Substances Pollution Contingency Plan (EPA 1990b) require EPA to ensure that cleanup actions implemented under CERCLA meet the specifications of ARARs. Applicable requirements are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental or facility siting laws that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be applicable.

Relevant and appropriate requirements are cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state environmental or facility siting laws that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances at a CERCLA site, address problems or situations sufficiently similar to those encountered at a CERCLA site that their use is well suited to the particular site. Only those state standards that are identified by a state in a timely manner and that are more stringent than federal requirements may be relevant and appropriate.

As described in EPA guidance (EPA 1990b), ARARs can be divided into three categories: chemical-specific, location-specific, and action-specific. Chemical-specific ARARs address certain chemical species or classes of contaminants and relate to the allowable limits of contaminant concentrations in various environmental media (soil, groundwater, surface water, air). These ARARs can be used to determine cleanup levels at a CERCLA site. Location-specific ARARs are based on the specific setting and nature of the site, such as proximity to wetlands, floodplains, or archaeological resources. Action-specific ARARs relate to specific response actions (e.g., excavation or treatment activities) that are proposed for implementation at the site.

In addition to ARARs, the National Contingency Plan provides for the use of other advisories, criteria, or guidance "to-be-considered" (TBC). TBCs are advisories, criteria, and standards that are issued by the federal or state regulatory body but are not legally binding because they have not been promulgated. The identification of TBCs is not mandatory; however, they are to be used, as appropriate, to complement the ARARs.

Potential ARARs for the proposed actions described in Chapters 6 and 7 are identified on the basis of the nature of contamination, the site location, and the proposed activities. A comprehensive list of potential location- and action-specific ARARs and TBCs, including both federal and State of Maryland requirements, is provided in Appendix A.

3.2.2 Waivers and Variances

Remedial alternatives that do not meet the requirements of an ARAR may qualify for a waiver or variance. Waivers apply only to the attainment of the ARAR; other statutory requirements, e.g., that remedies be protective of human health and the environment, cannot be waived (CERCLA §121[d][4]). The waivers provided in this guidance are listed below:

- *Interim Remedy*: An action that will not attain all applicable or relevant and appropriate requirements is an interim measure, which will be followed by a complete measure that will attain all ARARs.

- *Equivalent Standard of Performance*: Equivalent or better results can be obtained using a design or method different from that specified in the ARAR.

- *Greater Risk*: Compliance with an ARAR will cause greater risk to human health and the environment than noncompliance.

- *Technical Impracticability*: Achieving an ARAR(s) is impracticable from an engineering perspective.

- *Inconsistent Application of State Requirements*: Regarding a state standard, requirement, criterion, or limitation, the state has not consistently applied (or demonstrated the intention to apply consistently) the standard, requirement, criterion, or limitation in similar circumstances for other remedial actions.

- *Fund Balancing*: The costs associated with meeting an ARAR to obtain an added degree of protection or reduction of risk would jeopardize the funds for remedial actions at other sites.

3.2.3 Cleanup Levels Based on ARARs

Cleanup levels at a CERCLA site are generally established on the basis of chemical-specific ARARs, which are requirements or risk-based numerical limits that establish the allowable amount or concentration of a hazardous substance that may exist in or be released to the environment. The contaminant of concern identified by the HHRA for the WPP AOC is lead. However, no state or federal chemical-specific ARARs address lead in soil. The results of the HHRA indicate that the concentrations of lead in the site soils may pose risks to hypothetical future child residents. Due to the absence of published toxicity values, the risk assessment did not follow standard EPA methodology. The HHRA followed guidance from the EPA's Technical Workgroup for Lead, in which exposure models use an endpoint of blood lead levels (EPA 1996b). The HHRA also cited EPA's Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites, which sets forth an interim soil cleanup level for total lead at 400 ppm (mg/kg) (EPA 1989b). This soil cleanup level is not a chemical-specific ARAR, but is a chemical-specific TBC.

An additional chemical-specific TBC for soil at the WPP is the State of Maryland Department of the Environment's Cleanup Standards for Soil and Groundwater, August 2001 Interim Final Guidance (Update No. 1). This guidance is intended to be a technical supplement for Maryland Department of the Environment programs, including the Voluntary Cleanup Program. This guidance is referred to as "Cleanup Standards," but is considered guidance only (MDE 2001). The Maryland Soil Standards Guidance for lead is 400 mg/kg for both residential and nonresidential cleanup.

3.3 PRELIMINARY SOIL REMEDIATION LEVELS

The development of risk-based cleanup levels early in the RI/FS process can aid in identifying appropriate remedial action alternatives at a site. The site-specific information required to develop risk-based cleanup levels usually consists of (1) the medium of concern, (2) the contaminant(s) of concern and their concentrations, (3) exposure pathways and potential receptors, and (4) probable future land use. As stated above, the risk assessment for lead could not follow standard EPA methodology. The site-specific information, including current and probable future land use at the WPP AOC, is available. In light of the lack of promulgated standards for lead in soil, the preliminary soil remediation level in this FFS for lead is 400 mg/kg (EPA 1989b).

4 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

A list of potential remedial actions for the WPP AOC was developed by identifying technology types and process options that are potentially applicable to addressing soil contaminated with lead. The technology types and process options were then screened for applicability to the site in accordance with EPA guidance (EPA 1988b).

4.1 CRITERIA FOR IDENTIFYING AND SCREENING TECHNOLOGIES

Technologies identified in this section were screened on the basis of site-specific conditions and current understanding of the WPP AOC. Section 121 of CERCLA identifies a strong statutory preference for remedial actions that are highly reliable and provide long-term protection. The primary requirements for a selected remedy are that it protect human health and the environment and meet the objectives of the proposed action in a cost-effective manner. Additional selection criteria include the following:

- In preferred remedies, the principal element is treatment to permanently or significantly reduce toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants.

- Where practical treatment technologies are available, off-site transport and disposal without treatment is the least preferred alternative.

- Permanent solutions and alternative treatment technologies or resource recovery technologies should be addressed and used to the maximum extent practicable.

These criteria have been considered in identifying and screening technologies to determine the appropriate components of the remedial action alternatives for the WPP AOC.

The remedial action objectives for the site are described in Section 3. Based on the current understanding of the nature and extent of contaminants in the site soils, general response actions that could be implemented to achieve these objectives are (1) land use controls, (2) in-situ containment, and (3) removal and disposal or ex-situ treatment. Specific application of these technologies to site conditions was evaluated to determine which would be most appropriate for remediation of the WPP AOC.

Potentially applicable technology types and process options were screened on the basis of effectiveness, implementability, and cost, as defined below.

- Effectiveness — in terms of protecting human health and the environment in both the short term and long term;

- Implementability — in terms of technical and administrative feasibility and resource availability; and

- Cost — in a comparative manner (i.e., low, moderate, or high) for technologies of similar performance and/or implementability.

These screening criteria were applied only to the technologies and general response actions being evaluated; combinations of technologies to address site-specific contamination problems were evaluated after the technologies were assembled into alternatives. This evaluation is presented in Section 5.

4.2 POTENTIALLY APPLICABLE TECHNOLOGIES

4.2.1 Land Use Controls

Land use controls (LUCs) are measures that preclude or minimize public exposure by limiting access to or use of contaminated areas. LUCs include measures to restrict access, such as:

- Zoning/subdivision regulations
- Covenants/easements
- Deed notices
- Public advisories
- Building codes
- Permit processing
- Health code covenants
- Groundwater use restrictions
- Engineering controls
- Security guards
- Inspections and monitoring

LUCs do not reduce contaminant toxicity, mobility, or volume, but they can reduce the potential for exposure to contaminated material.

A suite of APG-specific LUCs are currently used to manage the exposure of site workers to unexploded ordnance (UXO) hazards and contaminated soil at the WPP site and to preclude access to the WPP site by trespassers. Any range maintenance work involving intrusive activities at the WPP is regulated under APG regulation APGR 385-7, which requires a permit from the APG Directorate of Installation Operations' Excavation Control Office. As part of the permit approval process, the approving authority requires site workers to observe requirements including, but not limited to: utility avoidance, ordnance avoidance, management standards for disturbed soil, and operating under an APG-approved health and safety plan.

J-Field and thus the WPP AOC is located in a restricted section of the proving ground. Access to the restricted area is limited to properly cleared personnel or individuals in an escorted capacity. To prevent unauthorized access, a wide variety of physical security countermeasures are in place, including barrier systems, sensors, and random patrols by law enforcement personnel. Because of the inherent dangers associated with testing and research, the use of the waters surrounding the proving ground is restricted by the federal government. The water areas surrounding APG are monitored by law enforcement and security personnel through active patrols and other technical means. Beaching of boats on or walking on the shorelines or islands within the restricted water zone is prohibited at all times. Boaters are advised not to handle or attempt to remove any items found within the proving ground. These items may be extremely dangerous and may include UXO. Persons outside any vessel for any purpose, including (but not limited to) swimming, scuba diving, or any other purpose are considered in violation of navigation. Violators are subject to prosecution under 18 U.S.C. Section 1382, and other applicable statues.

The shoreline of the WPP is located within the restricted water zone. The proving ground operates a fleet of patrol boats that are positioned at the perimeter of the restricted water zone boundaries during testing operations. Loud speakers and flashing red or blue lights are installed on all patrol boats to make them easily identifiable. The restricted water zone surrounding APG is normally open for navigation and fishing when not used for testing. Navigation includes anchoring a boat within the restricted water areas or using the restricted water areas for water-skiing, provided no boat or person touches any land (either dry land or underwater land) within the proving ground reservation and that no water skier comes closer than 220 yd (200 m) to any shoreline. However, public access to the nearshore waters west of the WPP is restricted at all times. These measures mitigate potential public exposure to contamination.

A groundwater monitoring well network is currently in place at the WPP AOC. Lead levels in groundwater do not pose human health risks under current or future-use scenarios. Therefore, future groundwater monitoring for lead at the site is not addressed in this FFS. Future groundwater monitoring to assess other contaminants of concern (i.e., TCE and arsenic) can be added (if necessary) to the current J-Field long-term monitoring program.

The screening analysis for land use controls is summarized in Table 4.1. On the basis of effectiveness, implementability, and cost, all land use controls currently in place have been retained as potentially applicable to address surface soil contamination at the WPP AOC. The potential for significant public exposure will remain low because land use can be controlled, and access to contaminated areas is restricted.

4.2.2 In-Situ Containment

In-situ containment technologies reduce contaminant mobility and the associated potential for exposure, but do not reduce contaminant toxicity or volume. In-situ containment technologies that address contamination in surface soils include surface controls/diversions and caps.

Surface controls/diversions are used to divert surface water runoff around contaminated areas to minimize the potential for contaminant resuspension. Graded contours, stormwater sewers, swales, and berms can effectively control surface water run-on and runoff and can limit the mobility of contaminants.

A contaminated area can be encapsulated by placing a barrier (cap) on top. Capping of soil could effectively reduce dust, precipitation-enhanced percolation and leaching, and contaminant resuspension via surface water runoff. This would limit exposure to contamination in the surface soils. A stabilized surface would be required prior to cap placement, and would likely require filling or grading and excavation, particularly of the Northern Pit. Therefore, a UXO survey would likely be required over the area to be capped. In addition, because portions of the WPP AOC are a designated floodplain, the potential for damage to a cap from floodwater exists. Containment systems would have to be constructed to meet 100-year floodplain location standards.

The screening analysis for in-situ containment is summarized in Table 4.2. On the basis of effectiveness, implementability, and cost, the in-situ containment technologies (surface controls/diversions and capping) have been retained as potentially applicable to address surface soil contamination at the WPP AOC.

4.2.3 Removal with Treatment or Off-Site Disposal

Removal of contaminated material can limit contaminant mobility and volume at the affected source area and can facilitate treatment and disposal, which can reduce contaminant toxicity, mobility, and volume.

Excavation with conventional earth-moving equipment (e.g., bulldozers, backhoes, and front-end loaders) can effectively remove contaminated soil in the Northern Pit and west of the Southern Pit at the WPP AOC. The area of excavation would have to undergo a UXO survey. During excavation, the soil would need to be monitored for CWA.

The impacted soils could be disposed of either on-site (if treated) or at an off-site disposal facility. Tests have not been conducted to determine whether the lead-contaminated soil at the WPP AOC would be classified as a hazardous waste under RCRA. Depending upon the results of Toxicity Characteristic Leaching Procedure (TCLP) testing, untreated soils from the site may be categorized as waste code D008 under 40 CFR 268, Subpart D, because of high lead concentrations. These soils could require treatment to satisfy land disposal restrictions prior to disposal.

The screening analysis for removal with treatment and/or disposal is summarized in Table 4.3.

4.2.3.1 Ex-Situ Physical/Chemical Treatment Technologies

Several ex-situ physical/chemical treatment technologies are available for treating soil contaminated with metals. These include stabilization/fixation, vitrification, soil washing, and oxidation/reduction technologies. These technologies satisfy EPA's preference to permanently reduce the toxicity, mobility, and/or volume of lead in soils from the WPP AOC. The main advantages of ex-situ vs. in-situ treatment technologies are that ex-situ treatment generally requires a shorter period of time and affords greater certainty of uniform treatment. In-situ treatment technologies are not screened in this FFS due to the limited volume and shallow nature of the lead-contaminated soils at the site. Ex-situ treatment would require excavation with UXO clearance and would result in increased costs for engineering, permitting, and material handling.

The screening analysis of potential ex-situ treatment technologies is discussed in the following sections and summarized in Table 4.4.

Stabilization/Fixation

Stabilization/fixation technologies are those in which a fixing or stabilizing agent is mixed into soil to create a product that is resistant to leaching. The process involves mixing reagents with contaminated soil in a mixing vessel, such as a pug mill, to immobilize the contaminants and solidify the waste. Stabilization/fixation effectively reduces the mobility of contaminants through both physical and chemical means and is considered effective for immobilizing metals. The predominant fixing agents currently in use are Portland cement, lime/fly ash, Portland cement/fly ash, and Portland cement/sodium silicate. Gypsum, bentonite, and zeolites could also be used, as could a number of proprietary agents. Chemical and physical stabilization with cement and fly ash is an established practice for treating hazardous waste and has been retained as potentially applicable to address surface soil contamination at the WPP AOC.

Ex-Situ Vitrification

Ex-situ vitrification is designed to encapsulate inorganic contaminants rather than reduce contaminant concentrations. This process involves electrically heating contaminated material to temperatures high enough to cause it to melt. Vitrification is applicable to a full range of contaminants. The vitrified product is a chemically stable, leach-resistant glass or crystalline material (similar to obsidian or basalt) that is ready for disposal. Because of the high cost, this technology is not considered cost-effective for the small volume of soils to be treated at the WPP AOC; on this basis, ex-situ vitrification has been rejected from further consideration to address surface soil contamination at the WPP AOC.

Soil Washing

Soil washing is an aqueous-based process that reduces soil contamination through the use of particle size separation. This technology is applicable to soils contaminated with metals. The effectiveness of soil washing is based on the finding that most inorganic contaminants tend to bind, either chemically or physically, to the fine-grained fraction of the soil matrix (clay, silt, and organic soil particles). Washing processes that separate the fine particles (silt and clay) from the coarser material (sand and gravel) separate and concentrate the contaminants into a smaller volume of soil that can be further treated or disposed of.

Gravity separation is an effective method for removing high- or low-specific-gravity particles such as lead. Attrition scrubbing removes adherent contaminant films from coarser particles. The clean larger fraction can be returned to the site for use as clean fill. The washing agent and soil fines are residuals from this process that would require further treatment. Because of the high cost, this technology is not considered cost-effective for the small volume of soils to be treated at the WPP AOC; on this basis, soil washing has been rejected from further consideration to address surface soil contamination at the WPP AOC.

Reduction/Oxidation

Reduction/oxidation (redox) reactions chemically convert contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, and/or inert. The oxidixing agents most commonly used for treatment are ozone, hydrogen peroxide, hypochlorites, chlorine, and chlorine dioxide. Chemical redox is applicable to soils contaminated with metals. This technology would be costly to perform on the small volume of lead-contaminated soils proposed for remediation at the WPP AOC. Therefore, reduction/oxidation has been rejected from further consideration to address surface soil contamination at the WPP AOC.

4.3 POTENTIALLY APPLICABLE TECHNOLOGIES

Potentially applicable technologies for remediation of the contaminated surface soils at the WPP AOC are summarized in Table 4.5. The technologies that have been retained through this analysis were used to develop preliminary remedial action alternatives for the WPP AOC. These alternatives are identified and discussed in Section 5. The no-action response is included to provide a baseline for comparison; this measure is retained as an alternative in Sections 5 and 6.

5 DEVELOPMENT AND SCREENING OF PRELIMINARY REMEDIAL ACTION ALTERNATIVES

Preliminary alternatives for remediating surface soils at the WPP AOC were developed and screened in accordance with CERCLA (as amended), EPA guidance (EPA 1988b), and the National Contingency Plan (EPA 1990b). Five preliminary alternatives, including No Action, were developed on the basis of the criteria presented in Section 5.1. These alternatives, identified and described in Section 5.2, were then screened on the basis of the criteria presented in Section 5.3. The screening analysis is presented in Section 5.4. Four final alternatives were selected from the results of the screening analysis; these alternatives are presented in Section 5.5. These final alternatives are further described and evaluated in detail in Section 6.

5.1 CRITERIA FOR DEVELOPING ALTERNATIVES

EPA has established an approach for developing remedial action alternatives that are appropriate to specific site conditions (EPA 1988b; EPA 1990b). In this approach, the scope, characteristics, and complexity of the site are considered in developing a range of alternatives that would protect human health and the environment. This protection can be achieved by eliminating, reducing, and/or controlling risks posed by each pathway at a site. Two major categories of response are considered in developing remedial action alternatives:

- Containment — involving little or no treatment, but protective of human health and the environment by preventing or controlling exposures to contaminants through engineering measures and by using institutional controls as necessary to ensure the continued effectiveness of a response.

- Treatment — ranging from alternatives that use treatment as the primary element of the response to address the principal threat(s) posed by a site to alternatives that use treatment to reduce the toxicity, mobility, or volume of contaminated material to the maximum extent feasible, minimizing the need for long-term management.

As stated in Section 121(b) of CERCLA, as amended, the most preferred alternatives are those that represent permanent and cost-effective solutions for protecting human health and the environment; permanently and significantly reduce toxicity, mobility, or volume of contaminated material; and apply alternative treatment or resource recovery technologies to the extent possible. Least preferred are those alternatives involving the transport and disposal of waste off site without treatment.

A No Action alternative is also included, in accordance with CERCLA requirements, to provide a baseline for comparison with other alternatives. For analysis in this FFS, the baseline no action alternative of the WPP AOC at J-Field would maintain existing APG-specific LUCs.

A “Free Release” alternative is also evaluated pursuant to a request from the U.S. Army Environmental Center. The Free Release alternative details the actions and costs required to remediate the site to a point where the site could be released from Army control for other uses including, potentially, residential use.

5.2 IDENTIFICATION OF PRELIMINARY ALTERNATIVES

Measures and technologies potentially applicable to the management of contaminated surface soil at the WPP AOC are identified and screened in Section 4 (Table 4.5). On the basis of this screening, various measures and technologies were identified as potential components of remedial action alternatives for the site. These have been incorporated into five preliminary remedial action alternatives:

1. Alternative 1: No Action

2. Alternative 2: Land use controls (LUCs)

3. Alternative 3: In-situ containment — Capping with a soil blanket and LUCs

4. Alternative 4: In-situ containment — RCRA-type cap and LUCs

5. Alternative 5: Excavation with off-site disposal (Free Release alternative)

In-situ containment is the primary emphasis of Alternatives 3 and 4. Source control through removal is the primary focus of Alternative 5. No in-situ treatment option to reduce toxicity, mobility, and volume of the contaminants is considered feasible because of the limited and shallow nature of the lead-contaminated soils at the WPP AOC.

MRM activities would be ongoing regardless of the alternative selected. As part of the MRM activities, the reforestation grove was established. This reforestation activity was not considered part of the remedy selected for the WPP AOC. The costs associated with establishing and maintaining the reforestation grove were paid by other APG programs. Because the IRP did not fund the activities associated with the reforestation grove, those reforestation costs have not been included in the description or analyses of costs for each alternative.

Despite the fact that it will not be considered part of the remedy selected for the WPP AOC, the reforestation grove will likely have a number of positive results, including the following:

1. The grove will have a role in phytoremediation that will augment the intrinsic remediation of the discrete portions of the surficial aquifer with degraded groundwater quality.

2. The presence of the reforestation grove at the WPP AOC will be compatible with anticipated LUCs.

For each action alternative, APG would continue to implement its existing LUCs during the cleanup period. These include engineering controls, security guards, boating access restrictions, and restrictions on subsurface access by site workers. Existing LUCs would be maintained for the No Action alternative, as well. Should LUCs be formally incorporated into a remedy, it is assumed that the existing APG LUCs would need to be augmented to account for LUC planning, implementation and monitoring. As a result, costs for LUC planning, implementation, and monitoring are reflected in Alternatives 2 through 5. In addition, five-year reviews would be required under all alternatives where waste is left in place above action levels, including the No Action alternative.

Each action alternative would require various support activities before its implementation. These include obtaining necessary approvals and permits, completing design activities, establishing construction staging areas, obtaining appropriate equipment, and developing contingency plans and operational controls to minimize contaminant releases. For some alternatives, site preparation activities would include the identification and removal of UXO and screening for CWA during any excavation or grading. For Alternatives 3 and 4, the number of trees planted in the reforestation grove would be reduced to accommodate the associated cap configuration.

Alternative 5 would be conducted in a manner such that, upon completion, no soil containing contaminants at concentrations above the cleanup criteria (400 mg/kg lead) would be present at the site, and the site would be free for use under any future-use scenario (Free Release). However, because the remedy would be followed up with the reforestation action, future uses would be somewhat constrained. For example, the WPP AOC would have to be at least partially deforested to make the site compatible with residential use. LUCs, such as deed restrictions, may still be necessary after the completion of Alternative 5 to prevent access to the limited area of groundwater contamination (which, on the basis of EPA comments to the draft HHRA [EA 2006], is not addressed in this FFS).

5.2.1 Alternative 1: No Action

Alternative 1 is included to provide a baseline for comparison with the other action alternatives. Under this alternative, the site would continue to operate under restricted access in the short term. Although the Army has no plans to change the current land use restrictions, there would be no guarantee that these would continue in the future under this alternative. The current conditions of the contaminated surface soil would continue, and five-year reviews would be conducted, as part of this alternative. As part of MRM activities and unrelated to the Alternative 1 remedy, the Northern and Southern Pits would be filled to grade and the reforestation grove would be established.

5.2.2 Alternative 2: Land Use Controls

Under this alternative, the site would continue to operate under restricted access, as noted in Alternative 1. The existing restriction access would be augmented with additional LUCs. The implementation of LUCs would follow the guidance outlined by the U.S. Department of Defense (DOD) (DOD 2001; Beehler 2004) to ensure that LUCs are appropriately incorporated into existing land use management processes. The DOD guidelines provide an overall framework with a range of options to implement LUCs on the basis of site-specific circumstances and define the roles of various parties critical to the LUC implementation process. Should a decision be made, in consultation with state and federal regulators, to place limits on the use of DOD real property, APG would develop LUCs that would be integrated into the Installation Master Plan or its equivalent. Five-year reviews would be performed as part of this alternative.

Under Alternative 2, the site would continue to operate under U.S. Army control with restricted access and would be restricted from residential use. Land usage could potentially change from current usage, but the land would remain under Army control. The WPP could not be released from Army control under Alternative 2 because of the potential presence of UXO throughout the site.

5.2.3 Alternative 3: In-Situ Containment — Capping with a Soil Blanket and Land Use Controls

Alternative 3 involves in-situ containment of the contaminated subsurface soil at the WPP AOC. The site is currently wooded around the perimeter and largely flat. However, the proposed area to be capped in this alternative contains the Northern Pit, which would be filled to bring it to grade prior to placement of the fill cap. In addition, the grade at the pushout area west of the pits and the Northern Pit would be raised to be above the 100-year floodplain (approximately 10 ft [3 m] above mean sea level). Before construction, a UXO survey/removal action would be required for the portion of the site undergoing construction activities. Prior to the addition of fill material, a geotextile membrane would be placed to isolate the contaminated soil from the fill. Based on the vegetation currently growing in the Northern Pit, and its elevation, this area could be considered wetland. A waiver might be required prior to filling this area and may mandate the creation of an additional wetland area at some other location on J-Field (see Appendix A, wetland ARARs).

Under Alternative 3, the contaminated surface soil would be contained in place. The contaminants are largely bound to the fine-grained soils found in the upper soil layer at the site. After leveling, the soil blanket cap would be placed over the contaminated area. The soil blanket would consist of an additional geotextile membrane over the fill, followed by stone to create a barrier to burrowing animals. Additional fill and topsoil would then be placed over the area. Runoff at the site would be graded radially away from the cap. The soil blanket would cover two areas totaling approximately 10,200 ft^2 (948 m^2) and encompassing the Northern Pit and the area west of the pits to near the shoreline. The cap for the Northern Pit would be approximately 190 ft by 45 ft. The cap for the area west of the Southern Burn Pit would be approxiamtely 40 ft by 40 ft (see Figure 5.1). Periodic inspection of the soil blanket's integrity and five-year reviews would be necessary as part of a long-term monitoring program for J-Field.

The LUCs described in Alternative 2 would also be included in this alternative. Under Alternative 3, the site would continue to operate under U.S. Army control with restricted access. Land usage could potentially change from current usage, but the land would remain under Army control. Alternative 3 includes provisions for a limited UXO survey/removal action over the portion of the site undergoing construction activities. However, the site could not be released from Army control under Alternative 3 because of the potential presence of UXO at the remainder of the site.

5.2.4 Alternative 4: In-Situ Containment — RCRA-Type Cap and Land Use Controls

Alternative 4 would be nearly the same as Alternative 3, but instead of a soil blanket, a RCRA-type cap would be placed over the contaminated surface soils. As in Alternative 3, a UXO survey/removal action would be performed for the portion of the site under construction, and the site would be graded. The RCRA cap would cover the same areas proposed in Alternative 3, but it would have a somewhat larger footprint to accommodate the more complex design. The RCRA cap would have to meet 100-year floodplain location standards. Periodic inspection of the cap's integrity and five-year reviews would be necessary as part of a long-term monitoring program for J-Field. The LUCs described in Alternative 2 would also be included in this alternative.

Under Alternative 4, the site would continue to operate under U.S. Army control with restricted access. Land usage could potentially change from current usage, but the land would remain under Army control. Alternative 4 includes provisions for a limited UXO survey/removal action over the portion of the site undergoing construction activities. However, the site could not be released from Army control under Alternative 4 because of the potential presence of UXO at the remainder of the site.

5.2.5 Alternative 5: Excavation with Off-Site Disposal (Free Release Alternative)

Alternative 5 involves the removal of contaminated surface soils at the J-Field WPP AOC. Under this alternative, surface soil that contains contaminants at concentrations exceeding the cleanup criteria (400 mg/kg lead) would be removed and transported to an off-site facility for disposal. A UXO survey would be performed to identify and remove any potential unexploded ordnance from the entire WPP AOC prior to construction activities. The entire WPP AOC would be cleared to allow the "Free Release" of this site for any future-use scenario. However, the presence of the planned reforestation grove would constrain future use somewhat. Prior to removal and disposal, the soil would need further characterization to determine whether it is a hazardous waste as defined under RCRA. Depending on the results, stabilization of the soil could be required prior to transportation and disposal.

Under the removal component of this alternative, soil would be excavated from the northern part of the Northern Pit and a small area west of the Southern Pit using standard construction equipment, such as a backhoe and dump trucks. Approximately 125 yd^3 (95 m^3) of contaminated soil would be removed from a depth interval of approximately 0 to 2 ft (0 to 0.6 m).

Disposal of the contaminated soils generated during the removal would take place at a licensed off-site landfill. Excavated soil failing TCLP screening would be subject to all RCRA-equivalent state hazardous waste regulations. Because contaminated soil would be removed and the entire site cleared of UXO, LUCs for soil contamination would not be required after completion of construction activities. Verification soil samples would be collected from the base and sidewalls of each excavation to confirm the levels of contaminants remaining at the site.

Five-year reviews would be necessary as part of this alternative because, although soil contamination would be addressed, the contaminants that are considered residential risk drivers would remain in groundwater.

5.3 CRITERIA FOR SCREENING ALTERNATIVES

The five preliminary remedial action alternatives were evaluated for applicability to remediating surface soil at the J-Field WPP AOC on the basis of three general criteria: effectiveness, implementability, and cost. The effectiveness of an alternative is defined by its overall ability to protect human health and the environment in both the short term and long term. Measures of effectiveness include (1) reduction of potential long-term impacts to human health and the environment; (2) reduction of contaminant toxicity, mobility, and/or volume through treatment; (3) control of potential impacts to human health and the environment during the action period; (4) timeliness; and (5) consistency with regulatory requirements.

The implementability of an alternative is defined by its technical and administrative feasibility and availability of resources. Technical feasibility refers to the ability to construct, reliably operate, and comply with technology-specific regulations for process options until the remedial action is complete. It also addresses the operation, maintenance, replacement, and monitoring of the technical components of an alternative, as appropriate. Potential constraints associated with the site environment are also considered. Administrative feasibility addresses the acceptability of an alternative by other agencies and groups and pertinent environmental requirements, such as permits, as appropriate. Resource availability addresses the resources required to implement specific components of an alternative and the ability to obtain them.

The cost of an alternative is considered only in a comparative manner at the screening stage by comparing general estimates for each alternative to evaluate relative cost. This comparison helps decision makers determine whether the cost of one alternative is much greater than that of another alternative of similar effectiveness and implementability. If the cost of an alternative is excessive compared with the effectiveness it provides, that alternative can be screened from further consideration. Costs presented below are for a 30-year timeframe. Monitoring activities beyond the first 30 years would add to the total cost of an alternative.

5.4 SCREENING OF PRELIMINARY ALTERNATIVES

5.4.1 Alternative 1: No Action

Under Alternative 1, the WPP AOC would remain unchanged. Activities that would continue under the No Action alternative include the existing APG-specific LUCs involving routine site maintenance and continued range security and risk management at J-Field. The site would also be subject to the five-year review process.

5.4.1.1 Effectiveness

Alternative 1 would not involve any treatment to reduce toxicity, mobility, or volume of contaminated surface soil at the WPP AOC and would not provide for a timely or permanent response to the contamination problem. However, the HHRA does not show unacceptable risk for current use by site maintenance workers and adolescent trespassers or likely future use by construction and commercial site workers. Potential long-term health impacts under current-use and likely-future-use scenarios would be low as a result of the continued implementation of existing APG-specific LUCs.

5.4.1.2 Implementability

Minimum site operations, including security and maintenance, would continue with readily available resources.

5.4.1.3 Cost

The only additional costs that would be associated with Alternative 1 (baseline conditions), over the costs already being incurred for normal operation and maintenance of the installation, would be the costs for five-year reviews over the 30-year planning timeframe. The cost to perform six five-year reviews (at $7,800 each) for 30 years is estimated to be approximately $47 K. The cost estimate documentation from the RACER model (Earth Tech 2007) is included in Appendix B.

The five-year review costs for Alternative 1 exceed the five-year review costs for the remaining alternatives because Alternative 1 five-year review efforts occur without the administrative support provided by the administrative LUCs associated with Alternatives 2, 3, 4, and 5.

5.4.2 Alternative 2: Land Use Controls and Long-Term Monitoring

Under Alternative 2, the WPP AOC would not undergo an active remediation. Activities that would continue or be implemented under this alternative include routine site maintenance and augmented LUCs. Augmented LUCs would include planning, implementation, and monitoring components. A LUC Implementation Plan (LUCIP) would be required, as would modifications to the Installation Master Plan (IMP) and GIS Overlay Maps. The site would remain under U.S. Army control and would also be subject to the five-year review process.

5.4.2.1 Effectiveness

Alternative 2 would not involve any treatment to reduce toxicity, mobility, or volume of contaminated surface soil at the WPP AOC and would not provide for a timely or permanent response to the contamination problem. However, the HHRA does not show unacceptable risk for current use by site maintenance workers and adolescent trespassers or likely future use by construction and commercial site workers. Potential long-term health impacts under current-use and likely-future-use scenarios would be low as a result of LUCs.

5.4.2.2 Implementability

Minimum site operations, including maintenance and security activities, would continue with readily available resources. The acceptability of this alternative would be affected by the lack of a treatment component and problems of ensuring long-term effectiveness. LUCs do not represent a fully effective long-term solution to potential exposure of hypothetical future site residents to contaminants associated with surface soil at the WPP AOC. Therefore, administrative feasibility may be considered low.

5.4.2.3 Cost

Costs associated with Alternative 2 would result from general maintenance of the existing APG security procedures and efforts to plan, implement, and monitor administrative procedures for a range of LUCs. Alternative 2 costs would also include costs for six 5-year reviews ($44 K). The total cost for Alternative 2 over 30 years is estimated to be approximately $356 K. A breakdown of these estimated costs is included in Appendix B.

5.4.3 Alternative 3: In-Situ Containment — Capping with a Soil Blanket and Land Use Controls

A soil blanket has already been installed in another area of the J-Field Soil Operable Unit (IT Group 2001). Under Alternative 3, a soil blanket, similar to that already installed at the Former Toxic Pits in J-Field, would be installed to isolate the impacted surface soil at the WPP AOC (Figure 3.1). Installation of the soil blanket would involve bringing the pits up to grade with clean fill, installing a geotextile barrier, and placing a 6-in. (15.2-cm) stone barrier layer to prevent burrowing animals from contacting existing soils. An additional geotextile would be placed on the stone layer. A minimum of 1 ft (30.5 cm) of clean fill followed by 1 ft of topsoil would be added to the stone layer to provide for adequate vegetative growth. Other activities to be implemented under this alternative include the APG-specific LUCs already in place. Augmented LUCs would also include planning, implementation, and monitoring components. A LUC Implementation Plan would be required, as would modifications to the Installation Master Plan and GIS Overlay Maps. In addition, a document such as a Memorandum of Agreement between the U.S. Army and regulators would be needed to scope and fund the participation of regulatory authorities over the life of the LUCs. Routine inspection of the soil blanket would be performed as part of an amended J-Field long-term monitoring program or an independent plan.. The site would remain under U.S. Army control and would be subject to the five-year review process.

5.4.3.1 Effectiveness

Alternative 3 would not include a treatment component; therefore, contaminant toxicity and volume would not be reduced through treatment. However, contaminant mobility would be reduced by capping the site with a soil blanket. Potential exposures to site workers and adolescent trespassers would be further reduced, and the alternative could be implemented in a timely manner. Inspection and maintenance would be required to verify effectiveness in the long term. Contaminants could be controlled through capping in the short term, but they might be mobilized over the long term if the cap were to deteriorate. The soil blanket cap would not be intended to prevent infiltration at the site. Based on the groundwater sampling results, the lead contaminants at the WPP AOC are likely bonded to the site soils. Potential long-term health impacts under current-use and likely-future-use scenarios are already low as a result of the existing APG-specific LUCs in place and would be further reduced by the soil blanket.

Short-term risks to on-site workers would be significant for Alternative 3 because of the construction activities. Risks include those related to the potential for encountering UXO. These risks would be minimized by performing a UXO screening/removal action for the portion of the site undergoing construction and by not excavating site soils. Potential short-term environmental impacts caused by construction activities include disturbance to the soil and temporary increases in fugitive dust emissions and ambient noise levels. Mitigation measures to reduce these impacts (such as dust control and temporary fencing) could be implemented during construction activities.

5.4.3.2 Implementability

Alternative 3 could be implemented by using readily available resources. The technical feasibility of a cap is high, and its integrity could be monitored through regular inspection of the site. Construction would consist of filling and leveling the areas of soil contamination and placement of the soil blanket.

The acceptability of in-situ containment (capping) could be affected by the lack of a treatment component and problems of ensuring long-term effectiveness. In-situ containment with LUCs would represent an effective long-term solution for current-use and likely-future-use scenarios at the WPP AOC. In-situ containment with LUCs does not represent a fully effective long-term solution to potential exposure of hypothetical future site residents to contaminants associated with surface soil at the WPP AOC. Therefore, administrative feasibility may be considered low. However, because of the potential presence of UXO at the site, the WPP AOC would remain under Army control.

5.4.3.3 Cost

The estimated cost for installation and monitoring of a soil blanket is $1,069 K. This estimate includes the costs associated with (1) a limited UXO survey/removal action; (2) filling the Northern Pit and a portion of the pushout area west of the Southern Pit to a grade above the 100-year flood level; (3) installation of a soil blanket on the surface of the site; (4) remedial design and project management; (5) periodic inspection and maintenance of the soil blanket; (6) costs to plan, implement, and monitor LUCs; and (7) six 5-year reviews. A detailed breakdown of these costs is included in Appendix B.

5.4.4 Alternative 4: In-Situ Containment — RCRA-Type Cap and Land Use Controls

Alternative 4 is similar to Alternative 3, but instead of a soil blanket, a RCRA-type cap would be installed to isolate the impacted surface soil at the WPP AOC (Figure 3.1). The cap would be a multi-layered system consisting of an upper vegetative layer, underlain by a drainage layer over a low-permeability layer. Prior to the cap installation, the site would need to be filled and leveled. A larger footprint would necessitate the filling of the Southern Pit as well as the Northern Pit. Other activities to be implemented under this alternative include routine site maintenance and security. Routine inspection of the cap would be performed as part of the J-Field long-term monitoring program. Augmented LUCs would also include planning, implementation, and monitoring components. A LUC Implementation Plan would be required, as would modifications to the Installation Master Plan and GIS Overlay Maps. In addition, a document such as a Memorandum of Agreement between the U.S. Army and regulators would be needed to scope and fund the participation of regulatory authorities over the life of the LUCs.The site would remain under U.S. Army control and would be subject to the five-year review process.

5.4.4.1 Effectiveness

Alternative 4 would not include a treatment component; therefore, contaminant toxicity and volume would not be reduced through treatment. However, contaminant mobility would be reduced by capping the site. Potential exposures to site workers and adolescent trespassers would be further reduced, and the alternative could be implemented in a timely manner. Inspection and maintenance would be required to verify effectiveness in the long term. Contaminants could be controlled through capping in the short term, but they could become mobile over the long term if the cap were to deteriorate. The RCRA-type cap would be intended to prevent infiltration at the site. However, the lead contaminants at the WPP AOC are thought to have low mobility due to their adhesion to site soils. Potential long-term health impacts under current-use and likely-future-use scenarios are already low as a result of institutional controls and would be further reduced by the cap.

Short-term risk to on-site workers, specifically the potential to encounter UXO and CWA, would be significant during the construction activities for Alternative 4. These risks would be minimized by performing a UXO screening/removal action for the portion of the site undergoing construction and by not excavating site soils. Potential short-term environmental impacts during construction activities include disturbance to the soil and temporary increases in fugitive dust emissions and ambient noise levels. Mitigation measures to reduce these impacts (such as dust control and temporary fencing) could be implemented during construction activities.

5.4.4.2 Implementability

Alternative 4 could be implemented by using readily available resources. The technical feasibility of a cap is high, and its integrity could be monitored through regular inspection of the site. Construction would consist of filling and leveling the areas of soil contamination, including areas large enough for the engineered cap, and placement of the cap.

The acceptability of in-situ containment (capping) could be affected by the lack of a treatment component and problems of ensuring long-term effectiveness. In-situ containment with LUCs would represent an effective long-term solution for current-use and likely-future-use scenarios at the WPP AOC. In-situ containment with LUCs does not represent a fully effective long-term solution to potential exposure of hypothetical future site residents to contaminants associated with surface soil at the WPP AOC. Therefore, administrative feasibility may be considered low. However, because of the potential presence of UXO at the site, the WPP AOC would remain under Army control.

5.4.4.3 Cost

The estimated cost for installation and monitoring of a RCRA-type cap is $1,110 K. This estimate includes the costs associated with (1) a limited UXO survey/removal action ($212 K); (2) filling the Northern Pit, a portion of the pushout area west of the Southern Pit, and additional areas (probably including the Southern Pit) as necessary to a grade above the 100-year flood level ($34 K); (3) installation of a RCRA-type cap on the surface at the site ($61 K); (4) remedial design ($15 K) and project management costs ($271 K); (5) periodic inspection and maintenance of the cap ($161 K); (6) LUC planning, implementation, and monitoring costs ($312 K); and (7) six 5-year reviews ($44 K). A detailed breakdown of these costs is included in Appendix B.

5.4.5 Alternative 5: Excavation with Off-Site Disposal (Free Release Alternative)

Under Alternative 5, contaminated soils would be excavated and removed from the site. Prior to excavation, land areas and shoreline portions of the entire WPP AOC would be cleared of UXO in support of a "Free Release" of the site upon completion of the remediation. Areas where surface soil samples contained lead concentrations above 400 mg/kg (Figure 3.1) would be excavated (two areas). A small area (approximately 20 by 10 ft [6 by 3 m]) surrounding soil samples SO-11 and SO-12 and a larger area (approximately 150 by 10 ft [45 by 3 m]) along the northern edge of the Northern Pit (samples SO-3, NP-6-WALL, NP-7-WALL, and NP-8-WALL) would be excavated to an approximate depth of 2 ft (0.6 m). This would generate approximately 125 yd^3 (95 m^3) of contaminated soil. Representative soil samples would be collected prior to excavation to characterize the waste for proper disposal and determine whether it would need to be stabilized before being removed from the site. Confirmation soil samples would be collected from the base and sidewalls of the excavations for lead analysis. After excavation/removal activities, the site would be graded and seeded. The site would remain subject to the five-year review process while under Army control. Augmented LUCs would also include planning, implementation, and monitoring components. A LUC Implementation Plan would be required, as would modifications to the Installation Master Plan and GIS Overlay Maps. In addition, a document such as a Memorandum of Agreement between the U.S. Army and regulators would be needed to scope and fund the participation of regulatory authorities over the life of the LUCs. If the site was no longer under Army control, additional LUCs, including construction, permitting, deed notification, easements, restrictive covenants, and monitoring and enforcement (including notice letters, site visits and inspections, and restrictions to limit groundwater usage) would be necessary.

5.4.5.1 Effectiveness

Alternative 5 involves the removal of contaminated surface soil from the WPP AOC. Excavating contaminated surface soil at the site would reduce potential impacts to human health and the environment in a timely manner and would reduce the potential for contaminant migration. Subsequent disposal of the soil at an off-site facility would not reduce contaminant toxicity and volume over the short and long term.

Short-term risk to on-site workers, specifically the potential for encountering UXO and CWA, would be significant for Alternative 5 during the construction activities. Potential short-term environmental impacts caused by construction activities include disturbance to the soil and temporary increases in fugitive dust emissions and ambient noise levels. Mitigation measures to reduce these impacts (such as dust control and temporary fencing) could be implemented during construction activities.

5.4.5.2 Implementability

Implementing the removal component of Alternative 5 would be relatively straightforward with available resources. The expected excavation depth of 2 ft (0.6 m) is easily accomplished with standard excavation equipment. No buildings or utilities are located near the excavation area. Local contractors are available to perform these activities and can also haul the excavated soil to the disposal facility. It is anticipated that this alternative would be administratively feasible, as well.

5.4.5.3 Cost

The total estimated cost for all components of this alternative is $5.0 million. This relatively high cost reflects the UXO survey/removal requirements necessary to complete this alternative. Other costs are for waste characterization sampling and analysis, soil excavation/stabilization, hauling and disposal (assuming a "hazardous" characterization), confirmation sampling, and site restoration. Five-year review costs and costs associated with LUCs such as construction permitting, easement negotiation, restrictive covenants, monitoring and enforcement (including site visits and inspections and deed restrictions for groundwater use) are included in the estimate. The costs associated with remedial design, permitting, and project management are also included. A breakdown of these estimated costs is included in Appendix B.

5.5 SCREENING SUMMARY AND IDENTIFICATION OF FINAL ALTERNATIVES

The screening results for each alternative were evaluated according to EPA's criteria of effectiveness, implementability, and cost. The preliminary remedial action alternatives can be broken down into nonactive (Alternatives 1–2) and active (Alternatives 3–5) remedial measures. The active measures can be further divided into in-situ (Alternatives 3–4) and ex-situ (Alternative 5) measures.

Although there are no current or likely future residential exposure scenarios, the evaluation is conservative and assumes these scenarios exist. However, because of the potential presence of UXO at the site, non-Army control of the site could only occur under Alternative 5. The nonactive measures (Alternatives 1–2) would be less effective at reducing the long-term toxicity, mobility, or volume of contaminated surface soil than the active measures (Alternatives 3–5). Each of the more active alternatives is implementable, but Alternative 4 (RCRA-type cap) is significantly more difficult to implement because of the complexity of the engineered cap.

The costs associated with the alternatives vary significantly. For the nonactive measures, Alternative 2 has a relatively low incremental cost because security measures are already in place for J-Field because it is part of an active range. Only minimal costs for five-year reviews are associated with the No Action alternative. For the active, in-situ measures, Alternative 4 is more expensive than Alternative 3. On the basis of these results, the following alternative was eliminated from further consideration:

- Alternative 4: In-situ containment — RCRA-type cap with LUCs

The various components of Alternative 4 are very similar to those in Alternative 3, which also includes a cap to isolate the impacted surface soils. However, the RCRA-type cap would be more expensive to design and install Based on the results of groundwater sampling, the leaching of lead from the impacted surface soils is not considered to be an issue at the WPP AOC. Therefore, the added effort and expense to provide an impermeable cap are not necessary for the site, and Alternative 4 is eliminated from further consideration. In addition, a permeable cap would be more compatible with the planned reforestation grove.

The No Action alternative (Alternative 1) is retained to provide a basis for comparison with the remaining alternatives during the subsequent detailed analysis. Therefore, the final alternatives selected for detailed analysis in Section 6 are:

- Alternative 1: No Action
- Alternative 2: Land use controls (LUCs)
- Alternative 3: In-situ containment — capping with a soil blanket and LUCs
- Alternative 5: Excavation with off-site disposal (Free Release alternative)

6 DETAILED ANALYSIS: SOIL REMEDIATION ALTERNATIVES

EPA has identified nine criteria in the National Contingency Plan (Section 300.430[e][9][iii]) that must be evaluated for each alternative. The criteria are as follows:

1. *Overall protection of human health and the environment* — addresses protection from unacceptable risks in both the short term and the long term by minimizing exposures, in accordance with the purpose and objectives of the proposed action described in Section 3. Because of its broad scope, this criterion also reflects the focus of criteria 2 through 5.

2. *Compliance with ARARs* — addresses the attainment of federal and state environmental requirements determined to be either applicable or relevant and appropriate to the alternative on the basis of site-specific considerations. Potential ARARs and TBCs are listed in Appendix A.

3. *Long-term effectiveness and permanence* — addresses residual risks (i.e., those risks remaining after completion of a remedial action). EPA guidance states that it is usually sufficient to indicate whether an alternative has the potential to achieve the preliminary cleanup levels and not necessary to quantify the risk that would remain after the alternative was implemented (EPA 1991).

4. *Reduction of contaminant toxicity, mobility, or volume* — addresses the degree to which treatment is used to address the principal threat(s) at the site; the amount of material treated; the magnitude, significance, and reversibility of the given reduction; and the nature and quantity of treatment residuals.

5. *Short-term effectiveness* — addresses the potential impacts to site workers, the general public, and the environment from implementing the alternative; the effectiveness and reliability of mitigative measures; and the time required to achieve protectiveness.

6. *Implementability* — addresses the technical feasibility, including the availability and reliability of required resources (such as specific technologies, materials and equipment, facility capacities, and skilled workers); the ease of implementation; and the ability to monitor effectiveness. This criterion also addresses administrative feasibility. The actual determination of the administrative feasibility would not be made until after the feasibility study is completed.

7. *Cost* — addresses both capital and annual operation and maintenance costs. Costs for the individual components of the alternatives are also considered. Costs presented for all alternatives were estimated by using the RACER

model (Earth Tech 2007). Information about the structure of the cost estimates and assumptions used, along with a second report detailing first-year costs, are provided in Appendix B.

8. *State acceptance* — addresses the comments made by the State of Maryland on the alternatives being considered for site remediation. Because the State's comments will not be received until this report has been issued for public review, the state-acceptance criterion will be addressed in a subsequent version of this report.

9. *Community acceptance* — addresses the comments made by the community on the alternatives being considered. Because public comments will not be received until after this report has been issued for public review, the community acceptance criterion will be addressed in a subsequent version of this report.

In the following sections, each of four surface soil remediation alternatives (as outlined in Chapter 5) is evaluated in detail on the basis of criteria 1 through 7 as listed in the National Contingency Plan (EPA 1990b). A comparative analysis is presented in Chapter 7.

6.1 ALTERNATIVE 1: NO ACTION

In compliance with CERCLA requirements, the No Action alternative is included as a final alternative to provide a baseline for comparison with the three action alternatives. Under this alternative, no action would be taken at the WPP AOC, and the contaminated surface soil would remain in place. Institutional control measures, including the APG range control security and access limitations, would remain in effect at the site in the near term. However, these security measures would not necessarily be permanent. Because soil containing contaminants at concentrations above action levels would be left in place, CERCLA five-year reviews of the site would be required. As part of the MRM activities, range maintenance would continue and would include filling the burn pits to grade and establishing a reforestation grove at the WPP AOC.

6.1.1 Overall Protection of Human Health and the Environment

Under current and likely-future-use conditions, the No Action alternative would be considered protective of human health and the environment (because there was acceptable risk shown in the HHRA and low risk to ecological receptors). However, assuming a scenario in which the future site use change, Alternative 1 would not be protective of human health because, should future use become residential, potential exposure of children to lead in two areas at the WPP where residential cleanup guidance standards are exceeded (i.e., 400 mg/kg) could occur (MDE 2001). Under Alternative 1, contaminant source areas in surface soil would not be removed, further contained, or treated; exposures could occur in the future via ingestion of lead-impacted soil. Further, although current site access restrictions would remain in place in the near term, the potential would exist that those restrictions could be discontinued in the future if land transfer occurred. Because soil containing contaminants at concentrations above action levels would be left in place, CERCLA five-year reviews would be required to address the future protectiveness of the remedy.

6.1.2 Compliance with ARARs

Regulatory requirements that might be applicable or relevant and appropriate to the proposed action are identified and evaluated in Appendix A. No chemical-specific ARARs have been identified that address the lead-contaminated soil at the WPP AOC. However, for the purposes of this FFS, EPA guidance has been used to set a preliminary soil remediation level of 400 mg/kg (EPA 1989b).

Alternative 1 also fails to meet the CERCLA-mandated preference for remedies that reduce contaminant toxicity, mobility, and volume through treatment (CERCLA Section 121[b][1]). Because no active remedies are associated with Alternative 1, there are no location- or action-specific ARARs.

6.1.3 Long-Term Effectiveness and Permanence

Alternative 1 would be protective of human health and the environment over the long term, assuming a realistic scenario in which soil contamination continues to remain relatively immobile and the site, which is currently part of an active Army range, does not become residential in use. Under the No Action alternative, current APG-specific LUCs would be carried out for an indefinite period. Existing LUCs would allow access only by site maintenance workers and other authorized personnel. Exposures to site workers involved with maintenance activities have been shown in the HHRA to be acceptable (EA 2006). Therefore, the risks involved in these activities are considered to be low. Because site access is restricted, potential impacts to members of the general public (such as adolescent trespassers) over the long term is also considered to be acceptable, provided that the current access restrictions remain in place. The long-term effectiveness would be considered low if land use changed to residential at the site.

Under Alternative 1, the level of contamination and risks to terrestrial biota over the long term would be similar to current levels. These risks are considered insignificant because the impacted area is only a small portion of the habitat available for use within the surrounding area.

6.1.4 Reduction of Toxicity, Mobility, or Volume

Implementation of the No Action alternative would not reduce the toxicity, mobility, or volume of contaminants at the site.

6.1.5 Short-Term Effectiveness

Under Alternative 1, existing LUCs would continue to allow access only by site workers and other authorized personnel. Exposures to site workers involved in maintenance activities could occur through direct contact, but these risks have been shown to be acceptable (EA 2006). Therefore, short-term risks to workers are considered to be low.

Under Alternative 1, protection of the environment likely would be maintained. The level of short-term risks to terrestrial biota from routine maintenance activities would be low.

6.1.6 Implementability

Site activities (minimal groundskeeping) would continue with the use of available resources in the near term. Permanent site access controls would not be guaranteed. Exposure pathways to site workers have been evaluated and are within the acceptable range.

6.1.7 Cost

Because soil containing contaminants at concentrations above action levels would be left in place, CERCLA five-year reviews would be required at the site to assess the future protectiveness of the remedy. The 30-year estimated marked-up cost for these reviews is $47 K. Details from the RACER estimating model (Earth Tech 2007) are included in Appendix B. Because installation and maintenance of the reforestation grove would be funded by non-IRP APG programs, those costs are not included in Appendix B.

6.2 ALTERNATIVE 2: LAND USE CONTROLS

Under this alternative, the site would continue to operate under restricted access. The existing restrictions (described in Section 4.2.1) would be augmented with additional LUCs. The implementation of LUCs would follow the guidance outlined by DOD (DOD 2001; Beehler 2004) to ensure that LUCs are appropriately incorporated into existing-land-use management processes. The DOD guidelines provide an overall framework with a range of options to implement LUCs based on site-specific circumstances; they also define the roles of various parties critical to the LUC implementation process.

Should a decision be made, in consultation with EPA and State regulators, to place limits on the use of DOD real property, APG would develop written LUCs to be integrated into the Installation Master Plan or its equivalent. Examples of the types of information the written LUCs could provide are:

- Location of the land subject to LUCs;

- Stipulations for markers to delineate the land subject to LUCs;

- Explanation of the LUCs to be implemented (e.g., deed restrictions on excavation, use of groundwater, or land uses);
- Description of generally allowed uses;
- Stipulations for augmentation of existing base security patrols;
- Details of the excavation/construction approval process;
- Vehicles for documentation of LUCs, such as the Installation Master Plan; and
- Geographic Information System overlays.

The LUCs would also address the development or modification of implementation plans like the IMP, self-audit procedures, and notices for site workers likely to work near the WPP AOC. As required by the CERCLA five-year review process, the LUCs would be subject to at least one five-year review cycle.

Under this alternative, the contaminated surface soil would remain in place and would not be treated. The lead contaminants found at the site are largely bound to the clayey soils. Deed restrictions would not be required for the site as long as the U.S. Army retained control over land-use decisions.

Independent of this remedy, as part of the MRM activities, the Northern and Southern Burn Pits would be filled to grade, and a reforestation grove would be established at the WPP AOC.

6.2.1 Overall Protection of Human Health and the Environment

Under current and likely-future-use conditions, the LUCs alternative would be considered protective of human health and the environment (because there was acceptable risk shown in the HHRA and low risk to ecological receptors). However, assuming a scenario in which the future site use became residential. Under Alternative 2, contaminant source areas in surface soil would not be removed, further contained, or treated; exposures could occur in the future via ingestion of lead-impacted soil.

6.2.2 Compliance with ARARs

Regulatory requirements that might be applicable or relevant and appropriate to Alternative 2 are identified and evaluated in Appendix A. No contaminant-specific ARARs have been identified that address the lead-contaminated soil at the WPP AOC. However, for the purposes of this FFS, EPA guidance has been used to set a preliminary soil remediation level of 400 mg/kg (EPA 1989b). In addition, Maryland cleanup guidance of 400 mg/kg is also considered to be TBC guidance (MDE 2001).

Alternative 2 also fails to meet the CERCLA-mandated preference for remedies that reduce contaminant toxicity, mobility, or volume through treatment (CERCLA Section 121[b][1]).

Alternative 2 would comply with other pertinent ARARs and TBCs as appropriate. Location-specific ARARs and TBCs address the protection of historic sites, archeological and cultural resources, endangered species and habitats, floodplains, and wetlands. No archeological and cultural resources are expected and the area has already been subject to disturbances during the disposal pit excavation activities. No critical ecological habitats have been found at the WPP AOC. Activities to implement LUCs under Alternative 2 are not expected to impact local wetlands or wildlife.

Action-specific ARARs address the protection of soil, water, and air during implementation of the remedial action. It is unlikely that any action-specific ARARs or TBCs would be applicable to Alternative 2.

6.2.3 Long-Term Effectiveness and Permanence

Alternative 2 would be protective of human health and the environment over the long term (assuming a realistic scenario in which soil contamination continues to remain immobile and land use does not change to residential). Under Alternative 2, current maintenance activities would be carried out for an indefinite period. Existing LUCs (including the current site security) would continue to allow access only by site workers and other authorized personnel. Exposures to site workers involved with maintenance activities have been shown in the HHRA to be acceptable (EA 2006). Therefore, the risks involved in these activities are considered to be low. Because site access is restricted, potential impacts to members of the general public (such as adolescent trespassers) over the long term is also considered to be acceptable. The long-term effectiveness would be considered low if land use changed to residential at the site. In that case, additional LUCs would be necessary, such as zoning/subdivision regulations, covenants/ easements, building controls, and/or deed restrictions to address the site soil and groundwater quality. The provisions of Alternative 2 assume that the Army retains control over site usage.

Under Alternative 2, the level of contamination and risks to terrestrial biota over the long term would be similar to current levels. These risks are considered insignificant because the impacted area is only a small portion of the habitat available for use within the surrounding area.

6.2.4 Reduction of Toxicity, Mobility, or Volume

Implementation of Alternative 2 would not result in the reduction of toxicity, mobility, or volume of contaminants through treatment.

6.2.5 Short-Term Effectiveness

Under Alternative 2, existing and additional LUCs would continue to allow access only by site workers and other authorized personnel. Exposures to site workers involved in maintenance activities could occur through direct contact, but these risks have been shown to be acceptable (EA 2006). Therefore, short-term risks to workers are considered to be low. In addition, future MRM activities that are not part of the remedy (filling the burn pits to grade and planting the reforestation grove) would have the secondary benefit of reducing the already-low risk posed to potential adolescent trespassers.

Under Alternative 2, protection of the environment would likely be maintained. Short-term risk to terrestrial biota from routine maintenance activities would be low.

6.2.6 Implementability

Current site activities (minimal groundskeeping) would continue with the use of available resources. Exposure pathways to site workers have been evaluated and are within the acceptable range.

The acceptability of LUCs would be affected by the lack of a treatment component and problems of ensuring long-term effectiveness. Therefore, administrative feasibility may be considered low.

6.2.7 Cost

The cost estimate for this alternative was derived using the RACER estimating model (Earth Tech 2007). For the purposes of this FFS, costs were developed for Alternative 2 and the remaining alternatives (3 and 5), using a 30-year timeframe to facilitate comparisons between alternatives. The costs reported here are current-year dollar summary reports, with markups.

Costs to augment the existing LUCs at the site would depend on regulatory requirements but would likely include costs for LUC planning, implementation and monitoring and are estimated to be $312 K. Over the 30-year planning horizon, six 5-year reviews would be performed for a cost of $44 K. The total estimated cost for Alternative 2 over 30 years is $356 K. Because installation and maintenance of the reforestation grove would be funded by non-IRP APG programs, those costs are not included in Appendix B.

6.3 ALTERNATIVE 3: IN-SITU CONTAINMENT — CAPPING WITH A SOIL BLANKET AND LAND USE CONTROLS

Alternative 3 would rely on a soil blanket to further isolate the lead-contaminated surface soil at the WPP AOC. This alternative would involve using clean fill to bring the areas under the cap footprint up to the 100-year floodplain elevation of 10 ft above MSL. The cap footprint would then be covered with a geotextile membrane and 6 in. (15.2 cm) of stone to create a barrier to burrowing animals. The soil blanket, a minimum of 2-ft (0.6 m) of clean backfill placed over the geotextile/stone barrier to burrowing animals, would include 1 ft (0.3 m) of clean backfill covered with 1 ft of topsoil. The soil blanket would cover two areas totaling approximately 10,200 ft^2 (950 m^2) and encompassing the Northern Pit and the area west of the pits to near the shoreline (Figure 3.1). The area would then be graded as necessary to create adequate drainage and to ensure that all portions of the soil blanket are above the 100-year floodplain. After placement of the soil blanket cap, the site would be seeded with native vegetation to protect the cap from erosion.

Annual inspections of the soil blanket would be conducted to evaluate the integrity of the soil blanket. Burrowing animals, soil erosion due to surface runoff, uprooted trees, and/or vehicle use on the soil blanket could cause damage. Emergency inspections would also be conducted as necessary after major storm events (such as occurred in 2003) to evaluate damage. Maintenance would be performed as needed and would include closing animal burrows, planting seeds in bare areas, and repairing erosions. Grassy vegetation on the soil blanket would be maintained by periodic mowing. All inspection/maintenance activities would be performed as part of the overall J-Field Long-Term Monitoring/Operations and Maintenance Plan (Weston 2004) or under a separate operation and maintenance plan, as required.

Under Alternative 3, the site would continue to operate under restricted access. LUCs would be implemented similar to those described under Alternative 2, with the exception that fencing would not be required to isolate the area under Alternative 3. Cap maintenance would be performed periodically, and implementation and monitoring of LUCs would be ongoing. Because soil containing contaminants at concentrations above action levels would remain, the site itself would continue to be subject to the five-year review process. As part of the MRM activities and independent of the remedy in this Alternative, a reforestation grove would be planted up to the perimeter, but not on the soil blanket cap.

6.3.1 Overall Protection of Human Health and the Environment

Under current and likely-future-use conditions, the capping with LUCs alternative would be considered protective of human health and the environment (because there was acceptable risk shown in the HHRA and low risk to ecological receptors). Assuming a scenario in which the future site use became residential, Alternative 3 would continue to be protective of human health as long as the cap was not disturbed by site activities such as construction. Under Alternative 3, contaminant source areas in surface soil would be contained by the soil blanket but would not be removed or treated; exposures could occur in the future via ingestion of lead-impacted soil if the soil blanket were disturbed.

6.3.2 Compliance with ARARs

Regulatory requirements that might be applicable or relevant and appropriate to the proposed action are identified and evaluated in Appendix A. No chemical-specific ARARs have been identified that address the lead-contaminated soil at the WPP AOC. However, for the purposes of this FFS, EPA and MDE guidance has been used to set a preliminary soil remediation level of 400 mg/kg (EPA 1989b; MDE 2001). Alternative 3 would fail to meet the CERCLA-mandated preference for remedies that reduce contaminant toxicity, mobility, or volume through treatment (CERCLA Section 121[b][1]).

Location-specific ARARs and TBCs address the protection of historic sites, archeological and cultural resources, endangered species and habitats, fish and wildlife, floodplains, and wetlands. No archeological and cultural resources are expected because the area to be covered has already been subject to disturbances during the disposal pit excavation activities. No critical ecological habitats have been found at the J-Field WPP AOC. Waivers may be required for the construction of a soil blanket due to the location of nearby wetlands and the Gunpowder River floodplain: for example, the Northern Pit proposed for filling under this alternative may be considered a wetland.

Action-specific ARARs address the protection of soil, water, and air during implementation of the remedial action. Mitigative measures such as silt fences to protect nearby wetlands and the Gunpowder River would be required.

6.3.3 Long-Term Effectiveness and Permanence

Alternative 3 would be protective of human health and the environment over the long term (assuming a realistic scenario in which soil contamination continues to remain immobile and land use does not change to residential). However, current maintenance activities and periodic inspection of the soil blanket would need to be carried out for an indefinite period.

Augmented LUCs (including the current site security) would continue to allow access only by site workers and other authorized personnel. Exposures to site workers involved with maintenance activities have been shown in the HHRA to be acceptable (EA 2006). Therefore, the risks involved in these activities are considered to be low. Because site access is restricted, potential impacts to members of the general public (such as adolescent trespassers) over the long term is also considered to be acceptable.

Installation of a soil blanket would further reduce the already low human health risks under current and likely-future-use scenarios. The long-term effectiveness might be considered low if land use changed to residential at the site. In that case, additional LUCs would be necessary, such as zoning/subdivision regulations, covenants/easements, building codes, and deed restrictions. However, the provisions of Alternative 3 assume that the Army retains control over site usage.

Under Alternative 3, the level of contamination and risks to terrestrial biota over the long term would be reduced due to the geotextile/stone barrier beneath the soil blanket. The barrier would be designed to prevent burrowing animals from disturbing contaminated soil in the subsurface. These risks are already considered insignificant because the impacted area is only a small portion of the habitat available for use within the surrounding area.

6.3.4 Reduction of Toxicity, Mobility, or Volume

Reduction of toxicity, mobility, or volume through treatment is not applicable because Alternative 3 does not involve treatment. Nevertheless, construction of the soil blanket would likely result in a reduction in the mobility of the contaminants present. Lateral mobility of contaminants leaching into groundwater is already limited by the adhesion of lead contaminants to the fine-grained soils at the site. The addition of a soil blanket cap would preclude the formation of dust and possible erosion to further reduce the mobility of the contaminants present at the surface.

6.3.5 Short-Term Effectiveness

Under Alternative 3, existing LUCs would continue to allow access only by site workers and other authorized personnel. The short-term risks to site workers would be significant for Alternative 3; mitigative measures would need to be employed. During construction activities, site workers would be protected by strictly adhering to the site health and safety plan prepared pursuant to Federal Occupational Safety and Health Administration (OSHA) Standards promulgated in 29 CFR 1910.120. The health and safety implications of the site activities, including the possibility of encountering UXOs and CWAs or other chemical contaminants, would be addressed in the health and safety plan.

The release of particulate emissions (dust) during filling and geotextile placement activities would need to be minimized. Dust-control measures could include spraying the site to minimize dust generation. Exposures to site workers involved in maintenance activities through direct contact would be eliminated with the construction of a soil blanket. These risks were already shown to be acceptable (EA 2006). Augmenting the existing LUCs with the construction of a soil blanket over the impacted portions of the WPP AOC would be effective in reducing the already low risk posed to potential adolescent trespassers.

Under Alternative 3, protection of the environment would likely be maintained. The level of short-term risks to terrestrial biota during construction activities and from routine maintenance activities would be low.

6.3.6 Implementability

Construction and operation of the components of Alternative 3 would be straightforward. Resources are readily available for construction activities. Standard construction equipment would be used to fill the site, place the geotextile/stone barrier, and haul and place the soil blanket. Local contractors are available to haul and place clean fill to the site and install the soil blanket. Minimum site operations (e.g., security, soil blanket inspection, and maintenance) would continue using available resources.

The acceptability of in-situ containment (capping) would be affected by the lack of a treatment component and problems of ensuring long-term effectiveness. In-situ containment with monitoring inspections does not represent a fully effective long-term solution to potential impacts associated with the lead-contaminated surface soil at the WPP AOC. Therefore, administrative feasibility may be considered low.

6.3.7 Cost

The cost estimate for this alternative was derived using the RACER estimating model (Earth Tech 2007). For the purposes of this FFS, costs were developed using a 30-year timeframe to facilitate comparisons between alternatives. The estimated costs reported for Alternative 3 are current-year dollar summary reports, with markups, and involve both one-time and recurring costs. Details concerning the structure of the cost estimates are discussed further in Appendix B.

This estimate includes the costs associated with (1) a limited UXO survey/removal action ($212 K); (2) filling the Northern Pit and a portion of the pushout area west of the Southern Pit to a grade above the 100-year flood level ($34 K); (3) installation of a soil blanket on the surface of the site ($38 K); (4) remedial design ($14 K) and project management ($254 K); (5) periodic inspection and maintenance of the soil blanket ($161 K); (6) costs to plan, implement, and monitor LUCs ($312 K); and (7) six 5-year reviews ($44 K). The total estimated cost for Alternative 3 over 30 years is approximately $1,069 K. Because installation and maintenance of the reforestation grove would be funded by non-IRP APG programs, those costs are not included here or in Appendix B.

6.4 ALTERNATIVE 5: EXCAVATION WITH OFF-SITE DISPOSAL (FREE RELEASE)

Under Alternative 5, contaminated surface soils would be removed from the site to achieve permanent source control and long-term protection of human health and the environment. This alternative does not address two key constraints:

- Residual groundwater contamination at the WPP AOC and J-Field in general, or

- The presence of UXO throughout the greater J-Field site and the testing/training range on Gunpowder Neck.

Prior to removal activities, a UXO survey/removal action for the entire J-Field WPP AOC would be performed. Representative soil samples would also be collected prior to excavation (or possibly after excavation to an on-site stockpile) to determine the waste characterization of the material and the appropriate disposal method. The types of analyses would depend on the disposal facility requirements, but would include Toxic Characteristic Leaching Procedure (TCLP) analysis for lead.

Excavation and transport of the soil from the WPP AOC would be accomplished by using standard earth-moving equipment such as backhoes, bulldozers, and dump trucks. After excavation, soil would be placed in trucks and transported either to temporary stockpiles or directly to the disposal facility. Stockpiling would be necessary if characterization of the soils showed that stabilization was necessary prior to hauling to the off-site disposal facility.

Areas where surface soil samples contained lead concentrations above 400 mg/kg (Figure 3.1) would be excavated (two areas). A small area (approximately 20 by 10 ft [6 by 3 m]) surrounding the sampling locations for SO-11 and SO-12 and a larger area (approximately 150 by 10 ft [45 by 3 m]) along the northern edge of the Northern Pit (samples SO-3, NP-6--WALL, NP-7-WALL, and NP-8-WALL) would be excavated to an approximate depth of 2 ft (0.6 m). This would generate approximately 125 yd^3 (95 m^3) of contaminated soil. Verification soil samples would be collected from the base and sidewalls of each excavation and analyzed for lead to confirm the levels of contaminants remaining at the site.

Disposal of the contaminated soils generated during the removal would take place at a licensed, off-site sanitary or hazardous waste landfill. Because contaminated soil would be removed and the site cleared of UXO, LUCs to address soil contamination would not be required after completion of construction activities. However, if the property were ever disposed of by the DOD, a notice of groundwater contamination on the deed would likely be required for the small area of TCE-contaminated groundwater on the western edge of the site. Five-year reviews of the site would be required as long as the Army retained control of the site because of the groundwater contamination. In addition, LUC measures would be needed for neighboring areas outside of the WPP where UXO could be present.

During remediation activities, good engineering practices and mitigative measures would be implemented to control both contaminant releases (such as fugitive dust emissions) and potential exposures to workers. All workers engaged in soil removal activities would be required to wear an appropriate level of personal protective equipment. Work zones would be clearly delineated and monitored to ensure worker safety. Equipment and personnel would be decontaminated as necessary before leaving the area. Dust-control measures would include spraying water, covering stockpiles, and covering loads during transport.

After excavation/removal activities were complete, verification soil samples would be collected from each excavation. Approximately 16 soil samples (6 from the smaller excavation and 10 from the excavation along the northern side of the Northern Pit) would be collected and submitted to the project laboratory for lead analysis. After soil removal, the site would be graded as necessary and seeded with native vegetation to protect the site from erosion. As part of MRM activities and independent of the remedy in this Alternative, a reforestation grove would be planted at the WPP AOC.

6.4.1 Overall Protection of Human Health and the Environment

Alternative 5 would be protective of human health and the environment over the long term. Under this alternative, contaminated surface soils at the WPP AOC would be removed and hauled to an off-site disposal facility. Under Alternative 5, contaminant source areas in soil would be remediated, thereby reducing the threat for contaminants to migrate to groundwater.

The already minimal risk for exposure of site workers and potential adolescent trespassers would also be reduced or eliminated following the removal activity.

6.4.2 Compliance with ARARs

Regulatory requirements that might be applicable or relevant and appropriate to the proposed action are identified and evaluated in Appendix A. No contaminant-specific ARARs have been identified that address the lead-contaminated soil at the WPP AOC. However, for the purposes of this FFA, EPA and Maryland Department of the Environment guidance has been used to set a preliminary soil remediation level of 400 mg/kg (EPA 1989b, MDE 2001). Under Alternative 5, this contaminant-specific TBC would be met.

Alternative 5 would fail to meet the CERCLA-mandated preference for remedies that reduce contaminant toxicity, mobility, or volume through treatment (CERCLA Section 121[b][1]) unless the excavated soil was stabilized prior to disposal at a licensed landfill.

Location-specific ARARs address the protection of historic sites, archeological and cultural resources, endangered species and habitats, fish and wildlife resources, and floodplains. No archeological and cultural resources are expected because the areas to be excavated have already been subject to disturbances during the disposal pit excavation activities. No critical ecological habitats have been found at the WPP AOC.

Action-specific ARARs address the protection of water, sediment, soil, and air during implementation of the remedial action. Alternative 5 would involve the removal and off-site disposal of lead-contaminated soil. Federal and state regulations governing the disposal of contaminated soil would apply. OSHA standards for worker protection would also apply. Mitigative measures such as silt fences to protect nearby wetlands and the Gunpowder River would be required.

6.4.3 Long-Term Effectiveness and Permanence

Alternative 5 would be protective of human health and the environment over the long term. Under this alternative, contaminated surface soil from the WPP AOC would be removed and disposed of. Excavation and disposal would greatly reduce contaminant toxicity, mobility, and volume at the site; therefore, potential exposures due to contaminant releases from residual site sources would be low. Verification sampling would be conducted upon completion of the excavation/disposal activities to assess the effectiveness and potential impacts of the remedial action.

Workers would be present on-site periodically to carry out routine maintenance activities. Residual risks would be reduced because the majority (if not all) of the contaminated soil exceeding cleanup criteria would be removed. Long-term exposure of workers and the general public to contaminants would be negligible because the contaminated soil would be removed from the surface and the excavated area would be graded and planted with native vegetation.

Risks associated with long-term exposure of biota would be reduced; however, no adverse impacts are expected in any event, because the WPP AOC encompasses only a small portion of the overall habitat available to wildlife in the J-Field area.

6.4.4 Reduction of Toxicity, Mobility, or Volume

No treatment technology for the excavated soil would be implemented as part of Alternative 5. Therefore, no significant reduction in toxicity or volume of the lead-contaminated soil would occur under this alternative. The mobility of the contaminants of concern would be reduced as a result of their disposal, possibly with prior stabilization, in an engineered landfill.

6.4.5 Short-Term Effectiveness

Under Alternative 5, existing LUCs would continue to allow access only by site workers and other authorized personnel. The short-term risks to site workers would be significant for Alternative 5; mitigative measures would need to be employed. During construction activities, site workers would be protected by strictly adhering to the site health and safety plan prepared pursuant to OSHA Standards promulgated in 29 CFR 1910.120. The most significant short-term risk would be that posed by the UXO survey/clearance. The health and safety implications of encountering UXOs and CWAs or other chemical contaminants would be addressed in a health and safety plan.

The release of particulate emissions (dust) during excavation and post-excavation grading activities would need to be minimized. Dust-control measures could include spraying the site with water to minimize dust generation. The potential for exposures through direct contact of site workers involved in post-remedial maintenance activities would be eliminated by the soil removal. These risks were already shown to be acceptable (EA 2006). Augmenting the existing LUCs with the soil removal would be effective in reducing the already low risk posed to potential adolescent trespassers.

Under Alternative 5, protection of the environment likely would be maintained. Short-term risk to terrestrial biota during construction activities and from routine post-remedial maintenance activities would be low.

6.4.6 Implementability

Alternative 5 could be implemented with readily available resources. Standard excavation and construction equipment would be used to remove contaminated soil from the site and to re-grade the area upon completion of the remedial activity. The shallow excavation depth could be accomplished with readily available resources. Local contractors can haul the excavated soil to the disposal facility. Minimum site operations (e.g., security and site maintenance) would also continue by using readily available resources.

The acceptability of soil excavation with disposal is expected to be high. However, the lack of a treatment component for this alternative to reduce contaminant toxicity or volume is not preferred by CERCLA (Section 121[b][1]). Post-construction verification sampling would ensure that the majority of lead-contaminated soil was removed from the site.

6.4.7 Cost

The cost estimate for this alternative was derived by using the RACER estimating model (Earth Tech 2007). The costs reported here are current-year dollar summary reports, with markups. Current institutional control measures, including the APG range control security and access limitations**,** would remain in effect at the site after the remediation. No costs are assigned to these measures. Because installation and maintenance of the reforestation grove would be funded by non-IRP APG programs, those costs are not included in Appendix B. Costs are assigned to soil removal with the assumption that the soils will be classified as hazardous waste because of high lead concentrations (waste code D008 under 40 CFR 268, Subpart D) and will be disposed of accordingly. Costs would be lower if the soil is not classified as hazardous.

The capital expenditures for UXO clearance of the entire WPP AOC (approximately 5.5 acres [2.2 ha]) and the cost to excavate, load, haul, and dispose of the estimated 125 yd^3 (95 m^3) of hazardous classified soil is approximately $3.57 million. This estimate includes the costs to remove UXO ($2,245 K), excavate the contaminated soil ($12 K), dispose of lead contaminated soil ($16 K), manage the UXO/soil removal effort ($1,264 K), and restore the site upon completion of the remedial activity ($34 K). The cost for remedial design/remedial action planning and documentation is estimated at more than $15 K. Other costs include LUCs implementation and reporting costs (including costs for five-year reviews). LUC and 5-year review costs would be approximately $1,500 K. Although contaminated soil would be removed under this alternative, five-year reviews would be necessary because the contaminants that are considered residential risk drivers would be present in groundwater ($44 K). However, the reforestation grove may serve a phytoremediation role and, in combination with intrinsic remediation, may result in the dissipation or removal of the groundwater risk drivers. Even if the Army relinquishes control of the site under this “Free Release” scenario, additional LUC costs (over and above the LUC costs associated with Alternatives 2 through 4) would result from the need to ensure that the remedy remains protective. Relevant protective measures include LUC-related planning documents, construction permitting, deed notification requirements, and the negotiation of easements and restrictive covenants. Furthermore, ensuring remedy protectiveness would involve additional monitoring and enforcement requirements such as notice letters, site visits, and inspections. The total cost estimate for Alternative 5 is $5,100 K. Details of this cost are presented in Appendix B. The RACER “Estimate Documentation Report,” which lists the estimate parameters, is included in Appendix B, along with the “Folder Cost Summary Report.” This second report lists detailed first-year costs for Alternative 5.

7 COMPARATIVE ANALYSIS OF ALTERNATIVES

The comparative analysis of remedial action alternatives for the WPP AOC uses the nine evaluation criteria described in Section 6. This analysis is the second stage of the detailed evaluation process and provides information with which a balanced decision for site cleanup can be made. Regulatory comments to this draft FFS will be incorporated into the final FFS report. After further consideration by the State and Federal regulators and following public comment to the proposed remedy, the final remedy components will be established and published in the Record of Decision for the site.

The evaluation criteria are grouped into threshold criteria, primary balancing criteria, and modifying criteria, comprising the tiered evaluation system identified in the National Contingency Plan (EPA 1990b).

7.1 THRESHOLD CRITERIA

The threshold criteria are the criteria that must be satisfied by the selected alternative. They are:

- Overall protection of human health and the environment, and
- Compliance with ARARs, unless a waiver condition applies.

These criteria are of greatest importance in the comparative analysis because they reflect the key statutory mandates of CERCLA, as amended. If an alternative does not satisfy both of these criteria, it cannot be selected as the final remedy.

7.1.1 Overall Protection of Human Health and the Environment

Only Alternative 5 would provide long-term protection of human health and the environment under all potential future-use scenarios at the WPP AOC. This protection could not be ensured by the other three alternatives evaluated by this FFS (Table 7.1). However, this conclusion assumes that the site would be utilized for residential use in the future. Based on the current site use as a military testing and training range, the proximity of an active open burn/open detonation site (Robins Point Demolition Ground), and the prior use of nearby areas of J-Field for ordnance and CWA disposal, the assumption of future residential use is very unlikely. Alternatives 1, 2, and 3 have been prepared with the assumption that the U.S. Army will retain authority over land-use decision making. Under current and likely-future-use scenarios, the impacts to human health were found to be acceptable (EA 2006). The ecological risk assessment also concluded that the current site conditions would have relatively low impact to the environment (Martino et al. 2006).

Alternative 5 would provide the greatest overall protection of human health and the environment. Removal of all potential UXO from the area and removal of surface soils with lead concentrations exceeding 400 mg/kg would provide the greatest overall protection of the four proposed alternatives. With the exception of a small area of TCE-contaminated groundwater adjacent to the Gunpowder River, the WPP AOC would be allowed unrestricted use following completion of the activities proposed in Alternative 5. Alternative 3 would provide more protection than Alternatives 1 and 2 due to the isolation of the lead-contaminated surface soil through capping. Alternatives 1 and 2 would do little to alter existing site conditions; however, the augmented LUCs would further restrict site access. Based on the current and likely-future-use scenarios for the WPP AOC, all of the proposed alternatives would provide adequate overall protection of human health and the environment.

7.1.2 Compliance with ARARs

There are no chemical-specific ARARs identified to address the lead-contaminated soils at the WPP AOC. EPA and MDE guidance suggests 400 mg/kg as a cleanup standard for lead in soil (EPA 1989b; MDE 2001). Only Alternative 5 would comply with this TBC guidance. Alternatives 1 and 2 would result in the least disturbance at the site. Therefore, these alternatives would result in the easiest compliance with location- and action-specific ARARs. Alternative 3 could require compliance with 100-year floodplain location standards (Table 7.1).

7.2 PRIMARY BALANCING CRITERIA

The primary balancing criteria category contains the five criteria that are used to assess the relative advantages and disadvantages of the alternatives to determine the most appropriate solution for a given site (Table 7.1):

1. Long-term effectiveness and permanence;

2. Reduction of toxicity, mobility, or volume through treatment;

3. Short-term effectiveness;

4. Implementability; and

5. Cost.

The first and second criteria address the statutory preference for treatment as a principal element of the remedy and the bias against off-site disposal of untreated waste. Together with the third and fourth criteria, they form the basis for determining the general feasibility of the remedy and whether costs are proportional to the overall effectiveness, considering both the cleanup period and the time following cleanup. By this means, we can determine whether the remedy is cost-effective.

7.2.1 Long-Term Effectiveness and Permanence

Under current and likely-future-use scenarios all alternatives would be protective of human health and the environment over the long term, assuming the realistic scenario in which the site remains under U.S. Army control and the surface soil contamination continues to remain immobile and does not leach to groundwater. Under each alternative, APG-specific LUCs, routine site maintenance, and security would continue at J-Field. Because access is restricted, potential impacts to members of the general public over the long term are considered negligible. Additional LUCs and/or capping (Alternatives 2 and 3) would add an extra layer of effectiveness to reduce potential site exposures. Five-year reviews would also increase long-term effectiveness under all alternatives. Environmental risks are considered low because the area containing soil with elevated lead concentrations occupies only a very small portion of the overall habitat available in and around the WPP AOC. Therefore, under current and likely future conditions, all alternatives would be considered effective over the long term.

Each action alternative offers additional long-term protections. Alternative 3 includes additional containment to further reduce the possibility of contaminants becoming mobile through dust, erosion, or leaching. Alternative 5 would remove most, if not all, soils in which the contaminant of concern exceeds the screening level. On this basis, Alternatives 3 and 5 could be considered more effective than Alternatives 1 and 2.

7.2.2 Reduction of Toxicity, Mobility, or Volume

Reduction of toxicity, mobility, or volume through treatment is not applicable to any of the alternatives because treatment is not involved. Alternative 3 would result in some reduction in contaminant mobility. Installation of a soil blanket could reduce the physical mobility of lead due to erosion or dust. Alternative 5, while not a treatment option, would reduce contaminant toxicity, mobility and volume at the WPP AOC due to the removal component of this option.

7.2.3 Short-Term Effectiveness

For Alternatives 1 and 2, conditions would remain essentially the same in the short-term, and no significant changes in potential exposures would be expected. Direct contact would be limited to site maintenance workers, but these risks have been shown to be acceptable (EA 2006).

Under Alternatives 3 and 5, existing LUCs would continue to allow access only by site workers and other authorized personnel. These LUCs could be eliminated after the completion of the removal component under Alternative 5, at which time deed restrictions could allow alternative land use. The short-term risks to site workers would be significant; mitigative measures would need to be employed. During construction activities, site workers would be protected by strictly adhering to APGR 385-7 and to the site health and safety plan prepared pursuant to OSHA Standards promulgated in 29 CFR 1910.120. The most significant short-term risk for Alternatives 3 and 5 would be that posed by the UXO survey/removal action. The health and safety implications of encountering UXOs and CWAs or other chemical contaminants would be addressed in the health and safety plan. For Alternatives 3 and 5, construction activities, and in the case of Alternative 5 the removal and disposal activities, would result in increased short-term exposures, in contrast to all other alternatives. Potential short-term impacts to site workers and the public would be minimized through the use of protective mitigative measures. The risks of construction and transportation accidents and related exposures would also be significant in comparison with Alternatives 1 and 2.

Potential short-term environmental impacts are expected to be minimal under all alternatives. Construction activities under Alternatives 3 and 5 would occur at a very limited area in relation to the overall area of available habitat. Under Alternatives 1 and 2 minimal activities would occur and the already low environmental impacts (Martino et al. 2006) would remain.

7.2.4 Implementability

Alternatives 2, 3, and 5 are readily implementable. Construction to install the soil blanket required for Alternative 3 could be carried out by using standard equipment and procedures with readily available resources. Under Alternative 5, construction to remove the lead-impacted soil and restore the site could also be carried out by using standard equipment and procedures with readily available resources. Routine maintenance activities under all alternatives would continue with currently available personnel. Resources for UXO screening/removal and CWA monitoring during construction activities for Alternatives 3 and 5 are available and have been utilized in the past at J-Field because of the site's former use as a disposal area.

The acceptability of Alternatives 1, 2, and 3 would be affected by the lack of a treatment component and problems in ensuring long-term effectiveness. Therefore, administrative feasibility may be considered low. However, additional LUCs, such as modifications to the Installation Master Plan specifying land use requirements, would increase the effectiveness of Alternatives 2 and 3 vs. the No Action alternative (Alternative 1). As long as the U.S. Army maintains effective control over J-Field, these alternatives would be effective. Although Section 121(b) of CERCLA maintains that the least preferred alternatives involve the transport and disposal of waste off-site without treatment (as in Alternative 5), the low volume of waste soil proposed under this alternative would likely be administratively acceptable given the lack of effective treatment options for such a low volume of waste.

7.2.5 Cost

Preliminary costs were estimated for each alternative to both allow a balanced comparison and consider effectiveness. The costs presented in this report were estimated by using the RACER Model (Earth Tech 2007) (see Appendix B). Certain assumptions were made regarding the design of these alternatives, as outlined in Section 6. Final costs will be developed during the design stage, after the remedy for site cleanup has been selected.

Alternative 2, which assumes additional LUCs, would be the least expensive of all the action alternatives in the short term. Alternatives 3 and 5 would cost considerably more because of the significant costs of obtaining UXO clearance and providing construction activities at this somewhat remote site. Alternative 5 would be the most expensive, mainly because of UXO clearance of the entire site, but it would provide the most certainty that the remedial goals would be met. Under Alternative 5, however, is the additional concern of the continued long-term monitoring and maintenance of the off-site disposal facility. Because it would be a commercial facility, the maintenance of institutional controls at the site would be the responsibility of a private company instead of the federal government. Breakdowns in institutional controls resulting in contaminant releases from U.S. Army waste could lead to future liability issues. No costs for future liability related to this issue are included in the cost estimates.

Alternatives 3 and 5 would provide similar protection under current and likely-future-use scenarios at the WPP AOC as a result of the isolation and removal components, respectively, for these two alternatives. However, all alternatives provide acceptable risks under current and likely-future-use scenarios. Therefore, Alternative 2 (augmented LUCs) is considered the most cost-effective action alternative. All alternatives provide acceptable risks under current and likely future use of the site.

7.3 MODIFYING CRITERIA

The modifying criteria are (1) state acceptance and (2) community acceptance. As discussed in Section 6 and the beginning of Section 7, this category can be fully considered only after the final FFS has been issued to the State and the public for formal comment. Therefore, these modifying criteria are not fully addressed in this comparative analysis. They will be addressed in detail in the final version of this document and in the Record of Decision.

7.4 SUMMARY AND PROPOSED REMEDIAL ACTION

All of the final remedial action alternatives for the WPP AOC satisfy the threshold criteria for protecting human health and the environment and comply with regulatory requirements. Under these alternatives, exposures and risks would be minimized by continued site access restrictions and, in the case of Alternatives 3 and 5, by isolating or removing the contaminated soil, respectively. Overall protectiveness would be comparable for each of these four alternatives assuming current and likely future land use scenarios.

With regard to the primary balancing criteria, all alternatives are expected to provide a permanent solution that would ensure protection for a very long time. Again, continued site access restrictions and control of J-Field by the U.S. Army would ensure that the site does not pose risks to human health or the environment under current and likely future land use scenarios. Alternatives 3 and 5 would be more protective because of their active approach in isolating contaminants or reducing the contaminant levels in soil at the site.

No alternative would reduce contaminant volume, mobility, or toxicity through treatment. Alternative 5 would reduce contaminant volume, mobility, and toxicity at the site due to the removal component.

The short-term effectiveness would be greatest for the no action alternative (Alternative 1) and the augmented LUC alternative (Alternative 2). Risks associated with the other alternatives would be higher due to construction activities and potential exposures to UXO/CWA and contaminated soils. Short-term risks to the environment would be highest for Alternatives 3 and 5. Mitigative measures would be used to minimize potential short-term impacts.

The implementation of all alternatives would be fairly straightforward. Additional studies would not be necessary to implement any of the alternatives.

Other than the No Action alternative, Alternative 2 would be the least expensive alternative over a 30-year period. Alternatives 3 and 5 would cost considerably more than either Alternative 1 or Alternative 2.

Alternative 2 (augmented LUCs) has been selected as the proposed site remedy because (1) no human health risks were found for current or likely future land use scenarios, and (2) it entails the least disruption of site activities but increases effectiveness by adding administrative control over site usage. Even the most expensive alternative (Alternative 5) could not support complete unrestricted use of the site because of the presence of UXO throughout J-Field and residual groundwater contamination in a small portion of the WPP AOC and other areas in the surrounding Gunpowder Neck Peninsula. The site continues to be a part of an active U.S. Army range and recontamination by UXO remains a possibility. Therefore, until such a time that the site would no longer be under U.S. Army control, the augmented LUCs outlined in Alternative 2 are proposed at the WPP AOC.

8 REFERENCES

Alexander, M., 1995, "How Toxic Are Toxic Chemicals in Soil?" *Environmental Science and Technology* 29:2713–2717.

APG (U.S. Army Aberdeen Proving Ground), 1983a, Disposal Voucher 606-13, Disposal Pickup and Destruction, Bldg 5354, Jan.

APG, 1983b, Disposal Voucher 606-13, Disposal Pickup and Destruction, Bldg 5354, April.

APG, 1983c, Disposal Voucher 606-13, Disposal Pickup and Destruction, June.

APG, 2001, *J-Field Study Area Record of Decision, Final Remedial Action,* U.S. Army Garrison, Aberdeen Proving Ground, Md., Sept.

ASTM (American Society for Testing and Materials), 2004, *Standard Guide for Conducting the Frog Embryo Teratogenesis Assay-Xenopus (FETAX),* ASTM Designation E 1439 – 98 (Reapproved 2004), *Annual Book of ASTM Standards,* Vol. 11.05, ASTM, Philadelphia, Pa.

ATSDR (Agency for Toxic Substances and Disease Registry), 1997, *White Phosphorus TOXFaqs*, fact sheet, ATSDR, Atlanta, Ga., Sept. [http://www.atsdr.cdc.gov/tfacts103.html].

Beehler, A.A., 2004, Assistant Deputy Undersecretary of Defense (Environment, Safety, and Occupational Health) Memorandum, "Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Record of Decision (ROD) and Post-ROD Policy," Washington, D.C., Jan.

Benioff, P., et al., 1995a, *Remedial Investigation Work Plan for J-Field, Aberdeen Proving Ground, Marylan*d, ANL/EAD/TM-40, Argonne National Laboratory, Argonne, Ill., March.

Benioff, P., et al., 1995b, *Remedial Investigation Sampling and Analysis Plan for J-Field, Aberdeen Proving Ground, Maryland, Volume 1: Field Sampling Plan*, ANL/EAD/TM-38, Argonne National Laboratory, Argonne, Ill., March.

Beyer, W.N., and E.J. Cromartie, 1987, "A Survey of Pb, Cu, Zn, Cd, As, and Se in Earthworms and Soil from Diverse Sites," *Environmental Monitoring and Assessment* 8:27–36.

Brenner, G.J., 1963, *The Spores and Pollen of the Potomac Group of Maryland,* Bulletin 27, Maryland Department of Geology, Mines, and Water Resources.

Burton, D.T., S.D. Turley, and M.A. Osborn, 2003, *Toxicity Assessment of Potentially Contaminated Soils and Sediments at the Concrete Slab Test Site (Cluster 5),* Draft Final Report, Services Agreement No. 7003-022, Work Authorization No. AMY300-01, General Physics Corp., Edgewood, Md.

Chapman, P.M., F. Wang, C. Janssen, G. Persoone, and H.E. Allen, 1998, "Ecotoxicology of Metals in Aquatic Sediments: Binding and Release, Bioavailability, Risk Assessment, and Remediation," *Canadian Journal of Fisheries and Aquatic Sciences* 55:221–2243.

Clark, W.B., 1910, "Some Results of a Recent Investigation of the Coastal Plain Formation of the Area between Massachusetts and North Caroline," *Geological Society of America Bulletin* 20:646–654.

Crowley, W.P., et al., 1976, geological map of the White Marsh quadrangle, Maryland, Maryland Geological Survey Quadrangle Geological Map, scale 1:24,000.

Daudt, C.R., et al., 1994, *Environmental Geophysics at J-Field, Aberdeen Proving Ground, Maryland*, ANL/ESD/TM-77, Argonne National Laboratory, Argonne, Ill., Nov.

Davis, B.N.K, 1971, "Laboratory Studies on the Uptake of Dieldrin and DDT by Earthworms," *Soil Biology and Biochemistry* 3:221–233.

DiToro, D.M., C.S. Zarba, D.J. Hansen, W.J. Barry, R.C. Swartz, C.E. Cowen, S.P. Pavlou, H.E. Allen, N.A. Thomas, and P.R. Paquin, 1991, "Technical Basis for Establishing Sediment Quality Criteria for Nonionic Organic Chemicals Using Equilibrium Partitioning," *Environmental Toxicology and Chemistry* 10:1541–1583.

DOD (U.S. Department of Defense), 2001, *Guidelines on Land Use Controls Associated with Environmental Restoration Activities*, Washington, D.C., Jan.

Donnelly, C.A., and F.J. Tenbus, 1998, *Temporal and Vertical Variation of Hydraulic Head in Aquifers in the Edgewood Area, Aberdeen Proving Ground, Maryland*, Water-Resources Investigations Report 98-4047, U.S. Geological Survey.

EA (EA Engineering Science and Technology, Inc.), 2005, *Approach Document for Baseline Human Health Risk Assessment for the Other Edgewood Area Sites*, Aug.

EA, 2006, *J-Field White Phosphorus Pits, Remedial Investigation Report Volume II: Baseline Human Health Risk Assessment, Aberdeen Proving Ground, Maryland*, March.

Earth Tech, Inc., 2006, Remedial Action Cost Engineering and Requirements (RACER™ 2006) System, Version 8.1.2, Englewood, Colo.

EPA (U.S. Environmental Protection Agency), 1984, *Ambient Water Quality Criteria for Lead*, EPA 440/5-84-027, U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

EPA, 1985, *Ambient Water Quality Criteria for Copper*, EPA 440/5-84-031, U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

EPA, 1988a, *Ambient Water Quality Criteria for Aluminium*, EPA 440/5-86-008, U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

EPA, 1988b, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA*, Interim Final, EPA/540/G-89/004 (OSWER Directive 9355.3-01), Office of Emergency and Remedial Response, Washington, D.C., Oct.

EPA, 1989a, *Risk Assessment Guidance for Superfund: Volume 1: Human Health Evaluation Manual: Part A*, EPA/540/1-898/002, Office of Emergency and Remedial Response, Washington, D.C., Dec.

EPA, 1989b *Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites*, OSWER Directive #9355.4-02, Office of Solid Waste and Emergency Response, Washington, D.C.

EPA, 1990a, *Contract Laboratory Statement of Work for Organic Analysis, Multi-Media, Multi-Concentration*, Document Number OLMO01.0, March.

EPA, 1990b, "National Oil and Hazardous Substances Pollution Contingency Plan; Final Rule (40 CFR Part 300)," *Federal Register* 55(35): 6154–6176, Feb. 21.

EPA, 1991, *Risk Assessment Guidance for Superfund, Vol. 1*, *Human Health Evaluation Manual, Part C, Risk Evaluation of Remedial Alternatives*, EPA/540/R-92/004, Office of Emergency and Remedial Response, Washington, D.C., Dec.

EPA, 1993a, *Data of Sediment and Surface Water around Gunpowder Neck Peninsula, August 1992*, Washington, D.C.

EPA, 1993b, *Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses*, Philadelphia, Pa., April.

EPA, 1993c, *Wildlife Exposure Factors Handbook*, Volume 1, EPA/600/R-93/187a, U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C.

EPA, 1995, *Region III BTAG Screening Levels*, Draft Report, Region III, U.S. Environmental Protection Agency, Philadelphia, Pa., Aug. 9.

EPA, 1996a, "Method 6200, Field Portable X-Ray Fluorescence Spectrometry for the Determination of Elemental Concentrations in Soil and Sediment," in *Methods for the Analysis of Waters and Waste*, EPA SW-846, as amended, Washington, D.C.

EPA, 1996b, *Recommendations for the Technical Review Workgroup for Lead, An Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil*, Technical Workgroup for Lead, Dec.

EPA, 1997, *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments*, EPA/540-R-97-006, U.S. Environmental Protection Agency, Environmental Response Team, Edison, N.J., June.

EPA, 1999, *Integrated Risk Information System (IRIS) on Lead and Compounds (Inorganic)*, U.S. Environmental Protection Agency, National Center for Environmental Assessment, Office of Research and Development, Washington, D.C.

EPA, 2001, *Methods for Assessing Chronic Toxicity of Marine and Estuarine Sediment-Associated Contaminants with Amphipod Leptocheirus Plumulosus*, First edition EPA/600/R-01/020, U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

EPA, 2002, User's Guide for the Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK), Windows Version—32-Bit Version. 540-K-01-005, May.

EPA, 2005, *Ecological Risk Assessment: Freshwater Screening Benchmarks*, U.S. EPA, Mid-Atlantic Region III, Philadelphia, Pa., updated April 21 (available at http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fw/screenbench.htm; accessed June 6, 2005).

Fort, D.J., 2005, personal communication, Fort Environmental Laboratory, Inc., Stillwater, Okla.

Gish, C.D, 1970, "Organochlorine Insecticide Residues in Soils and Soil Invertebrates from Agricultural Lands," *Pesticides Monitoring Journal* 3:241–252.

Gish, C.D., and R.E. Christensen, 1973, "Cadmium, Nickel, Lead, and Zinc in Earthworms from Roadside Soil," *Environmental Science and Technology* 7:1060–1062.

Glaser, J.D., 1969, *Petrology and Origin of Potomac and Magothy (Cretaceous) Sediments, Middle Atlantic Coastal Plain*, Report of Investigations No. 11, Maryland Geological Survey, Baltimore, Md.

Grant, A., and R. Middleton, 1998, "Contaminants in Sediments: Using Robust Regression for Grain-size Normalization," *Estuaries* 21:197–203.

Hansen, H.J., 1968, *Geophysical Log Cross-Section Network of the Cretaceous Sediments of Southern Maryland*, Report of Investigation No. 7, Maryland Geological Survey, Baltimore, Md.

Hansen, D.J., et al., 1996, "Predicting the Toxicity of Metal-Contaminated Field Sediments Using Acid-Volatile Sulfide and Interstitial Water Normalizations," *Environmental Toxicology and Chemistry* 15:2080–2094.

Hayse, J., and L. Martino, 2004, *J-Field, White Phosphorus Pits Proposed Sampling Design for the Collection of Media for Toxicological Testing*, Argonne National Laboratory, Argonne, Ill., for the U.S. Army Directorate of Safety Health and Environment, Aberdeen Proving Ground, Md., Dec.

Helmke, P.A., W.P. Robarge, R.L. Korotev, and P.J. Schomberg, 1979, "Effects of Soil-applied Sludge on Concentrations of Elements in Earthworms," *Journal of Environmental Quality* 8:322–327.

Hendriks, A.J., W-C. Ma, J.J. Brouns, E.M. de Ruiter-Dijkman, and R. Gast, 1995, "Modeling and Monitoring Organochlorine and Heavy Metal Accumulation in Soils, Earthworms, and Shrews in Rhine-Delta Floodplains," *Archives of Environmental Contamination and Toxicology* 29:115–127.

Hlohowskyj, I., et al., 2000, *Remedial Investigation Report for J-Field, Aberdeen Proving Ground, Maryland; Volume 3: Ecological Risk Assessment*, Argonne National Laboratory, Argonne, Ill., for U.S. Army, Directorate of Safety, Health, and Environment, Aberdeen Proving Ground, Md., Dec.

Hope, B.K., 1995, "A Review of Models for Estimating Terrestrial Ecological Receptor Exposure to Chemical Contaminants," *Chemosphere* 30(12):2267–2287.

Hughes, W.B., 1993, *Hydrogeology and Soil-Gas at J-Field, Aberdeen Proving Ground, Maryland*, Water-Resources Investigation Report 92-4087, U.S. Geological Survey, Towson, Md., prepared in cooperation with the U.S. Army, Aberdeen Proving Ground Support Activity, Environmental Management Division.

ICF Kaiser Engineers, 1995, *Reference Sampling and Analysis Program at the U.S. Army Aberdeen Proving Ground, Soil, Sediment, and Surface Water Reference Data Report*, prepared under U.S. Department of the Army Contract No. DAAA15-91-D-0014, Task Order No. 12, for U.S. Army Environmental Center, Aberdeen Proving Ground, Md., July.

Ireland, M.P, 1979, "Metal Accumulation by the Earthworms *Lumbricus rubellus*, *Dendrobaena veneta*, and *Eiseniella tetraedra* Living in Heavy Metal Polluted Sites," *Environmental Pollution* 19:201–206.

IT Group, 2001, *Design Work Plan, Protective Soil Blanket J-Field*, Edgewood, Md., April.

Kimmell, T., et al., 2003, *J-Field, White Phosphorus Burning Pits, Remedial Investigation Quality Assurance Project Plan, Version 1.1*, Argonne National Laboratory, Argonne, Ill., Dec.

Lewis, P.A., et al., 1994, *Short-Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms*, EPA/600/4-91/002, U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio.

Long, E.R., and L.G. Morgan, 1990, *Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program*, NOAA/TM/NOS/OMA-52, National Oceanic and Atmospheric Administration, Office of Oceanography and Marine Assessment, Rockville, Md.

Long, E.R., D.D. MacDonald, J.C. Cubbage, and C.G. Ingersoll, 1998, "Predicting the Toxicity of Sediment-Associated Trace Metals with Simultaneously Extracted Trace Metal: Acid-volatile Sulfide Concentrations and Dry Weight-normalized Concentrations: A Critical Comparison," *Environmental Toxicology and Chemistry* 17:972–974.

Mahony, J.D., et al., 1996, "Partitioning of Metals to Sediment Organic Carbon," *Environmental Toxicology and Chemistry* 15:2187–2197.

Martino, L.E., and J. Hayse, 2003, *J-Field White Phosphorus Burning Pits Remedial Investigation Field Sampling Plan and Ecological Risk Assessment Work Plan, Aberdeen Proving Ground, Maryland*, Argonne National Laboratory, Argonne, Ill., Dec.

Martino, L.E., et al., 2006 *J-Field White Phosphorus Burning Pits, Remedial Investigation Report, Vol. I: Contamination Assessment and Ecological Risk Report, Aberdeen Proving Ground Maryland,* Argonne National Laboratory, Argonne, Ill., Final, Dec.

Martino, L., 2006, e-mail from Martino (Argonne National Laboratory) to Wrobel, J., Burgess, A., and Paul, J., (U.S. Army Garrison Aberdeen Proving Ground), June 20.

Mazelon, M., 1993, letter from Mazelon (Chief Engineer, Roy F. Weston, Inc., Aberdeen Proving Ground) to R. Rizieri (U.S. Army Corps of Engineers, Aberdeen Proving Ground), Feb. 26.

MDE (Maryland Department of the Environment), 2001, *Cleanup Standards for Soil and Groundwater*, Interim Final Guidance (Update No. 1), MDE, Baltimore, Md., Aug.

Morrison, D.E., B.D. Robertson, and M. Alexander, 2000, "Bioavailability to Earthworms of Aged DDT, DDE, DDD, and Dieldrin in Soil," *Environmental Science and Technology* 34:709–713.

Nemeth, G., et al., 1983, *Environmental Survey of the Edgewood Area of Aberdeen Proving Ground, MD*, DRXTH-AS-FR-82185, U.S. Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, Md., Jan.

Nemeth, G., 1989, *RCRA Facility Assessment, Edgewood Area, Aberdeen Proving Ground, Maryland*, Report 39-26-0490-90, U.S. Army Environmental Hygiene Agency, Waste Disposal Engineering Division, Aberdeen Proving Ground, Md., Nov.

Neubauer, R.J., et al., 1994, *Interim Technical Report: The Preliminary Ecological Stress Survey of the Gunpowder River Study Area (Draft)*, prepared by ICF Kaiser Engineers, Abingdon, Md., for U.S. Army Environmental Center, Aberdeen Proving Ground, Md., Jan.

Neuhauser, E.F., Z.V. Cukic, M.R. Malecki, R.C. Loehr, and P.A. Durkin, 1995, "Bioconcentration and Biokinetics of Heavy Metals in the Earthworm," *Environmental Pollution* 89:293–301.

Norris, L., and M. Borland, 1993, *Screening Procedures for Trace Level Analysis of Potentially Contaminated Soil Samples: J-Field White Phosphorus Area, Vol. III*, prepared by SciTech Services, Inc., Abingdon, Md., for U.S. Army Edgewood Research, Development, and Engineering Center, Aberdeen Proving Ground, Md., Nov.

Omernik, J.M., and A.L. Gallant, 1989, *Aggregations of Ecoregions of the Conterminous United States*, JT1/J0/89-1, U.S. Environmental Protection Agency, Environmental Research Laboratory, Corvallis, Ore., May.

Peijnenburg, W.J.G.M., R. Baerselman, A.C. de Groot, T. Jager, L. Posthuma, and R.P.M. Van Veen, 1999, "Relating Environmental Availability to Bioavailability: Soil-type-dependent Metal Accumulation in the Oligochaete *Eisenia Andrei*," *Ecotoxicology and Environmental Safety* 44:294–310.

Phelan, D.J., et al., 1996, *Hydrologic, Soil, and Water-Quality Data for J-Field, Aberdeen Proving Ground, Maryland, 1989-1994*, Open File Report 96-128, U.S. Geological Survey, Towson, Md.

Phelan, D.J., et al., 1998, *Assessment of Soil, Surface-Water, and Ground-Water Contamination at Selected Sites at J-Field, Aberdeen Proving Ground, Maryland*, Water-Resources Investigations Report 98-4037, U.S. Geological Survey, Baltimore, Md., Aug.

Powars, D.S., 1997, *Stratigraphy and Geophysical Logs from a Borehole Drilled to Bedrock at Robins Point, J-Field, Edgewood Area, Aberdeen Proving Ground, Maryland*, Open File Report 97-357, U.S. Geological Survey, Towson, Md.

Prasad, S., and L. Martino, 1995, *EMFLUX® Soil-Gas Survey of J-Field White Phosphorus Pits Area, U.S. Army Aberdeen Proving Ground, Maryland*, TU-14/ANL/APG/J-F/RI, Argonne National Laboratory, Argonne, Ill.

Princeton Aqua Science, 1984, *Munitions Disposal Study*, prepared for U.S. Department of the Army, Directorate of Engineering and Housing, Environmental Management Office, Aberdeen Proving Ground, Md., Nov.

Ramos, L., M.A. Fernandez, M.J. Gonzalez, and L.M. Hernandez, 1999, "Heavy Metal Pollution in Water, Sediments, and Earthworms from the Ebro River, Spain," *Bulletin of Environmental Contamination and Toxicology* 63:305–311.

Reid, B.J., K.C. Jones, and K.T. Semple, 2000, "Bioavailability of Persistent Organic Pollutants in Soils and Sediments – A Perspective on Mechanisms, Consequences, and Assessment," *Environmental Pollution* 108:103–112.

Ripplinger, J., et al., 1998, *Human Health Risk Assessment for J-Field Edgewood Area, Aberdeen Proving Ground, Maryland*, ICF Kaiser Engineers, Edgewood, Md., Nov.

Sample, B.E., G.W. Suter II, J.J. Beauchamp, and R.A. Efroymson, 1999, "Literature-Derived Bioaccumulation Models for Earthworms: Development and Validation," *Environmental Toxicology and Chemistry* 18:2110–2120.

Shor, L.M., and D.S. Kosson, 2000, "Bioavailibility of Organic Contaminants in Soils," in J.J. Valdes (ed.) *Bioremediation*, Kluwer Academic Publishers, The Netherlands, pp. 15–43.

Sonntag, W., 1991, *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.

Stephan, C.E., D.I. Mount, D.J. Hansen, J.H. Gentile, G.A. Chapman, and W.A. Brungs, 1985, *Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses*, PB85-227049, National Technical Information Service, Springfield, Va.

TN Technologies, 1992, *Spectrace 9000 Portable XRF Analyzer*, Part No. 717715, Rev. 03, Round Rock, Tex., Jan.

U.S. Army Technical Escort Unit, 2003, *Final Report J-Field WP Pit Shoreline UXO Avoidance Project Edgewood Area, Aberdeen Proving Ground, Maryland*, Sept.

USDA (U.S. Department of Agriculture), 1927, *Soil Survey*, Bureau of Chemistry and Soils, Baltimore, Md.

USDA, 1975, *Soil Survey of Harford County Area, Maryland*, Soil Conservation Service, Washington, D.C., Aug.

U.S. Department of the Army, 1984, *Munitions Disposal Study*, Directorate of Engineering and Housing, Environmental Management Office, Aberdeen Proving Ground, Md.

USGS (U.S. Geological Survey), 1991, *Phase II Workplan and Field Sampling Plan Update for the Remedial Investigation at J-Field, Aberdeen Proving Ground, Maryland*, prepared by Water Resources Division, Towson, Md., for the U.S. Army Aberdeen Proving Ground Support Activity, Environmental Management Division, May.

Vavra, F., 2003, correspondence from Vavra (Remedial Project Manager, U.S. EPA Region III) to K. Stachiw (Chief Environmental Conservation and Restoration Division, APG), Sept. 17.

Weston (Roy F. Weston, Inc.), 1994, *Characterization and Interim Remediation of J-Field at Edgewood Area Aberdeen Proving Ground, Maryland,* Technical Report-Delivery Order 6, Volume 1, West Chester, Penn.

Weston, 2001a, *Feasibility Study, J-Field Study Area, Aberdeen Proving Ground, MD*, West Chester, Penn., Sept.

Weston, 2001b, *Technical Impracticability Evaluation for J-Field Surficial Aquifer, Aberdeen Proving Ground, MD,* West Chester, Penn., April

Weston, 2004, *J-Field Study Area, Long-Term Monitoring/Operations and Maintenance Plan, Aberdeen Proving Ground, Maryland,* West Chester, Penn., Aug.

Yuen, R., et al., 1999, *Remedial Investigation Report for J-Field, Aberdeen Proving Ground, Maryland; Volume 1: Remedial Investigation Results*, ANL/EAD/TM-80, Argonne National Laboratory, Argonne, Ill., Nov.

FIGURES

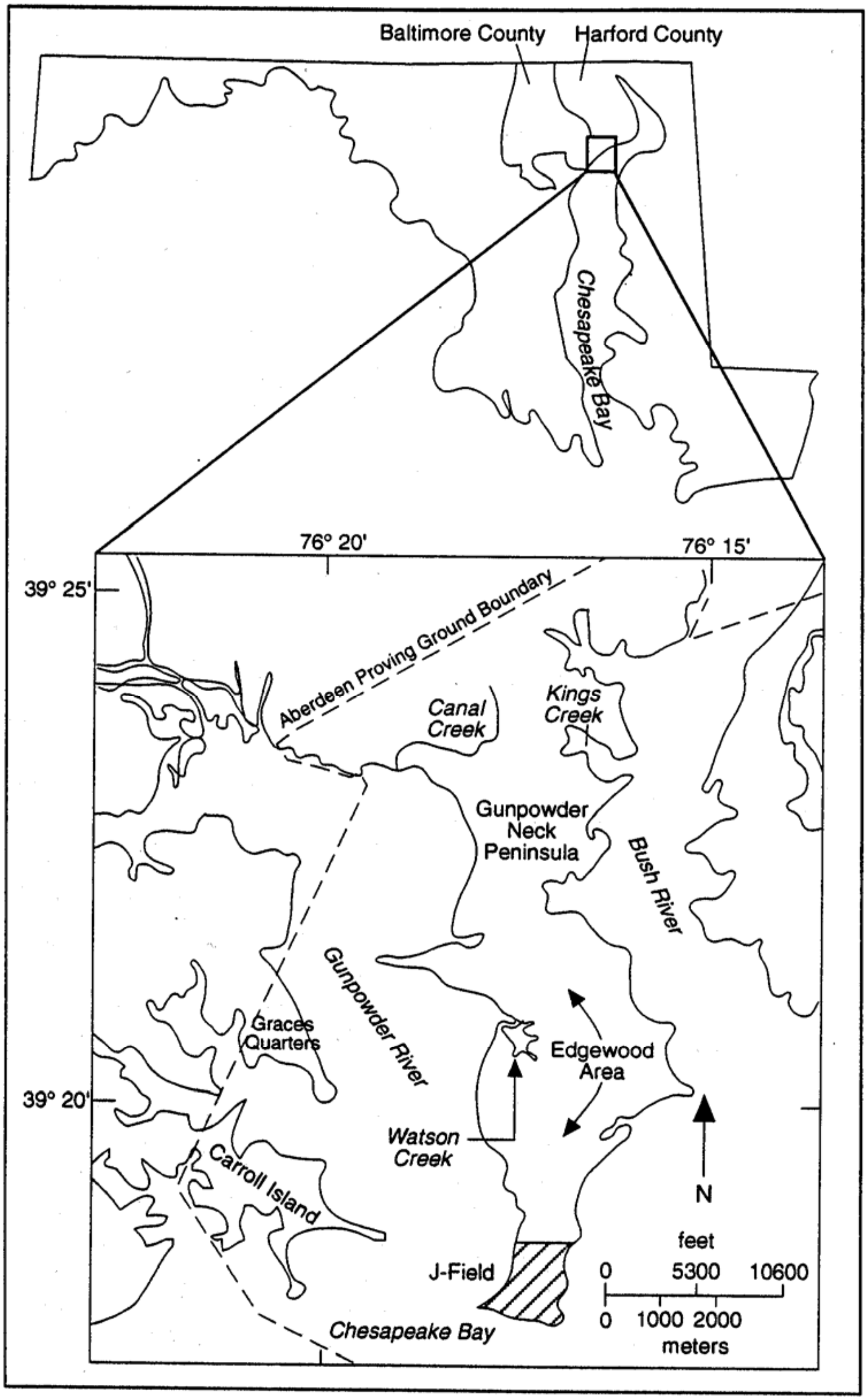


FIGURE 1.1 J-Field Area Map

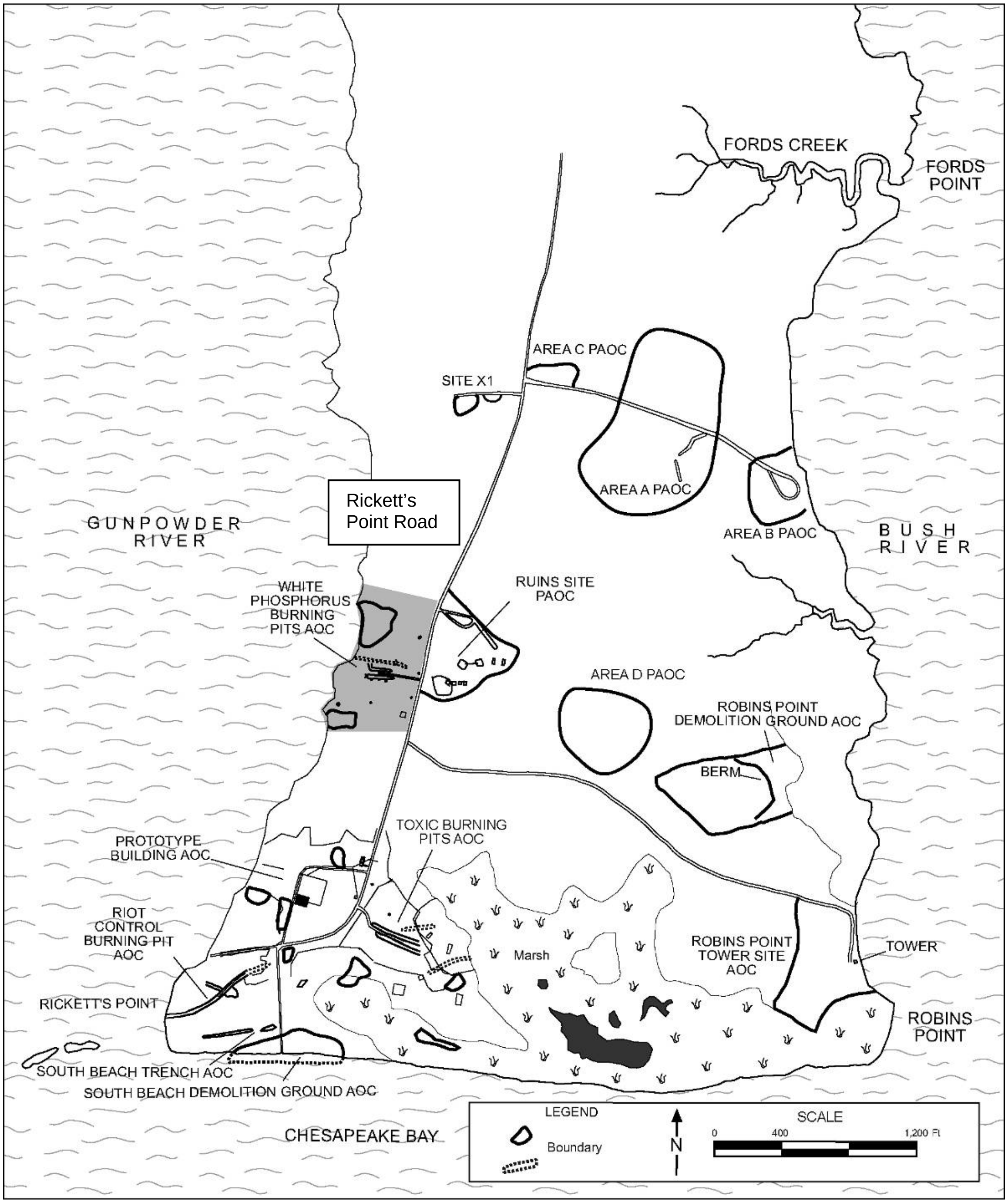


FIGURE 1.2 J-Field Areas of Concern and Potential Areas of Concern

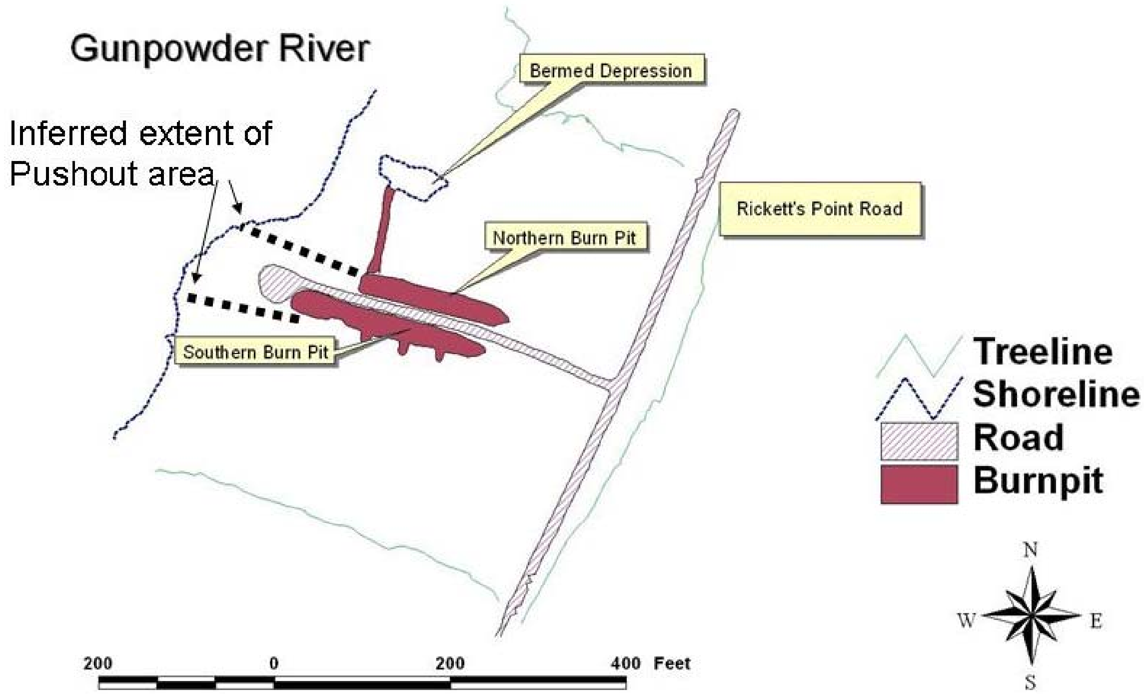


FIGURE 2.1 White Phosphorus Burning Pits Area of Concern

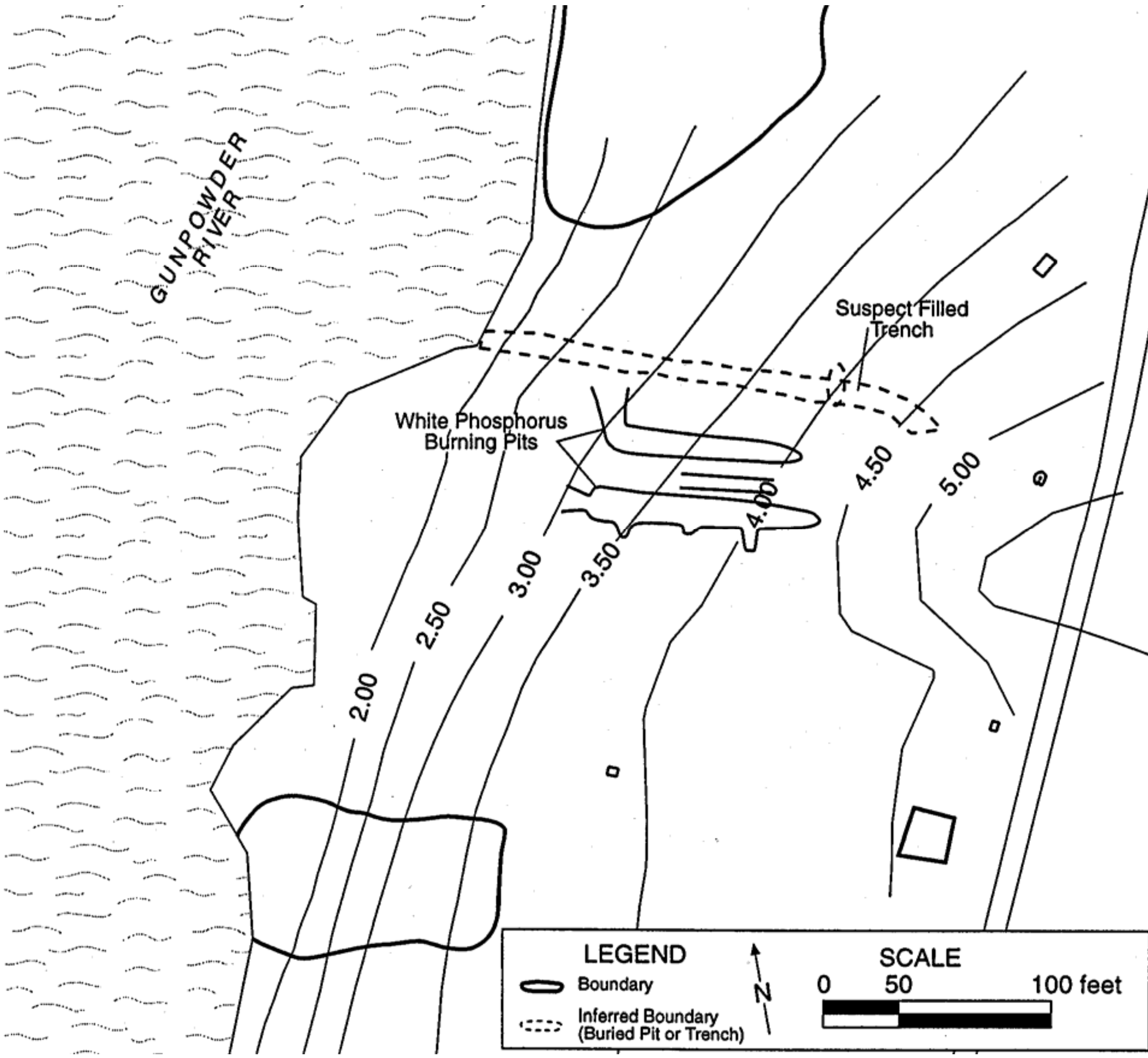


FIGURE 2.2 Water Table Contour of the Surficial Aquifer at the White Phosphorus Burning Pits AOC: May 1995 (Source: Yuen et al. 1999) (Note: Contour interval is feet above MSL.)

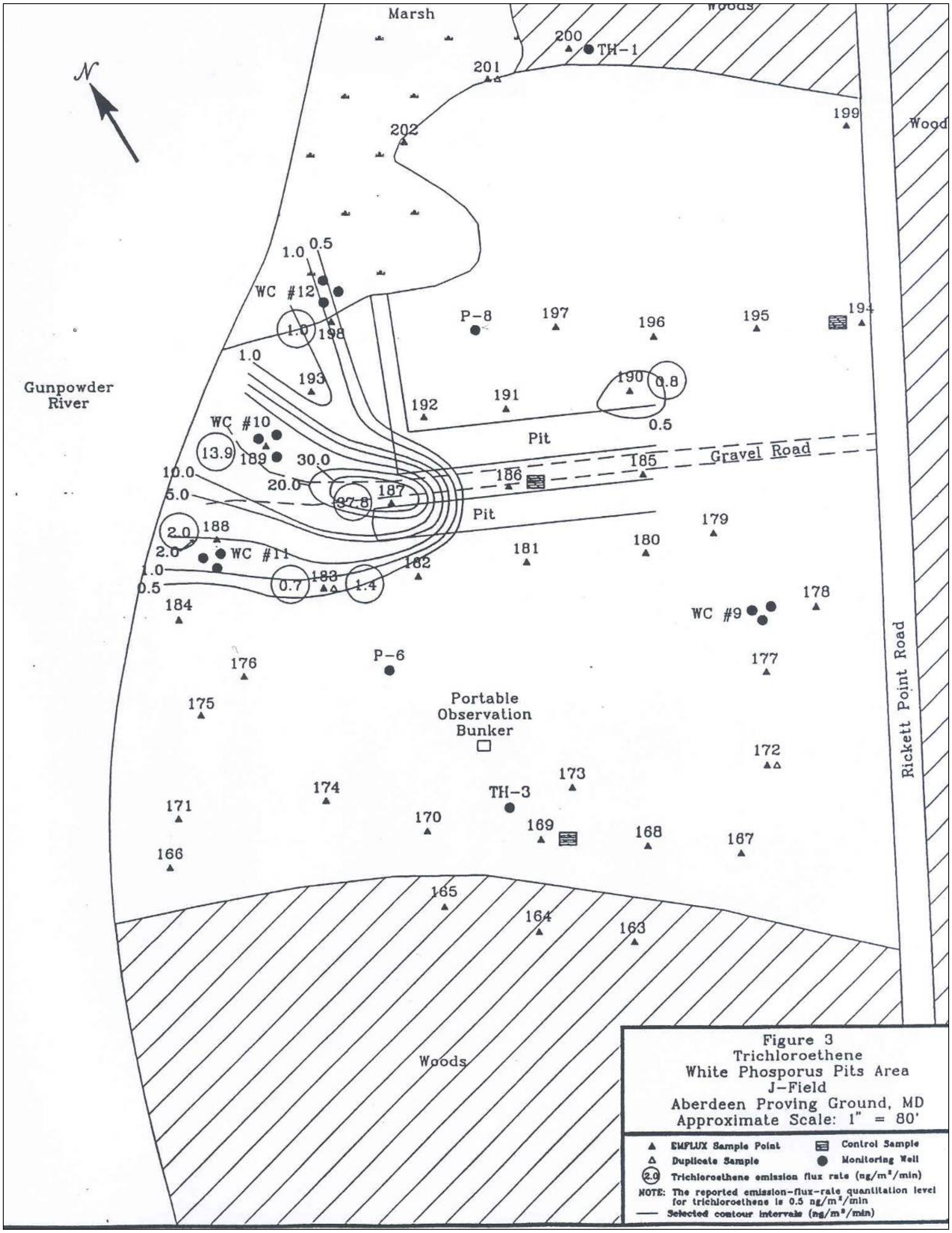


FIGURE 2.3 Trichloroethene Emission Flux Rate (ng/m^2/min) (Source: Prasad and Martino 1995) (Note: Figure number and scale appearing in legend are not applicable to this reproduction.)

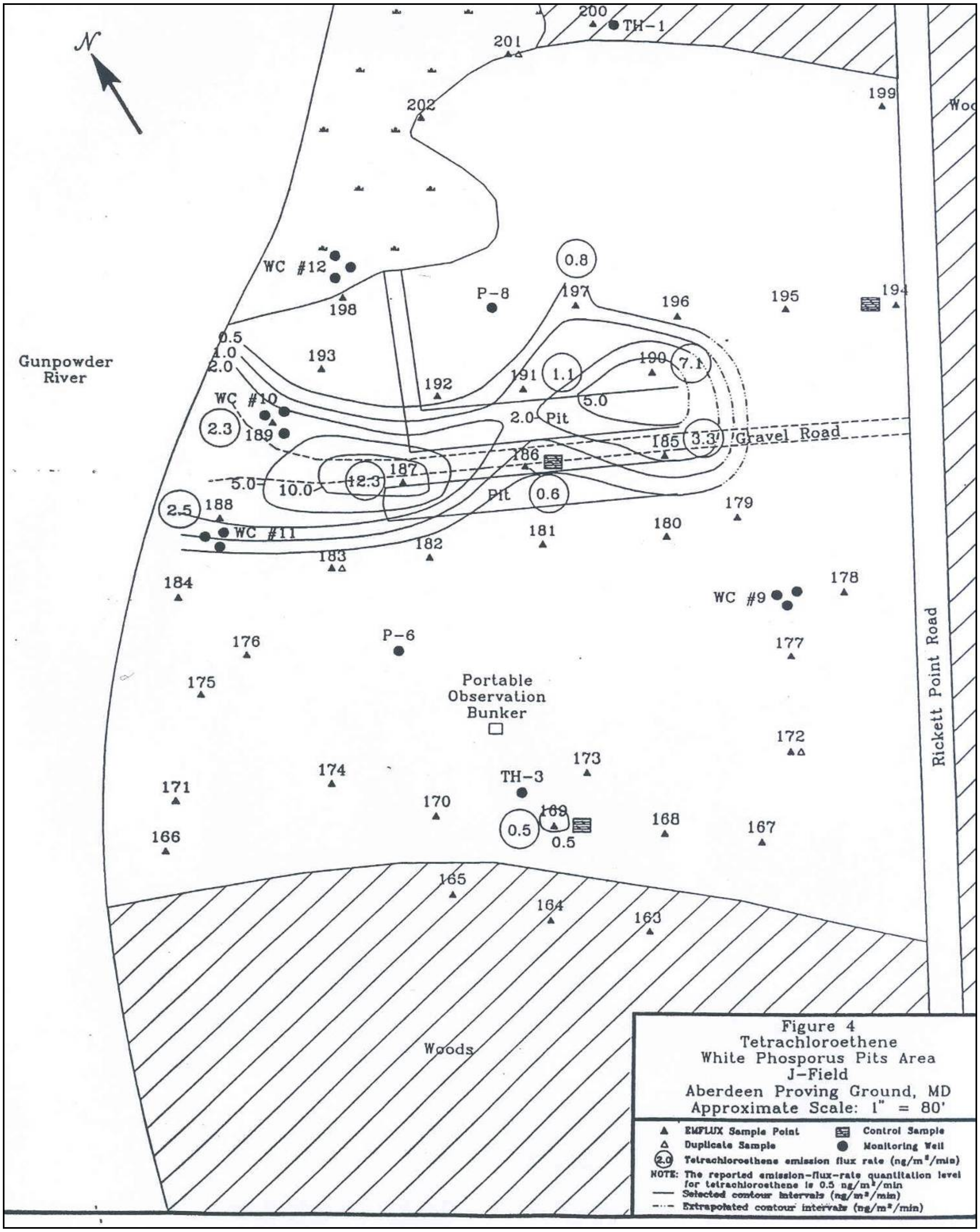


FIGURE 2.4 Tetrachloroethene Emission Flux Rate (ng/m^2/min) (Source: Prasad and Martino 1995) (Note: Figure number and scale appearing in legend are not applicable to this reproduction.)

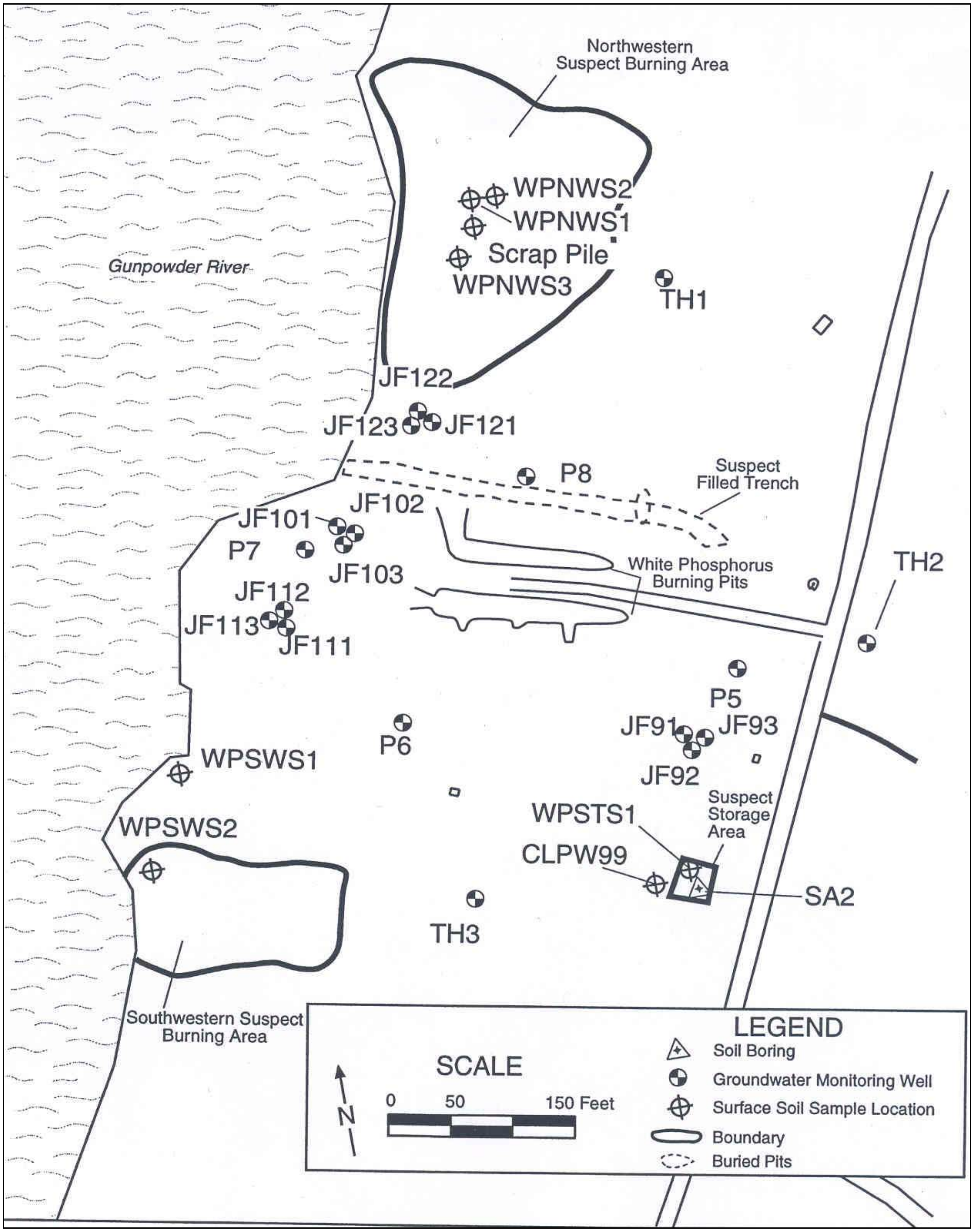


FIGURE 2.5 Monitoring Wells and Soil Sample Locations (Source: Yuen et al. 1999)

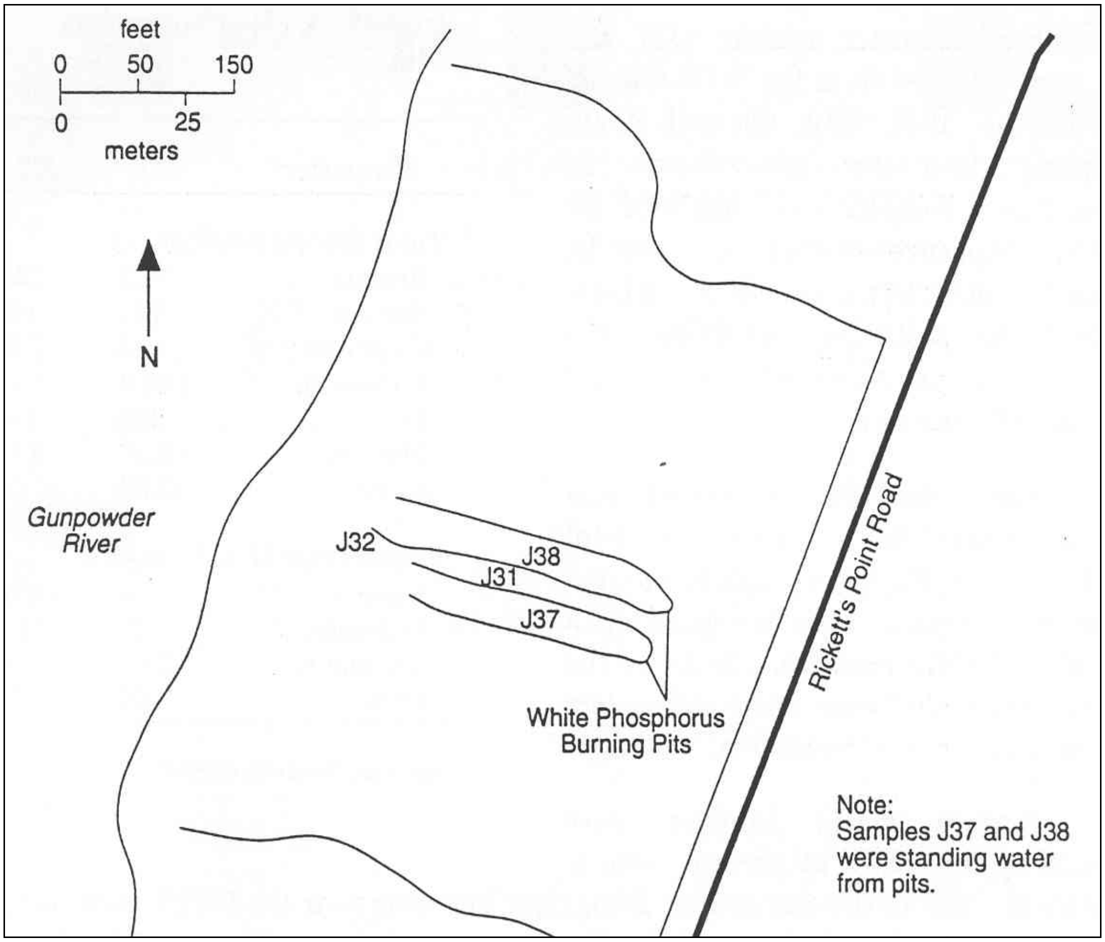


FIGURE 2.6 Locations of Surface Soil (J31 and J32) and Surface Water Samples (J37 and J38) in the White Phosphorus Burning Pits AOC (Source: Adapted from Nemeth 1989)

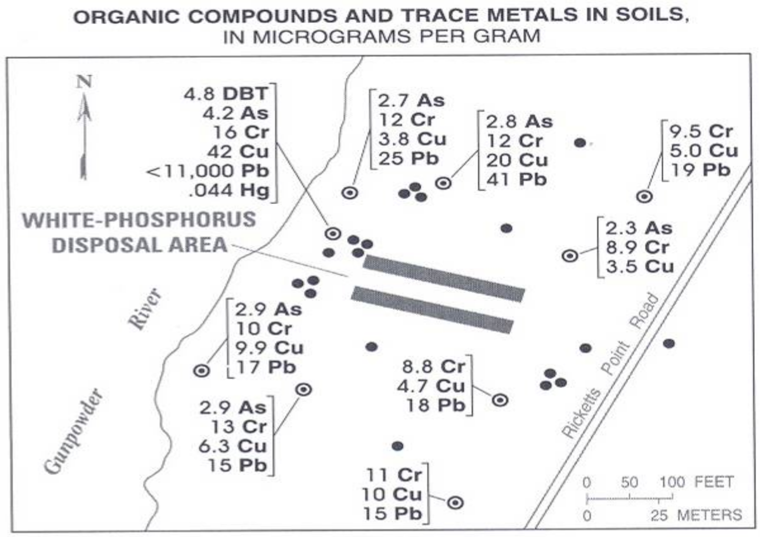


FIGURE 2.7 Location of USGS Sampling Sites in the Vicinity of the White Phosphorus Burning Pits AOC (Source: Phelan et al. 1998)

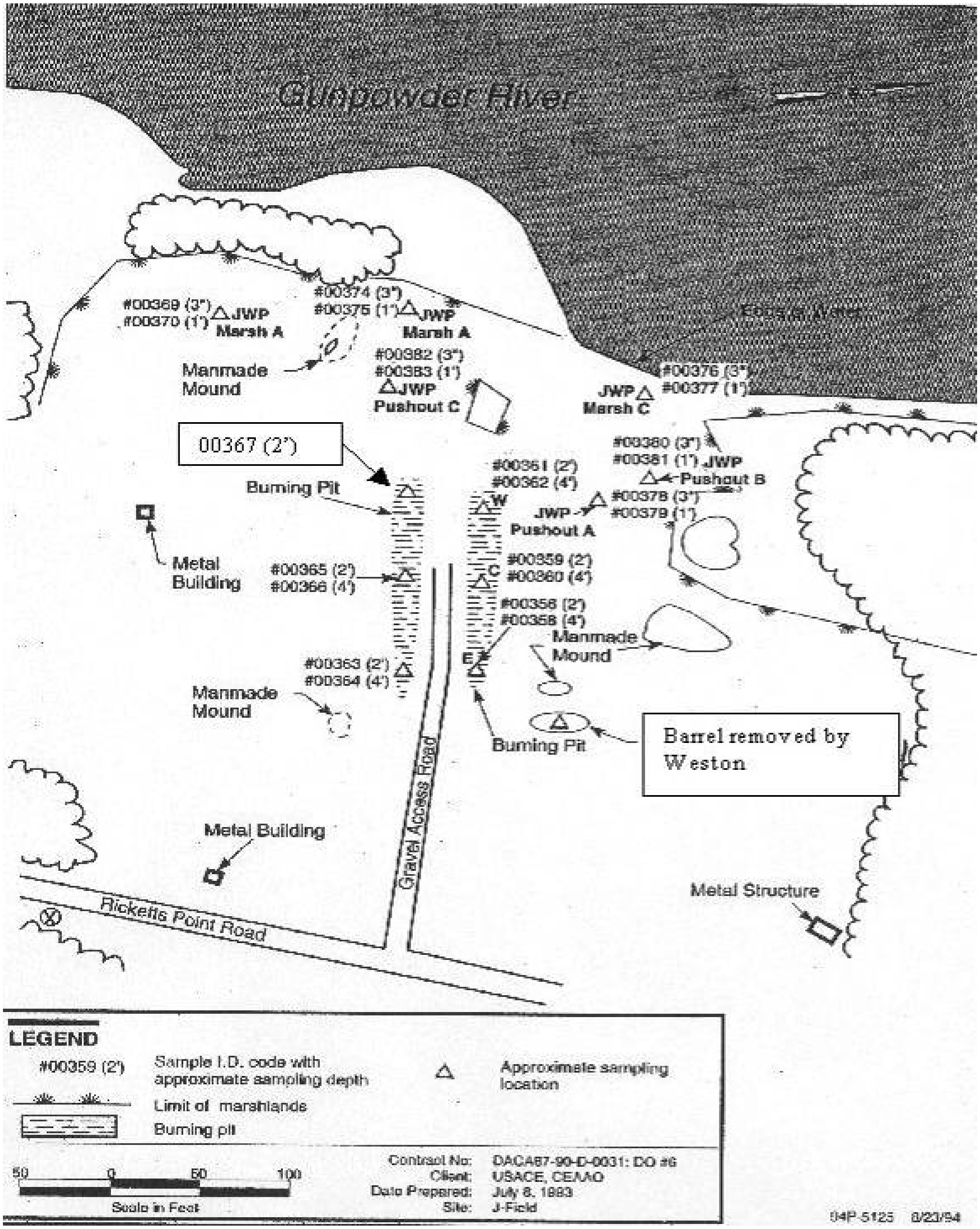


FIGURE 2.8 Locations of Soil Samples Collected by Weston (Source: Weston 1994)

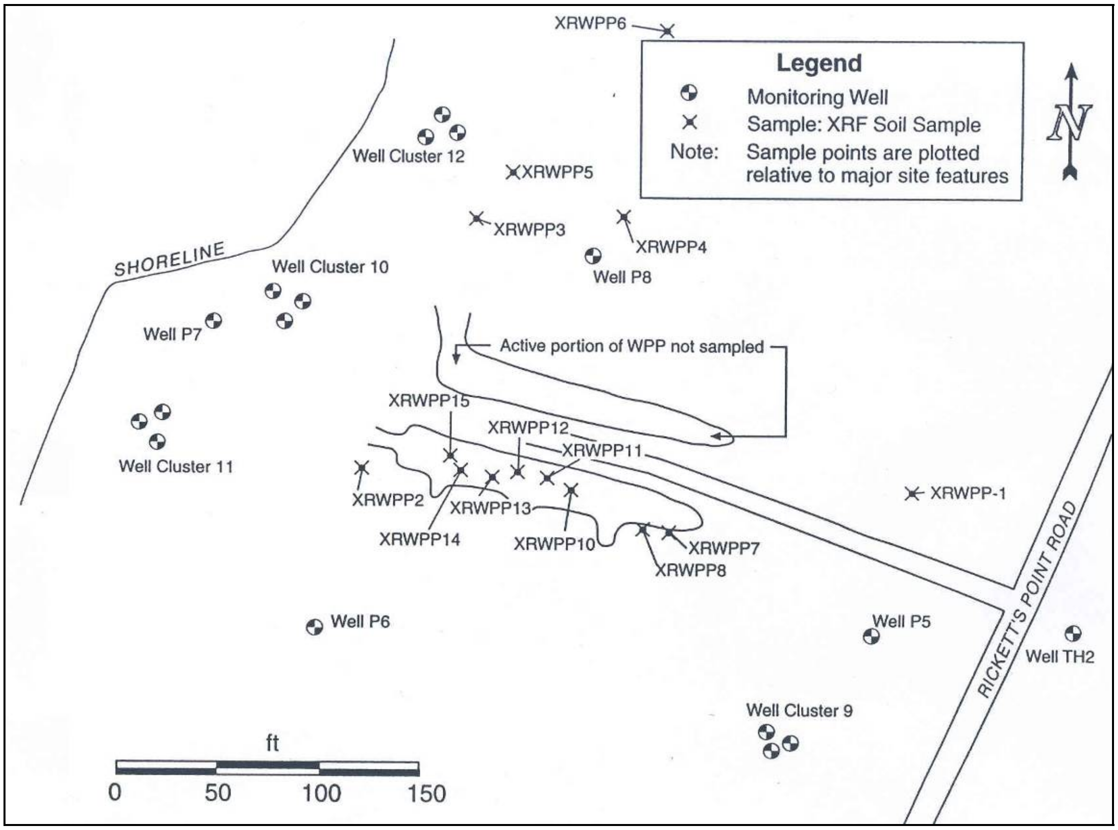


FIGURE 2.9 XRF Soil Sample Locations at the White Phosphorus Burning Pits AOC (Source: Prasad and Martino 1995)

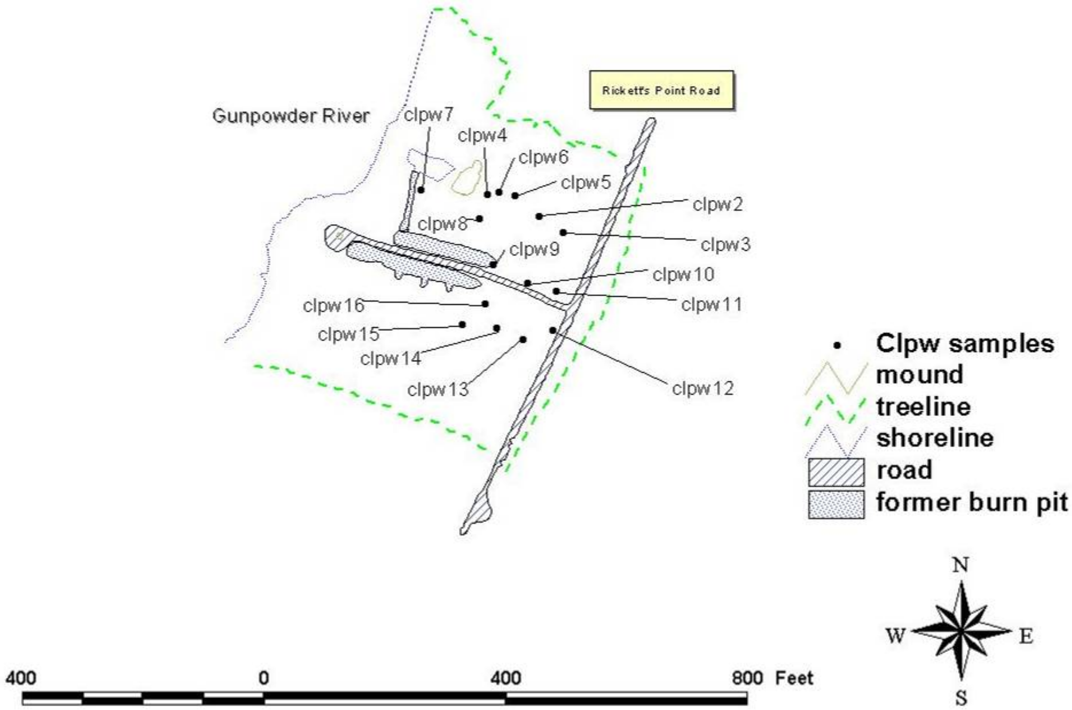


FIGURE 2.10 1994 Soil Sampling Locations

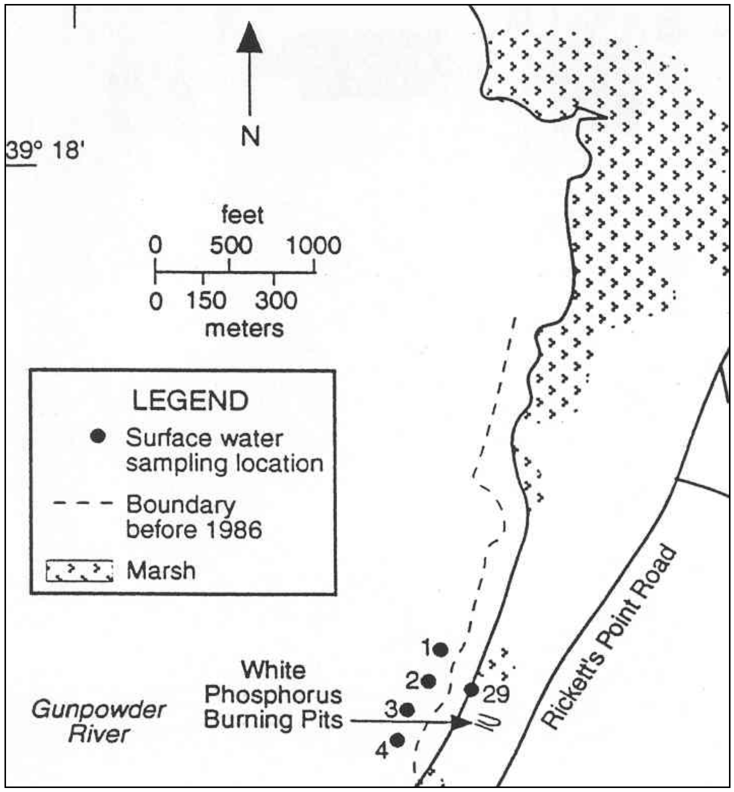


FIGURE 2.11 1988 Surface Water Sampling Locations at the White Phosphorus Burning Pits AOC (Source: Adapted from USGS 1991)

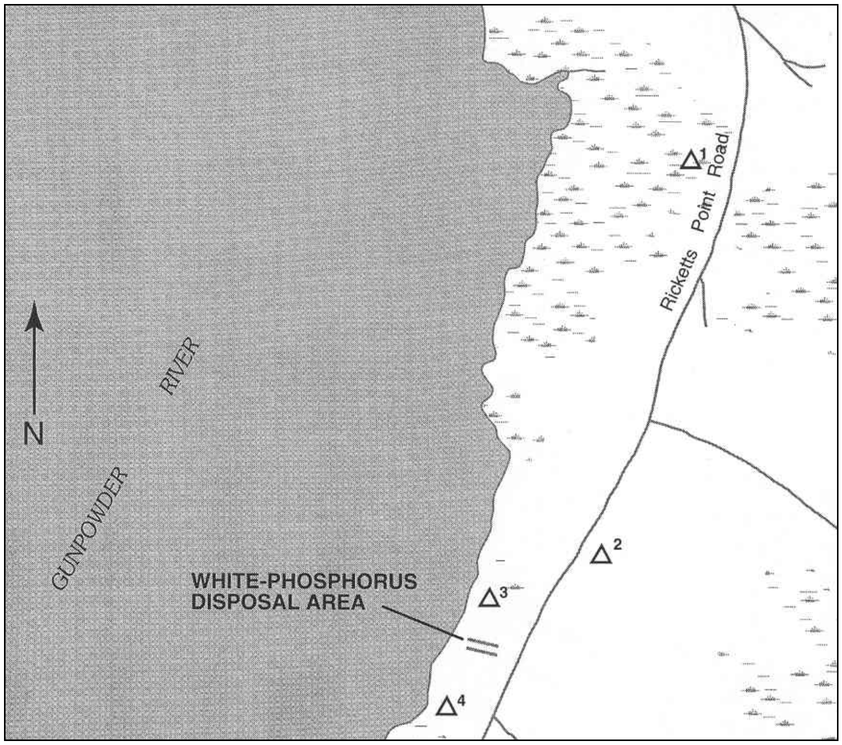


FIGURE 2.12 1993 Surface Water Sampling Locations at the White Phosphorus Burning Pits AOC (Source: Phelan et al. 1996)

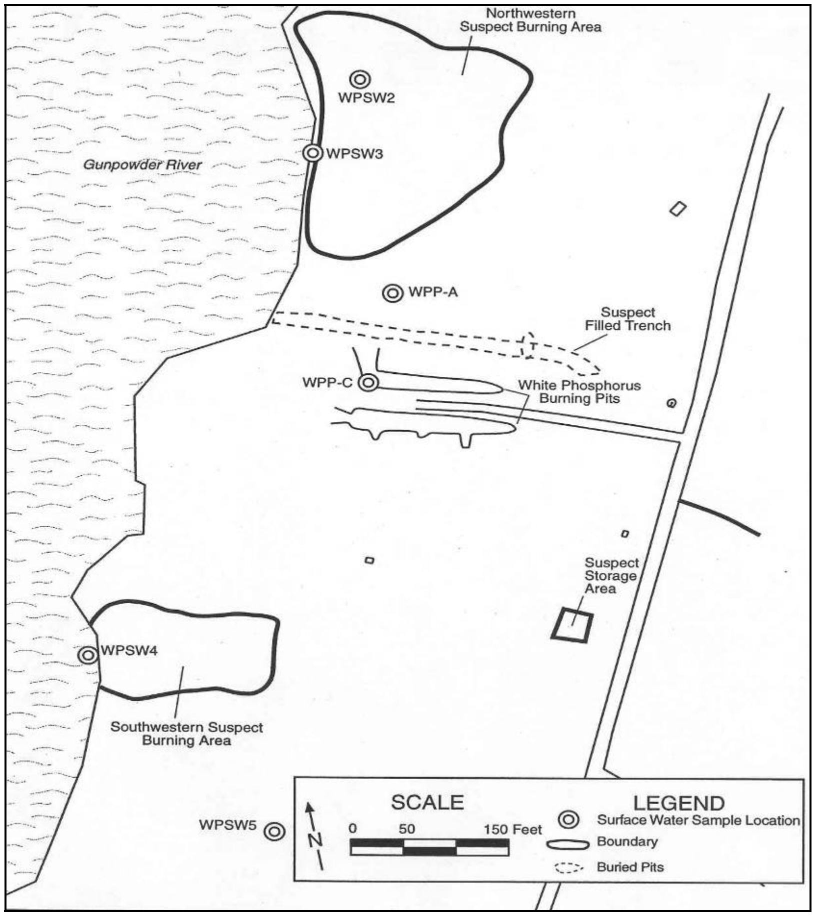


FIGURE 2.13 Other Surface Water Sampling Locations (Source: Yuen et al. 1999)

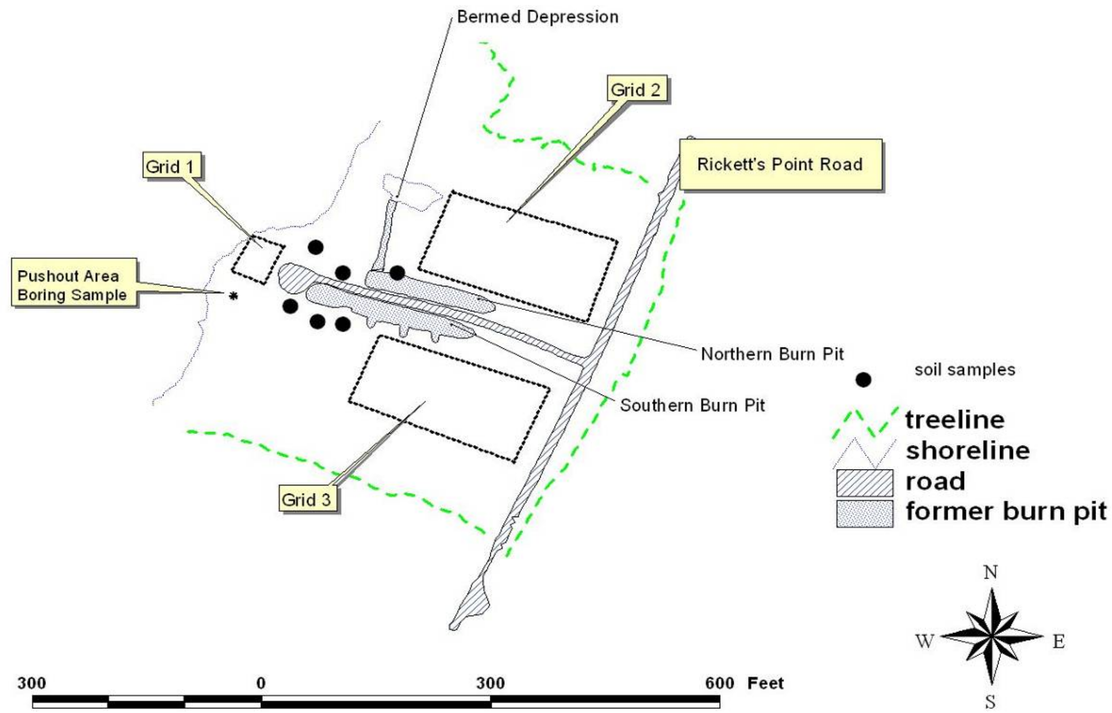


FIGURE 2.14 Soil Sample Grids and Soil Sampling Locations Outside the White Phosphorus Burning Pits

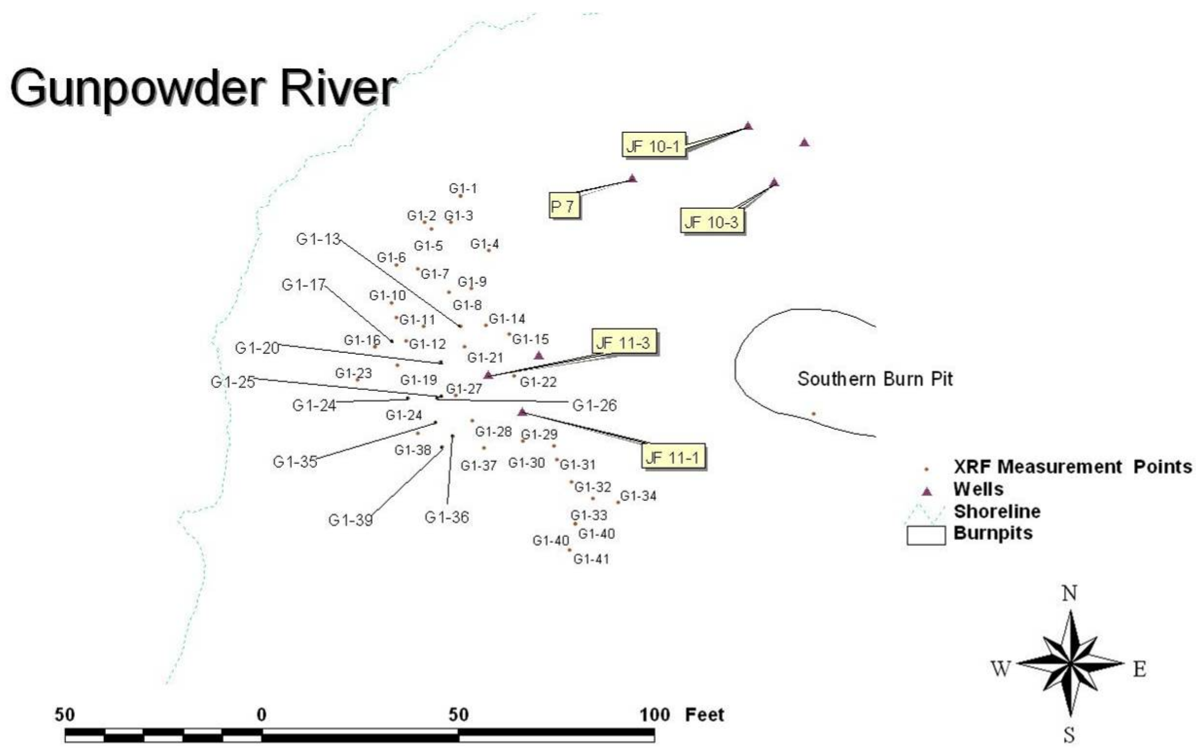


FIGURE 2.15 XRF Measurement Locations for Grid 1

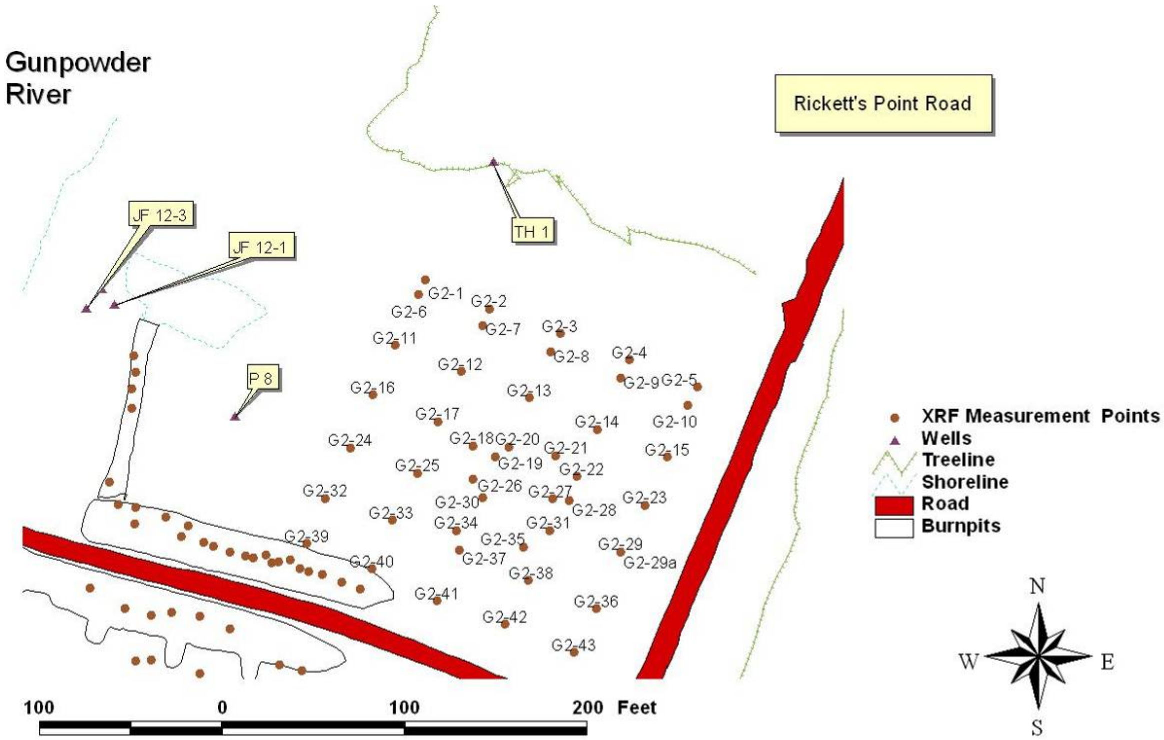


FIGURE 2.16 XRF Measurement Locations for Grid 2

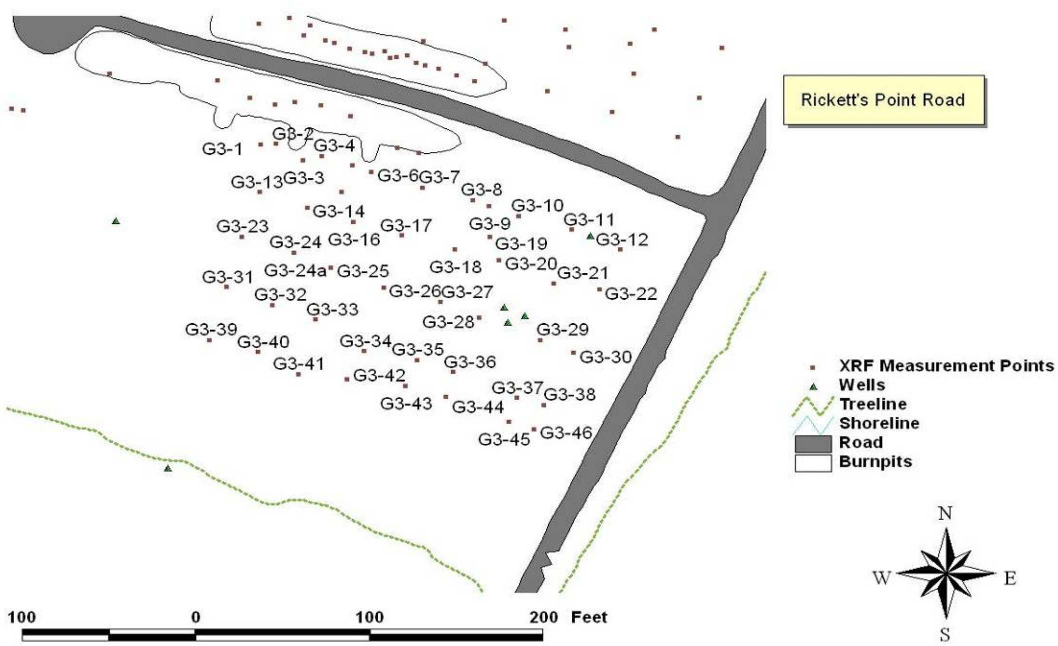


FIGURE 2.17 XRF Measurement Locations for Grid 3

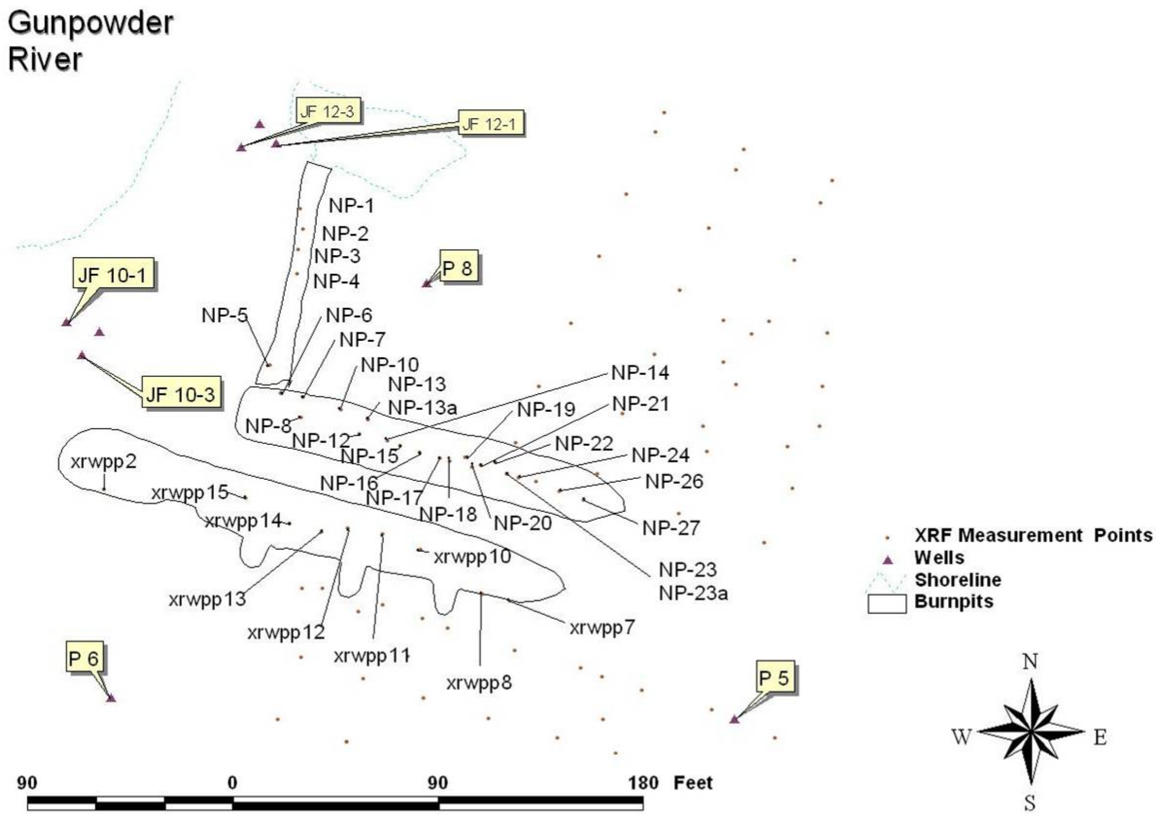


FIGURE 2.18 XRF Measurement Locations for the Burn Pits

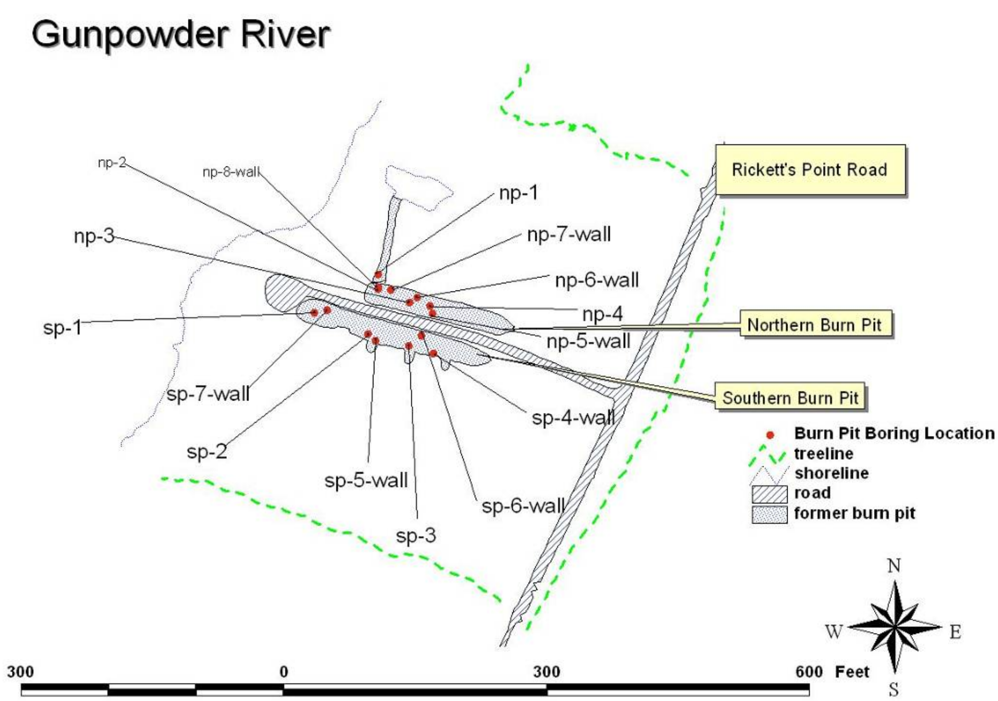


FIGURE 2.19 Burn Pit Intrusive Sampling Locations

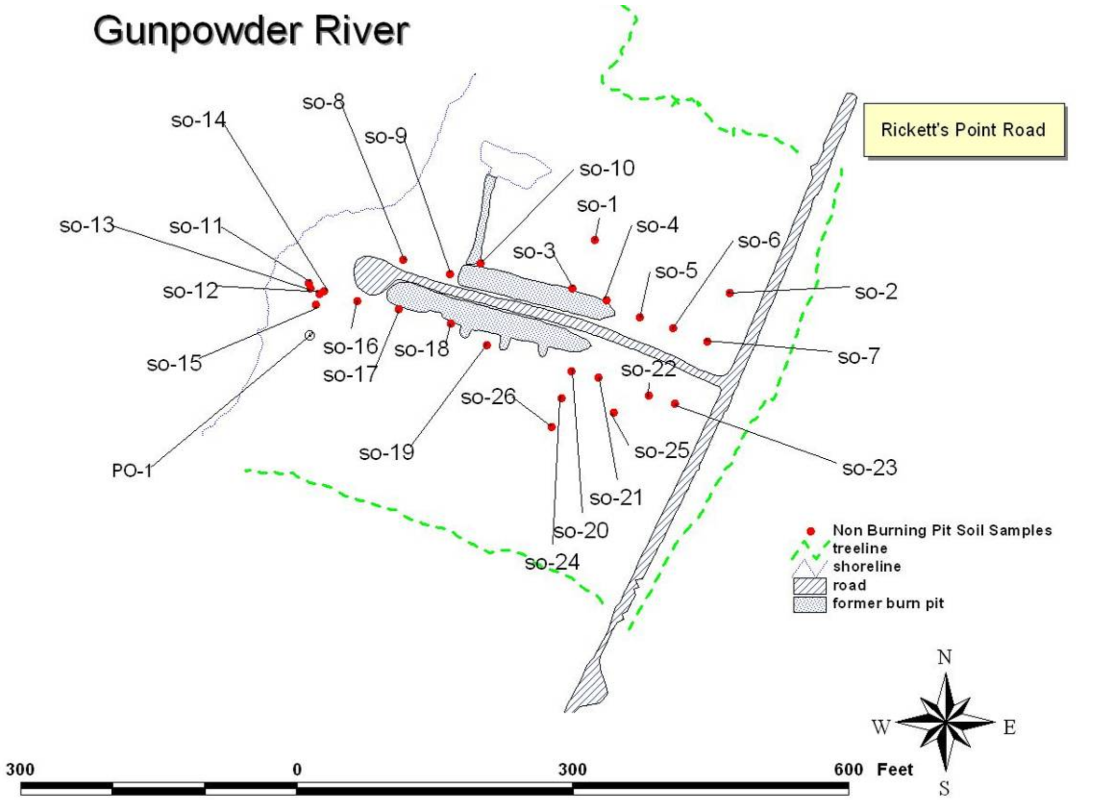


FIGURE 2.20 Non-Burn-Pit Intrusive Soil Sampling Locations

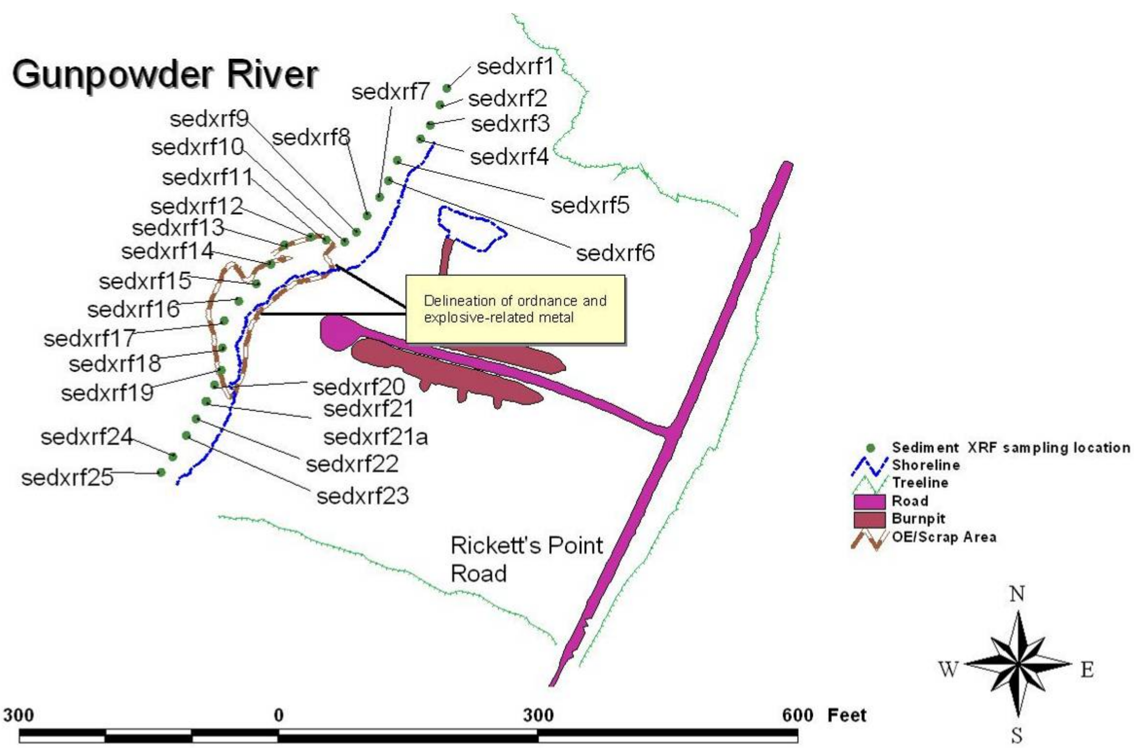


FIGURE 2.21 Sediment XRF Measurement Locations

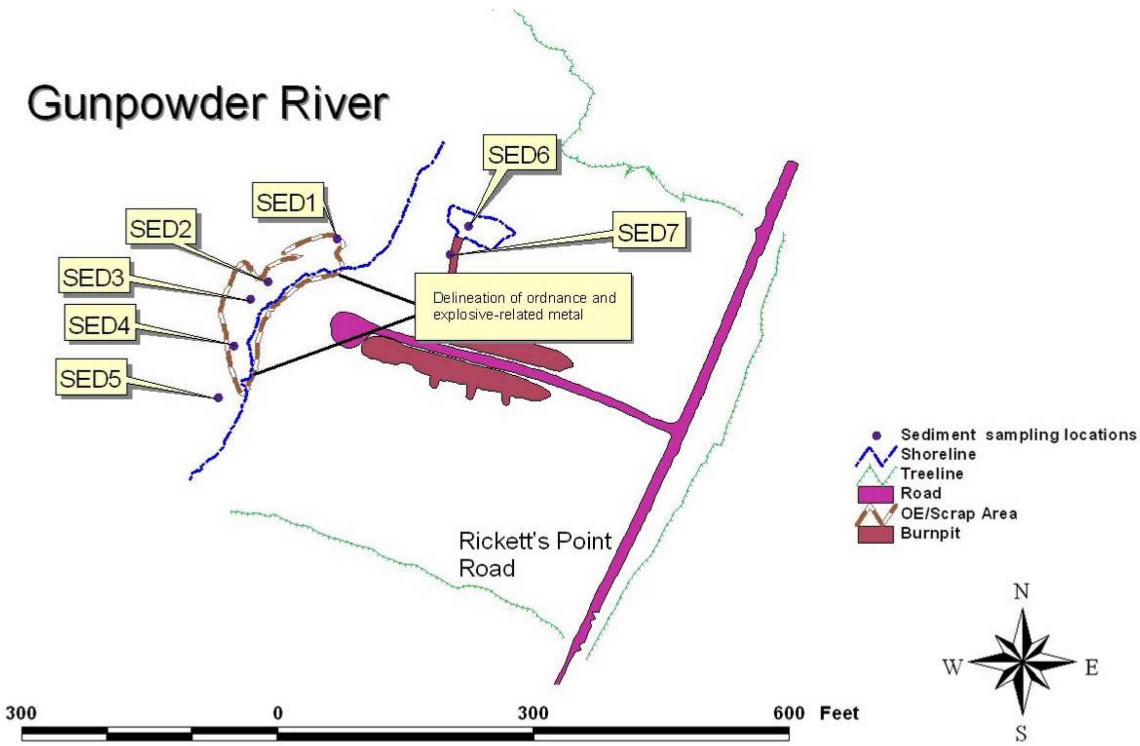


FIGURE 2.22 Intrusive Sediment Sampling Locations

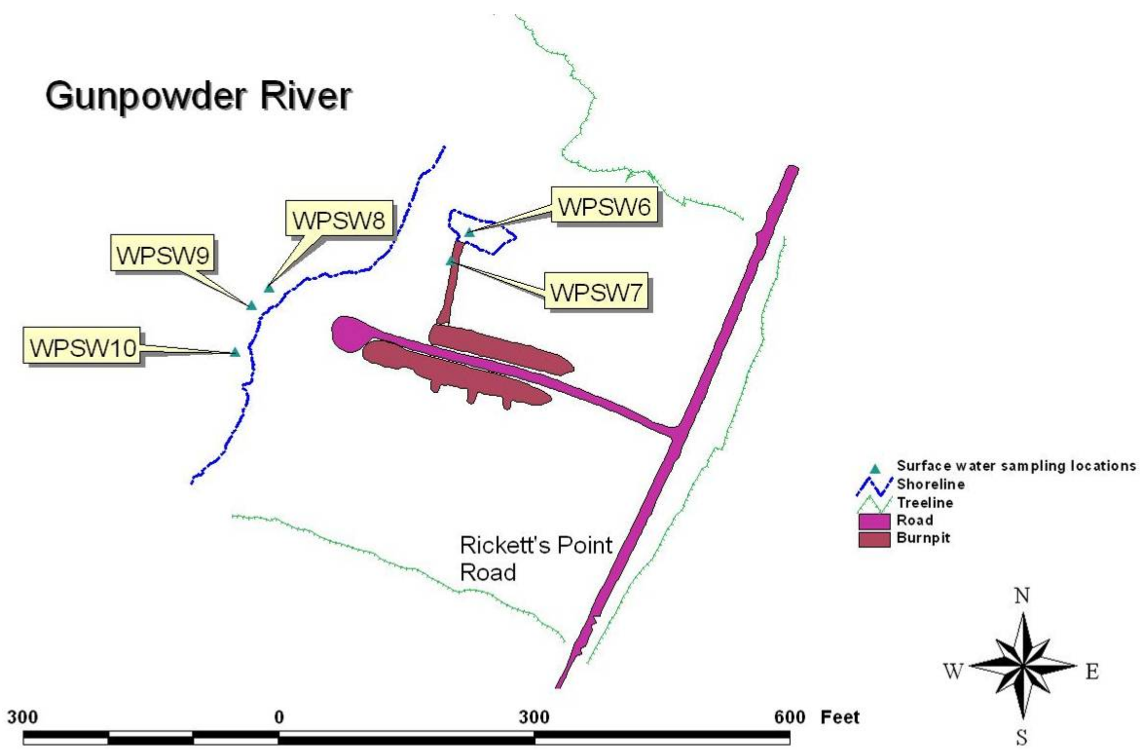


FIGURE 2.23 Surface Water Sampling Locations

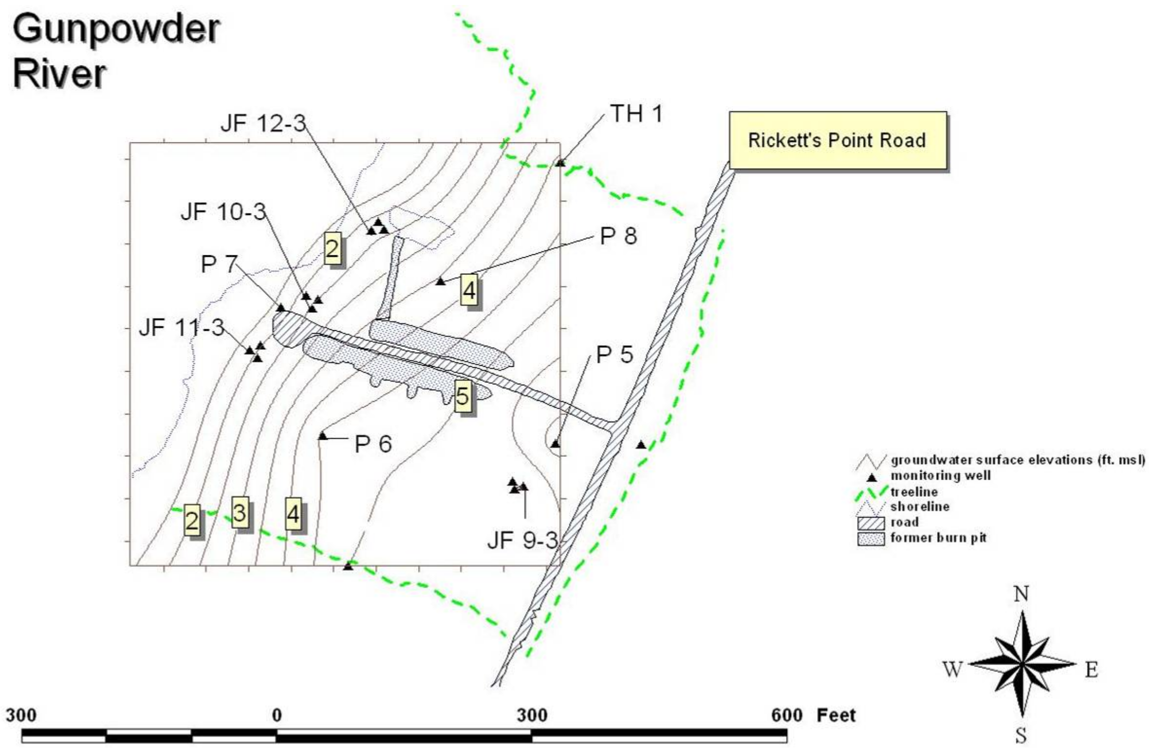


FIGURE 2.24 Groundwater Surface Elevations in the Surficial Aquifer

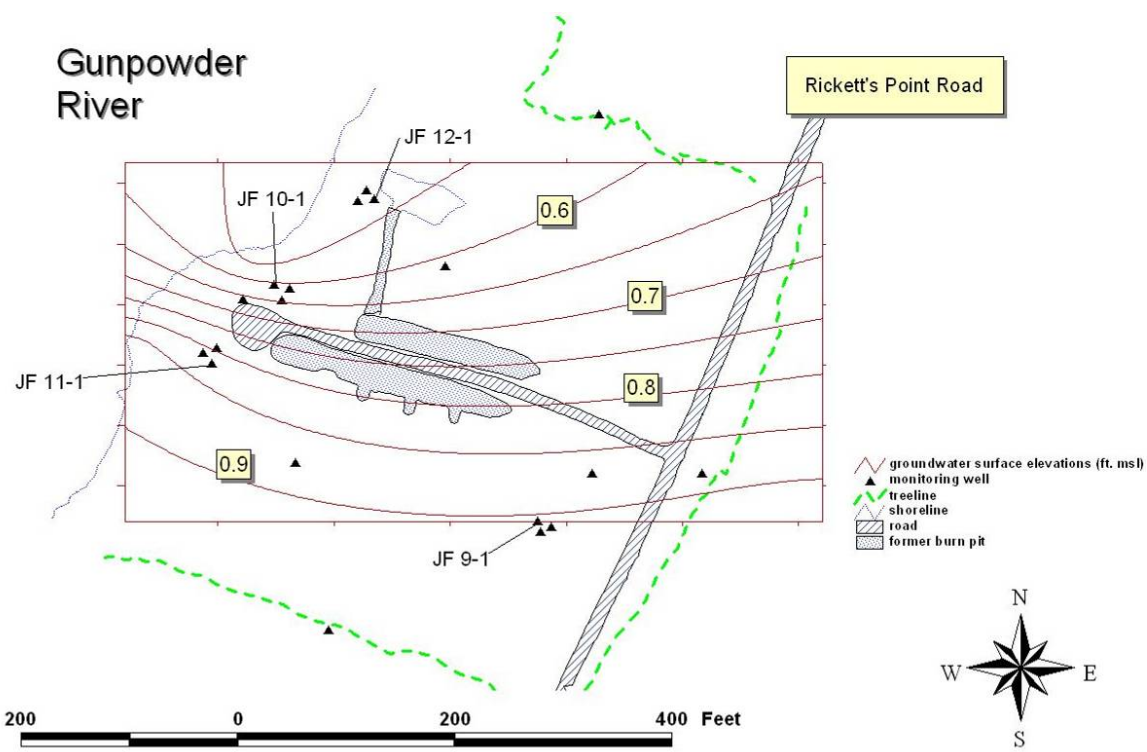
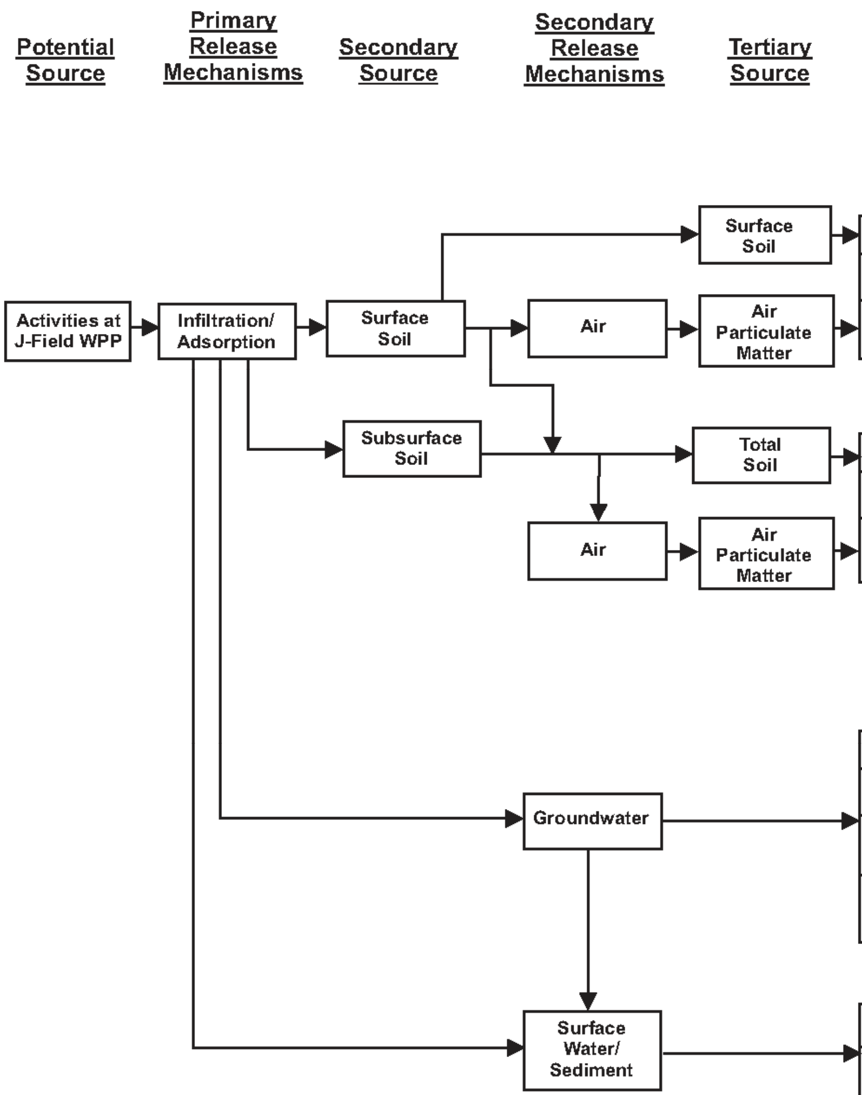


FIGURE 2.25 Groundwater Surface Elevations in the Confined Aquifer



Specific Receptors of Concern

Potential Exposure Routes	Residents (Adults, Children)	Trespasser (Adolescent)	Construction Worker	Commercial Workers	Site Workers
Ingestion		X			X
Dermal Contact		X			X
Inhalation of Air Particulates					
Ingestion	X		X	X	
Dermal Contact	X		X	X	
Inhalation of Air Particulates	X		X	X	
Ingestion	X		X		
Dermal Contact	X		X		
Inhalation of VOCs While Showering	X (Adults)				
Infiltration of VOCs into Buildings	X			X	
Incidental Ingestion	X	X			X
Dermal Contact	X	X			X

FIGURE 2.26 Human Health Conceptual Site Model: J-Field White Phosphorus Burning Pits (EA 2006)

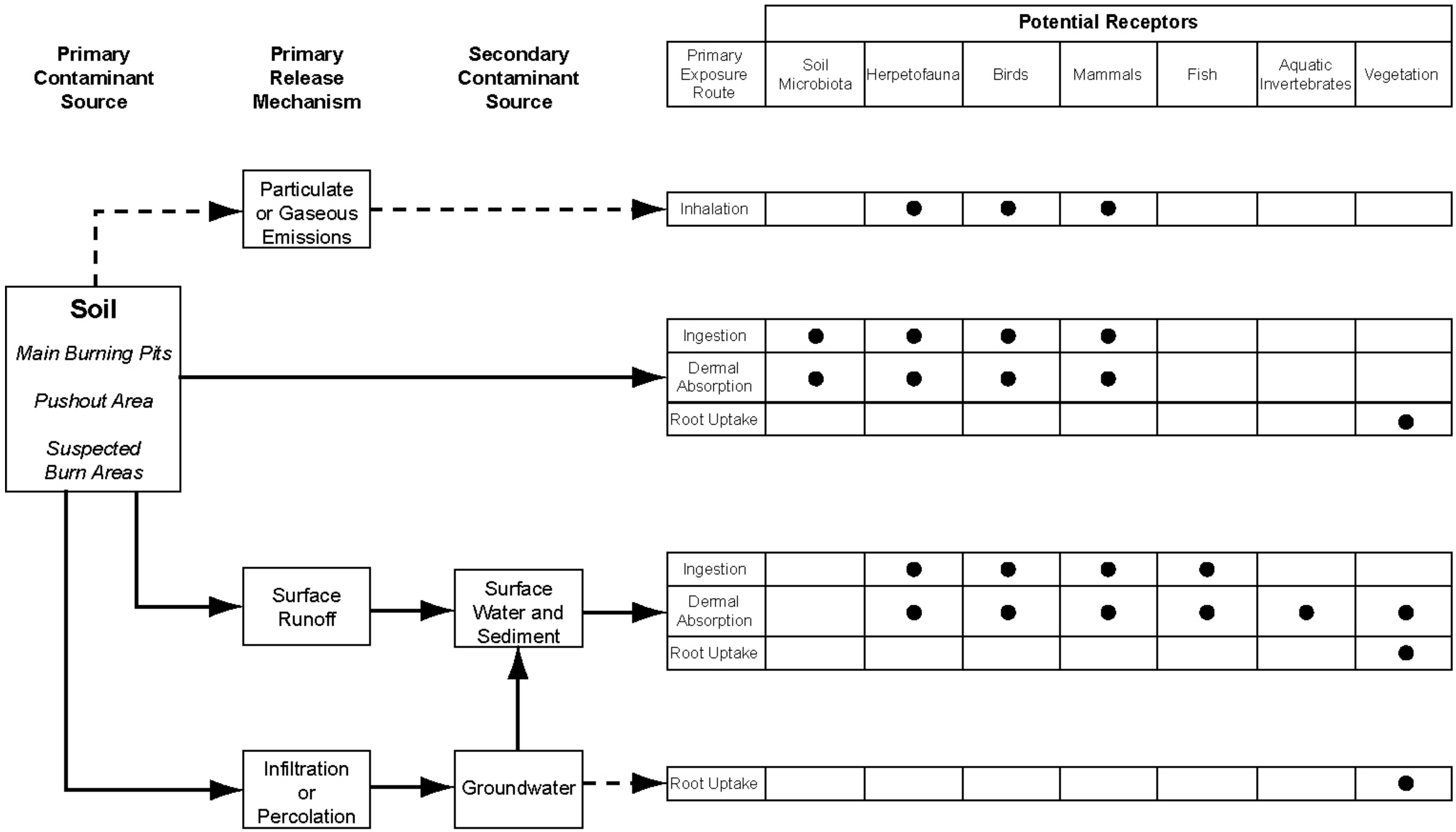


FIGURE 2.27 Conceptual Site Model of Exposure Pathways for White Phosphorus Burning Pits AOC (Solid arrows identify principal exposure pathways; broken arrows identify minor exposure pathways; circles identify appropriate receptors for each exposure route.)

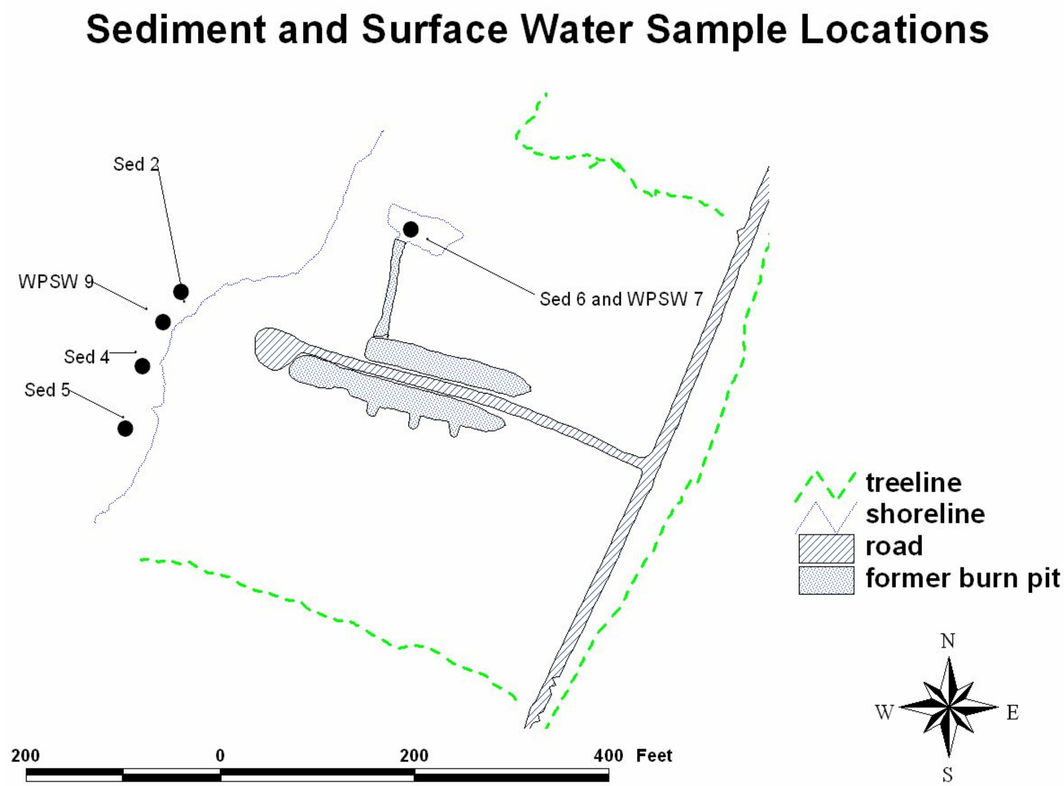


FIGURE 2.28 Media Collection Locations at J-Field White Phosphorus Burning Pits AOC for Sediment and Surface Water Toxicity Tests

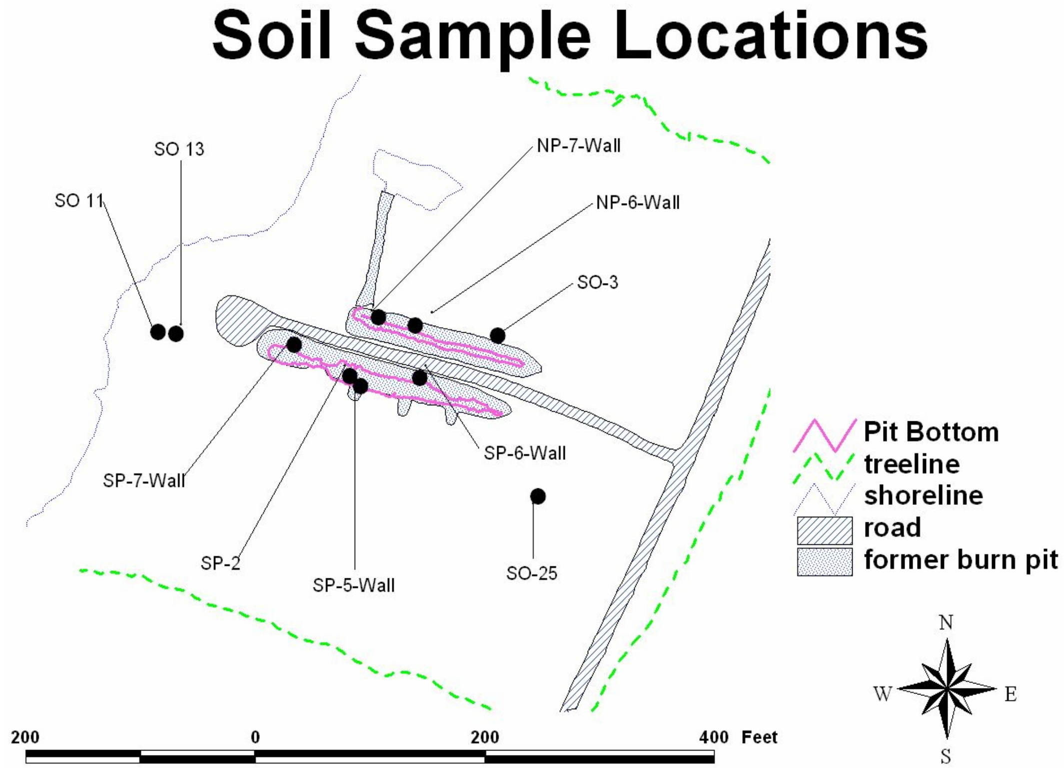


FIGURE 2.29 Media Collection Locations at the J-Field White Phosphorus Burning Pits AOC for Soil Toxicity Tests

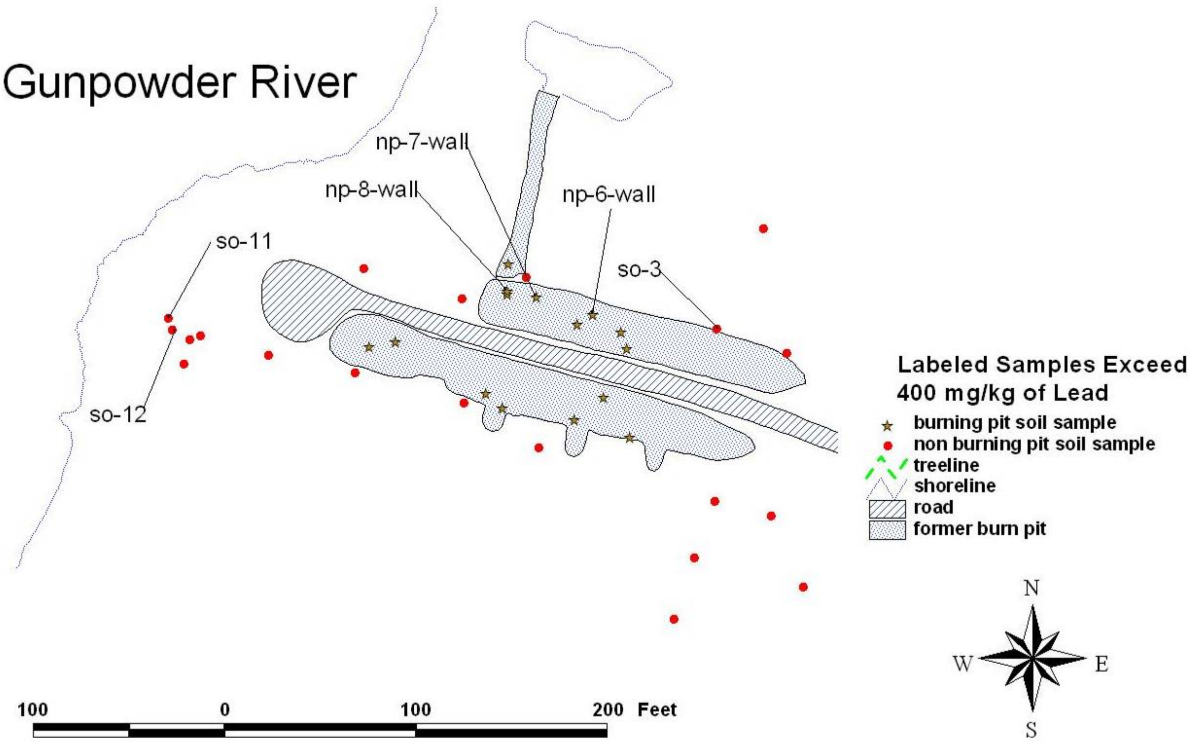


FIGURE 3.1 Location of Soil Samples with Lead Concentrations above 400 mg/kg

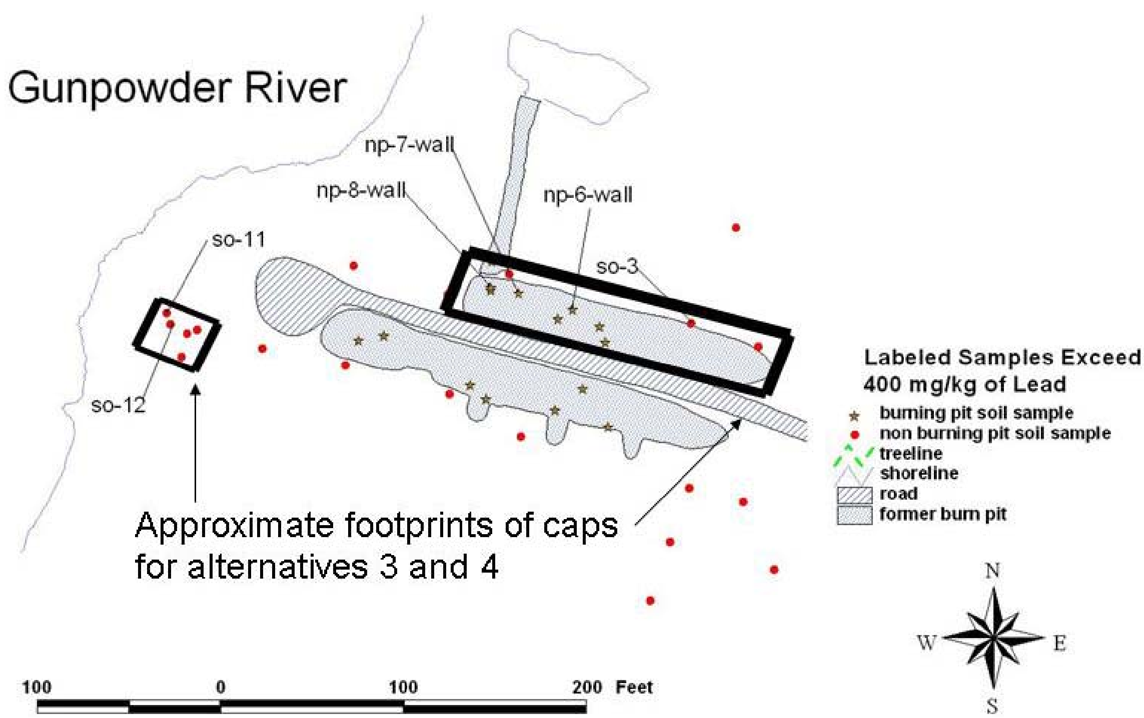


FIGURE 5.1 Approximate Footprints of Caps for Alternatives 3 and 4

TABLES

TABLE 2.1 Results of Hydraulic Conductivity Tests at the WPP AOC

			Hydraulic Conductivity (ft/d)		
Well No.	Length of Screen (ft)	Screening Opening (in.)	Hvorslev Method	Cooper Method	Hydrologic Unit
JF9-3	5	0.01	0.29	–[a]	Surficial aquifer
JF11-3	3	0.01	0.69	0.58	Surficial aquifer
JF9-2	5	0.06	0.20	–[a]	Confining unit
JF9-1	5	0.01	3.16	7.41	Confined aquifer
JF11-1	5	0.01	111	508	Confined aquifer

[a] "–" = could not be determined

Source: Adapted from Hughes (1993).

TABLE 2.2 Summary of Investigation Activities at the White Phosphorus Burning Pits AOC

Investigation Summary	Installation of Monitoring Wells	Installation of Deep Soil Borings	Groundwater Sampling and Analyses	Surface Water Sampling and Analyses	Surface Soil Sampling and Analyses	Sediment Sampling and Analyses	Soil-Gas Sampling and Analyses	Reference
Installation and sampling of 3 wells ("TH" well series); surface water and sediment sampling.	3 wells installed.	3 deep borings installed.	3 wells sampled.	5 surface water locations in proximity to WPP sampled.		5 sediment locations in proximity to WPP sampled for white phosphorus.		Nemeth et al. (1983)
Installation and sampling of "P" series wells; sampling and analysis of soil borings, surface soil, wells, and surface water samples.	4 wells installed ("P" well series).	4 deep borings installed; 1 composite sample from each boring analyzed for metals, phosphorus, "GC purgeables," pesticides.	4 wells sampled for metals, pesticides, radium, alpha and beta, coliform, water quality parameters, total organic halides.	Metals, phosphorus, "GC purgeables," pesticides.	One composite sample from each pit analyzed for metals, nitrate, phosphorus, cyanide, petroleum hydrocarbons, phenols, toluene, and ethyl benzene.			Princeton Aqua Science (1984)
Sampling and analysis of surface soil, monitoring wells, and surface water.	No wells installed; sampled existing wells.		4 wells sampled for metals, explosive-related compounds, indicator parameters, radioactivity, thiodiglycol, VOCs, SVOCs, pesticides, and PCBs.	Metals, explosive-related compounds, gross alpha and beta, VOCs, SVOCs, and pesticides/PCBs.	Samples from two locations analyzed for metals, RCRA EPA toxicity testing metals, explosive-related compounds.			Nemeth (1989)

TABLE 2.2 (Cont.)

Investigation Summary	Installation of Monitoring Wells	Installation of Deep Soil Borings	Groundwater Sampling and Analyses	Surface Water Sampling and Analyses	Surface Soil Sampling and Analyses	Sediment Sampling and Analyses	Soil-Gas Sampling and Analyses	Reference
Passive soil-gas sampling; installation and sampling of “JF” well series; sampling and analysis of soil and surface water adjacent to the burn pit.	4 clusters with 3 wells in each cluster installed (“JF” well series).	12 deep borings installed.	Most WPP wells sampled for metals, VOCs, SVOCs, organosulfur, explosive-related compounds, and radioactive compounds.	1 sample analyzed for VOCs, SVOCs, pesticides, and explosive-related compounds.	10 samples collected and analyzed for metals, VOCs, SVOCs, and explosives.		34 passive soil-gas samples collected.	Hughes (1993), Phelan et al. (1996)
Sampling and analysis of soil from soil borings in the burning pits and adjacent soil sites.		6 borings; 3 from each pit analyzed for VOCs, PCBs, and metals.			6 samples analyzed for VOCs, PCBs, and metals.			Mazelon (1993), Weston (1994)
Passive soil-gas sampling; geophysical analysis performed; sampling and analysis of existing monitoring wells; sampling and analysis of surface soil and surface water samples.		Borings installed adjacent to burn pits; samples analyzed for CWA only.	13 wells sampled and analyzed for explosives, general chemistry, VOCs, CWA-related compounds, and metals.	5 samples analyzed for PCBs, pesti-cides, CWA degradation compounds, metals, and explosive-related compounds.	24 samples analyzed for metals and/or organics; XRF and immunoassay analyses of surface soil.		40 passive soil-gas samples collected.	Prasad and Martino (1995), Yuen et al. (1999)

TABLE 2.3 J-Field White Phosphorus Burning Pits Analytical Data for Soil Composites: 1983[a]

Analyte	Sample Location			
	JWP-1	JWP-2	JWP-3	JWP-4
Arsenic (mg/kg)	0.85	1.2	1.7	1.1
Barium (mg/kg)	32.0	17.7	36.0	28.7
Cadmium (mg/kg)	<0.185	<0.188	<0.186	<0.182
Chromium (mg/kg)	11.1	9.12	12.4	13.0
Iron (mg/kg)	8,156	7,430	9,082	8,853
Lead (mg/kg)	5.85	4.82	5.26	4.66
Manganese (mg/kg)	41.4	33.1	33.7	41.5
Mercury (mg/kg)	0.048	0.020	0.049	0.023
Potassium (mg/kg)	790	602	940	887
Zinc (mg/kg)	67.9	35.1	50.0	45.5
Cyanide (mg/kg)	<0.02	<0.02	<0.02	<0.02
pH	4.8	4.8	5.4	4.8
Phenols (mg/kg)	<0.093	<0.075	<0.096	<0.086
Total phosphorus (mg/kg)	23.2	27.8	26.9	41.2
CEC (meq/100 g)	3.6	3.6	4.2	3.3
% solids	84.3	83.3	85.8	84.0
GC purgeables (mg/kg)	ND[b]	ND	ND	ND
GC pesticides/PCBs (mg/kg)	ND	ND	ND	ND
GC herbicide (mg/kg)	ND	ND	ND	ND

[a] Soil samples obtained from holes drilled to produce groundwater monitoring wells, July 27, 1983, to August 3, 1983.

[b] ND = nondetectable: < 0.005 ppm.

Source: U.S. Department of the Army (1984).

TABLE 2.4 Concentrations of Chemical Constituents in Soil from the White Phosphorus Burning Pits AOC: 1983

	Concentration[b] (mg/kg, unless noted)		
Analyte[a]	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 constituents detected in at least one sample. Constituents measured but not detected were 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 collected in January 1983.

[c] Locations of background samples not given.

[d] On the basis of 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).

TABLE 2.5 Analytical Results for Soil Samples J31 and J32 from the White Phosphorus Burning Pits AOC: 1986

Analyte	Sample J31	Sample 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).

TABLE 2.6 Summary of Selected Soil Sample Results for the White Phosphorus Burning Pits AOC: 1992

Analyte[a]	Concentrations by Soil Sample Location and Sample Number/Depth[a] 00357 JWP1-E (2 ft)	00358 JP1-E (4 ft)	00363 JWP2-E (2 ft)	00364 JWP2-E (4 ft)	00369 JWPM-A (3 in.)	00370 JWPM-A (1 ft)	00367 JWP2-W (2 ft)
Volatile Organic Compounds (μg/kg)							
Methylene chloride	ND[b]	ND	9.53	15.2	13.4	ND	ND
Acetone	494	156	165	38.9	185	21.5	ND
Toluene	ND	ND	ND	ND	ND	ND	ND
Xylenes	ND	16.6	ND	ND	11.2	9.17	16.3
PCBs (μg/kg)							
Aroclor 1254	ND	ND	ND	ND	ND	ND	381
Aroclor 1260	ND	ND	ND	ND	ND	ND	ND
Target Analyte List Analytes (mg/kg)							
Antimony	ND	ND	ND	ND	5.92	ND	ND
Arsenic	3.22	2.24	2.82	ND	4.20	2.46	4.95
Beryllium	0.279	0.796	0.520	ND	0.318	0.335	0.389
Cadmium	ND	0.626	ND	ND	2.02	ND	1.32
Chromium	11.6	12.8	16.7	4.93	15.8	7.53	24.7
Cobalt	ND	ND	ND	ND	ND	ND	ND
Copper	10.5	8.63	8.40	ND	59.4	11.0	103.0
Lead	8.37	8.87	6.46	4.89	209	44.3	1,940
Zinc	24.0	62.5	13.0	19.7	284	37.9	413
Nickel	ND	13.7	ND	6.18	ND	ND	7.65

TABLE 2.6 (Cont.)

Analyte	00376 JWPM-C (3 in.)	00363 JWPM-C (1 ft)	00378 JWPP-A (3 in.)	00379 JWPP-A (1 ft)	00382 JWPP-C (3 in.)	00383 JWPP-C (1 ft)
	Concentrations by Soil Sample Location and Sample Number					
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
Target Analyte List 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. Metric equivalents for sample depths are: 3 in. = 7.6 cm, 1 ft = 0.3 m, 2 ft = 0.6 m, and 4 ft = 1.2 m.

[b] ND = not detected.

Source: Weston (1994).

TABLE 2.7 X-Ray Fluorescence Results for White Phosphorus Burning Pits AOC Soil: 1994

	Concentration (mg/kg)[a]									
Analyte	Cr (LO)[b]	Mn	Fe	Co	Ni	Cu	Zn	As	Pb	Ba
Sample										
XRWPP1	180	ND	***7,717***	ND	ND	58	***343***	29	38	***150***
XRWPP2	255	ND	***10,819***	ND	ND	103	***553***	ND	***79***	***198***
XRWPP3	167	289	***10,050***	ND	ND	46	***413***	ND	***84***	***132***
XRWPP4	256	ND	***7,849***	ND	ND	ND	***301***	38	15	***121***
XRWPP5	424	ND	***5,651***	ND	ND	ND	***170***	49	5	***107***
XRWPP6	236	290	***8,967***	ND	ND	ND	***215***	39	7	***159***
XRWPP7	ND	251	***11,459***	277	ND	ND	83	37	ND	***224***
XRWPP8	ND	309	***10,273***	240	ND	ND	***117***	41	ND	***149***
WPP10	107	213	***14,806***	ND	ND	64	***879***	29	ND	***75***
XRWPP11	ND	519	***23,553***	449	70	115	***253***	ND	***26***	***210***
XRWPP12	ND	640	***17,353***	314	92	136	***984***	ND	***93***	***142***
XRWPP13	ND	ND	***11,209***	136	ND	ND	150	31	22	***162***
XRWPP14	ND	ND	***11,364***	ND	ND	83	***412***	ND	69	***284***
XRWPP14 Dup	ND	248	***11,251***	118	ND	73	***434***	ND	***88***	***309***
XRWPP15	ND	ND	***17,512***	ND	ND	243	***545***	31	***66***	***266***
Detection Limit	90	203	111	101	63	44	35	25	14	9

[a] Bold italic type indicates that the metal is present at greater than 10 times the standard deviation of counting statistics. Standard type indicates that the metal is present at less than 10 times but greater than 3 times the standard deviation of counting statistics. ND indicates that the metal was not detected at the detection limit.

[b] Cr (LO) = chromium reading with low XRF energies.

Source: Prasad and Martino 1995

TABLE 2.8 Immunoassay Test Results (in ppm) for White Phosphorus Burning Pits AOC Soil Samples: 1994[a]

Sample/Depth[b]	PCBs	Petroleum Hydrocarbons	PAH
CLPW3, 0-6 in.	<1	NT[c]	NT
CLPW5, 0-6 in.	<1	NT	NT
CLPW6, 0-6 in.	<1	NT	NT
CLPW4, 0-6 in.	<1	NT	NT
CLPW4, 6-12 in.	NT	NT	NT
CLPW9, 0-6 in.	>1, <10[d]	<10	<1
CLPW9, 6-12 in.	<1	<10	<1
CLPW8, 0-6 in.	<1	<10	<1
CLPW8, 6-12 in.	<1	<10	<1
CLPW14, 6-12 in.	<1	<10	<1
CLPW12, 6-12 in.	<1	<10	<1
CLPW12, 0-6 in.	>1, >10[d]	<10	<1
CLPW14, 0-6 in.	<1	<10	<1

[a] Tests conducted with the RISc™ immunoassay analytical method.

[b] Metric equivalents of sampling depths are: 0-6 in. = 0-15.2 cm, and 6-12 in. = 15.2-30.5 cm.

[c] NT = not tested.

[d] Values above 1 ppm were also tested to determine if samples were greater than (>) or less than (<) 10 ppm.

TABLE 2.9 Summary of Inorganic Results for Selected Soil Samples from the White Phosphorus Burning Pits AOC: 1994

	Concentration (mg/kg) by Sample Location									
						CLPW8		CLPW9		
Analyte	CLPW3 (0-6 in.)[a]	CLPW4 (0-6 in.)	CLPW5 (0-6 in.)	CLPW6 (0-6 in.)	CLPW7 (0-6 in.)	(0-6 in.)	(6-12 in.)	(0-6 in.)	(6-12 in.)	CLPW9-Dup (6-12 in.)
Aluminum	6,950	6,350	6,840	6,530	6,300	10,900	7,810	8,370	10,200	8,190
Antimony	<2[b]	<2[b]	<2.1[b]	<2.2[b]	2.9[b]	<1.9[b]	<1.9	<2	<2	<2
Arsenic	2.7	2.1	2.8	2.5	2.4	8.2	5.3	2.9	3.6	4.3
Barium	48	45.1	47.9	59	50.5	58.7	109	78.7	190	99.1
Beryllium	0.34	0.43	0.41	0.39	0.36	0.48	0.41	0.33	0.58	0.47
Cadmium	<0.83	<0.84	<0.85	<0.92	<0.85	<0.79	2.2	1.4	2.7	2.1
Calcium	723	258	316	552	462	1,490	3,350	3,640	10,900	4,580
Chromium	10.3	10.5	11.5	9.6	10.9	34.6	23.7	27.8	36.2	30
Cobalt	4.1	4.4	4.2	4.2	4	5.4	5.1	5.8	6.8	4.6
Copper	14.7	12.2	10.7	17.7	17.1	19.2	49.9	29.8	67.3	24
Cyanide	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Iron	9,000	9,460	10,600	8,580	10,100	14,000	16,800	11,200	37,200	10,500
Lead	35.1[b,c]	23.2[b,c]	21.8[b,c]	25.8[b,c]	105[b,c]	75.9[b,c]	111	44.8	53.9	53.3
Magnesium	844	747	836	852	810	1,520	1,390	2,070	2,400	1,360
Manganese	82.6	109	95.4	106	93.9	164	189	200	302	163
Mercury	<0.09[c]	<0.1[c]	<0.11[c]	<0.13[c]	<0.09[c]	<0.11[c]	<0.08	<0.11	<0.1	<0.12
Nickel	7.1	7	7.1	7.6	7.1	11.2	17.3	13.9	13.5	9.3
Potassium	293	265	264	280	305	576	391	404	430	412
Selenium	<0.25[b]	<0.26[b]	0.3[b]	<0.28[b]	<0.26[b]	0.36[b]	<0.24	<0.24	<0.24	<0.24
Silver	<0.5	<0.51	<0.51	<0.56	<0.51	<0.48	0.88	<0.49	<0.49	<0.49
Sodium	27.5	33.8	37.9	54	42.3	65.2	60.1	111	90.6	62.1
Thallium	<0.28	<0.3	<0.3	<0.32	<0.3	<0.27	<0.28	<0.28	<0.28	<0.28
Vanadium	12.9	14	15.7	13.4	13.8	25.2	16.5	18.4	18.8	19
Zinc	139[c,d]	84.6[c,d]	104[c,d]	129[c,d]	184[c,d]	98.1[c,d]	399	232	242	297

TABLE 2.9 (Cont.)

	Concentration (mg/kg) by Sample Location							
	CLPW99		CLPW12		CLPW13		CLPW14	
Analyte	(0-6 in.)	(6-12 in.)	(0-6 in.)	(6-12 in.)	(0-6 in.)	(6-12 in.)	(0-6 in.)	(6-12 in.)
Aluminum	6,610	8,400	6,810	8,990	5,590	7,070	4,920	6,540
Antimony	<2.1	<1.9	<2.1	<1.9	<2	<1.9	<2	<1.9
Arsenic	2.6	5	3.8	3.2	1.5	2.1	2.3	1.5
Barium	47.4	34.1	69.7	72.7	79.3	45	102	41.3
Beryllium	0.31	0.3	0.36	0.27	0.34	0.24	0.33	0.27
Cadmium	<0.88	<0.8	<0.85	<0.8	<0.82	<0.77	<0.85	<0.78
Calcium	929	848	438	348	429	410	744	363
Chromium	11	11.2	25.6	12.2	10.6	9.8	15.3	10.6
Cobalt	4.3	3.9	4.3	3.6	3.7	3.1	3.5	3.6
Copper	8.5	3.4	30.5	3.6	9.5	3.3	13.7	16.8
Cyanide	<3	<3	<3	<3	<3	<3	<3	<3
Iron	10,600	11,400	10,800	12,300	7,480	9,110	8,000	8,200
Lead	15	10.7	13.1	8	28.6	9.2	231	7.6
Magnesium	903	1,010	945	1,140	751	902	784	1,030
Manganese	101	53.6	90.6	47	93.8	51.1	91.9	45.2
Mercury	<0.1	<0.12	<0.09	0.09	<0.08	<0.1	<0.09	<0.11
Nickel	6.6	7.1	9.4	6.7	6.4	6.3	6.2	7.9
Potassium	325	424	515	636	268	288	279	383
Selenium	<0.25	<0.24	<0.25	<0.23	<0.24	<0.23	<0.25	<0.24
Silver	<0.53	<0.48	<0.51	<0.48	<0.49	<0.46	<0.51	<0.47
Sodium	38	31.5	34.5	27.4	23.6	26.6	28.3	28.4
Thallium	<0.29	<0.28	<0.29	<0.27	<0.28	<0.27	<0.29	<0.27
Vanadium	15.5	16.7	14.7	17.9	12.1	13.6	12.1	12.5
Zinc	52.2	25.2	588	44	47.2	20.6	76.6	25.5

[a] Sample depth shown in parentheses. Metric equivalents of sample depths are: 0-6 in. = 0-15.2 cm, and 6-12 in. = 15.2-30.5 cm.

[b] Spiked sample recovery was not within the control limits.

[c] Relative percent difference (RPD) of sample duplicate was outside the control limits.

[d] Value is estimated because of the presence of interference.

TABLE 2.10 Analytical Results for Various Parameters in Surface Soil Samples Collected from the White Phosphorus Burning Pits AOC: 1995[a]

	Concentration by Sample Location[a]								
Analyte	WPNWS1 (0-6 in.)	WPNWS2 (0-6 in.)	WPNWS3 (0-6 in.)	WPSWS1 (0-6 in.)	WPSWS2 (0-6 in.)	WPST1 (0-6 in.)	WPST1 (6-12 in.)	SA2 (0-2 ft)	Background[b]
SVOCs (µg/kg)									
Benzo(a)anthracene	***140***	<524	<502	<485	<347	<370	NT	NT	135
Benzo(b)fluoranthene	***420***	57	<502	130	<347	<370	NT	NT	183
Benzo(k)fluoranthene	<749	<524	69	<485	<347	<370	NT	NT	102
Benzo(a)pyrene	120	<524	<502	72	<347	<370	NT	NT	259
bis(2-Ethylhexyl)-phthalate	<749	120	<502	<485	<347	<370	NT	NT	NA
Chrysene	***290***	<524	<502	88	<347	<370	NT	NT	197
di-n-Butylphthalate	<749	78	<502	51	<347	<370	NT	NT	NA
Fluoranthene	***290***	<524	<502	160	<347	<370	NT	NT	173
Indeno(1,2,3-c,d) – pyrene	76	<524	<502	<485	<347	<370	NT	NT	165
Pyrene	190	<524	<502	107	<347	<370	NT	NT	290
Metals (mg/kg)									
Arsenic	***5.0***	4.6	3.2	1.1	0.35	2.5	2.9	*5.3*	5.0
Barium	***115***	***108***	***96***	10	<2.2	31	26	21	94
Beryllium	0.86	0.83	0.60	0.23	<0.12	0.19	0.23	0.20	1.0
Cadmium	<0.69	***1.5***	***0.85***	0.62	<0.31	<0.45	<0.46	<0.46	0.70
Copper	***34***	***29***	*29*	10	<2.4	2.5	2.6	4.3	20
Lead	***80***	***76***	58	7.5	1.8	7.7	5.5	5.5	61
Mercury	***0.13***	***0.10***	***0.080***	0.070	<0.044	0.056	<0.048	<0.056	0.080
Nickel	17	15	12	6.1	<2.2	4.3	6.5	4.6	20
Selenium	***1.2***	***0.48***	***0.64***	***0.62***	<0.17	***0.65***	***0.61***	0.28	0.43
Zinc	***187***	***290***	***193***	***123***	8.5	20	23	21	118
pH (standard units)	5.4	5.3	5.4	5.7	5.2	NT	NT	NT	–

[a] Notation: NA = not available; NT = not tested; a dash indicates not applicable. Sample concentrations equal to or exceeding the background values are presented in bold italics.

[b] Background values were derived from soil data in ICF Kaiser Engineers (1995).

TABLE 2.11 Range of Concentrations for White Phosphorus Burning Pits AOC Soil Samples Collected During Previous Investigations

Analyte	Range of Concentrations (µg/kg)
Aluminum	322,000-24,400,000
Antmony	89-2,900
Arsenic	352-14,100
Barium	1,100-939,000
Benz(a)anthracene	140-262
Benzo(a)pyrene	72-262
Benzo(b)fluoranthene	57-420
Benzo(k)fluoranthene	69-374.5
Beryllium	57.5-857
bis(2-Ethylhexyl)phthalate	120-374.5
Cadmium	157-2,740
Calcium	86,600-10,900,000
Chromium	419-183,000
Chrysene	88-290
Cobalt	680-6,980
Copper	1,205-67,300
di-n-Butylphthalate	51-374.5
Fluoranthene	160-290
Indeno(1,2,3-cd)pyrene	76-262
Iron	1,160,000-37,200,000
Lead	1,830-2,960,000
Magnesium	65,600-2,400,000
Manganese	11,700-302,000
Mercury	22-140
Nickel	1,100-17,300
Potassium	27,400-1,280,000
Pyrene	107-262
Selenium	84-1,150
Silver	36.5-880
Sodium	8,900-599,000
Vanadium	1,520-31,000
Zinc	8,520-2,720,000
PCBs	323
Methylene chloride	ND[a]-17.0
Acetone	ND-494
Toluene	ND-7.42
Xylenes	ND-18.4

[a] ND = not detected.

Sources: Princeton Aqua Science (1984), Nemeth (1989), Weston (1994), Hiohowskyj et al. (2000)

TABLE 2.12 Analytical Results for Surface Water Samples from the White Phosphorus Burning Pits AOC: 1986

Analyte	Concentration by Location J37	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).

TABLE 2.13 Analytical Results for Selected Metals in Surface Water Samples Collected from the White Phosphorus Burning Pits AOC: 1994[a]

	Concentration (μg/L) by Sample Location						Freshwater Marsh	Estuarine Marsh
Analyte	WPP-A	WPP-C	WPSW2	WPSW3	WPSW4	WPSW5	Background[b] (μg/L)	Background[c] (μg/L)
Arsenic	3.3 B	8.2 B	2.9	<3.6	<3.6	<1.8	NA	NA
Cadmium	<4.0	<4.0	<3.0	<3.0	<3.0	<3.0	NA	NA
Calcium	6,700	24,400	12,600	49,300	48,000	15,500	NA	NA
Chromium	6.5 B	***16***	<8.0	<8.0	<8.0	<8.0	8.0	NA
Copper	4.8 B	25	<23	28	<23	<23	NA	5.0
Iron	2,240	***18,000***	***27,300***	2,170	368	8,060	5,750	2,140
Lead	***14***	***71***	***21***	***7.6***	2.8	4.9	6.0	3.0
Magnesium	3,790 B	9,820	23,700	131,000	***131,000***	9,100	NA	216
Mercury	<0.20	<0.20	<0.10	<0.10	<0.10	0.10	NA	NA
Zinc	50 E	***411 E***	62	41	***24***	96	76	15

[a] Notation: B = constituent detected in quality control blank; E = estimated value; NA = not available. Sample concentrations equal to or exceeding the calculated background are presented in bold italics.

[b] Freshwater marsh calculated background values were used as comparison criteria for WPSW2, WPSW3 (samples from the marsh area), WPP-A, WPP-C, and WPSW5.

[c] Estuarine river calculated background values were used as comparison criteria for WPSW4 (offshore sample).

TABLE 2.14 Risk Characterization Summary for Aquatic Community Assessment Endpoints at the White Phosphorus Burning Pits AOC

Assessment Endpoint (AE)	Rationale for AE Selection	Measurement Endpoint	Results	Risk Characterization
Primary producers	Reductions in growth directly affect food availability for primary consumers, thus indirectly affect the food availability of upper- trophic-level predators; growth also considered to directly reflect overall plant productivity and condition.	Growth of *Raphidocelis subcapitata* (formerly *Selenastrum* planktonic alga) and *Lemna* (vascular aquatic plant) exposed to surface water from the AOC in 96-hour toxicity tests.	Reduced growth of *Raphidocelis subcapitata.* No effect on growth of *Lemna.*	Phytoplankton production may be at risk, but vascular aquatic vegetation not at risk from surface water at AOC.
Zooplankton	Zooplankton are an important food source for higher-trophic-level predators. Primary exposure route is concentrations of COPECs in surface water.	48-hour toxicity tests to evaluate survival of *Daphnia* exposed to surface water from the AOC.	No effects on survival, compared with laboratory controls.	Zooplankton not at risk from COPECs in surface water at the AOC.
Benthic invertebrates	Benthic invertebrates are an important food source for higher-trophic-level predators. Primary exposure route is concentrations of COPECs in sediments.	Toxicity tests to evaluate effects of sediments from the AOC on survival and growth of the amphipod *Hyalella* during 10- and 28-day exposures.	No effect on the survival and growth of *Hyalella*.	Benthic invertebrates not at risk from COPECs in sediments at the AOC.
Fish	Fish represent a link from zooplankton and benthic invertebrates to piscivorous birds. Primary exposure route would be from concentrations of COPECs in surface water.	48-hour toxicity tests to evaluate effects of surface water from the AOC on survival of *Pimephales*.	No toxicity.	Surface waters at the AOC pose no risk to the acute survival of fish.
Amphibians	Amphibians represent a trophic link from marsh insects to birds and other predators. Primary exposure route would be from concentrations of COPECs in surface water.	48- and 96-hour toxicity tests with *Rana* larvae to evaluate survival when exposed to surface water from the AOC.	No toxicity.	Survival of amphibians not at risk from exposure to surface water at the AOC.

TABLE 2.15 Risk Characterization Summary for Plant Community Assessment Endpoints at the White Phosphorus Burning Pits AOC

Assessment Endpoint (AE)	Rationale for AE Selection	Measurement Endpoint	Results	Risk Characterization
Growth of old-field herbaceous vegetation	Reductions in growth directly affect food availability for primary consumers and thus indirectly affect the food availability for upper-trophic-level predators; growth also considered to directly reflect overall plant productivity and condition.	Toxicity testing using site soils; endpoints (lettuce seedling height and weight) considered to directly reflect growth.	Mean weight significantly reduced relative to negative control only for soil from Suspect Pushout Area. No differences in mean seedling height from pit and suspect areas.	Growth of old-field herbaceous vegetation at risk at the Suspect Pushout area from heavy metals.
Reproduction of old-field herbaceous vegetation	Reduced reproduction will adversely impact population survival and distribution and potentially result in secondary effects to primary consumers and upper-trophic-level biota.	Reproduction evaluated via toxicity testing of site soils with an endpoint of seed germination.	70% seedling emergence in soils from Northern Pit and Suspect Pushout Area; 65% seedling emergence rate from negative control, and more than 90% from Southern Pit and Suspect Filled Trench areas.	Reproduction of old-field herbaceous vegetation at risk at the Northern Pit and Suspect Pushout Area from heavy metals.
Survival of old-field herbaceous vegetation	Survival directly affects population size, community structure, productivity, and biomass.	Toxicity testing with site soils and an endpoint of seedling survival.	100% seedling survival at all locations.	Survival of old-field herbaceous vegetation not at risk at the WPP AOC.
Diversity of old-field herbaceous vegetation	Diversity directly affects vegetation community structure and function and has secondary effects on consumer trophic levels with respect to food and habitat.	Transects and point counts used to directly evaluate diversity at the site and reference areas.	Species diversity and richness similar to reference site.	Diversity of old-field herbaceous vegetation not at risk at the WPP AOC.

TABLE 2.16 Risk Characterization Summary for Soil Microbiota and Macroinvertebrate Assessment Endpoints at the White Phosphorus Burning Pits AOC

Assessment Endpoint (AE)	Rationale for AE Selection	Measurement Endpoint	Results	Risk Characterization
Maintenance of soil microbiota community structure and function	Soil microbiota important in decomposition and nutrient cycling, which in turn affects primary production. Disruption/ alteration of soil biota populations may lead to localized disruption of ecosystem structure and function.	Biomass nitrogen production; considered representative of soil microbial biomass, which in turn reflects overall microbial abundance.	No significant differences between soils from the pit area and background site.	Microbial abundance and community structure not at risk from soils at the site.
		Nematode abundance and community structure; reflects disruption of microinvertebrate community structure.	No difference in abundance or trophic structure between the pit area and background site.	
		Basal and substrate-induced soil respiration measured as CO_2 evolution; considered representative of microbial decomposition and nutrient cycling activity.	Soil respiration rates comparable between the pit area and background site.	Nutrient cycling processes not at risk from soils at the site, except to localized areas.
		Soil nitrogen mineralization rate; representative of nitrogen cycling by soil microbiota.	No significant difference in nitrogen mineralization rate between the pit area and the background site.	
		Litter decomposition; direct measure of microbial degradation of organic matter and subsequent nutrient release.	Nutrient release reduced in soils from the pit area compared with the background location.	

TABLE 2.16 (Cont.)

Assessment Endpoint (AE)	Rationale for AE Selection	Measurement Endpoint	Results	Risk Characterization
Maintenance of soil macroinvertebrate community structure and function	Soil macroinvertebrates important in decomposition and nutrient cycling, which in turn affects primary production. Macroinvertebrates also important prey for higher-trophic-level biota. Disruption/alteration of soil biota populations may lead to localized disruption of ecosystem structure and function.	Abundance and diversity of macroinvertebrate infauna and epifauna; reflects overall community structure. Total number of epifauna captured considered a direct measure of surface activity.	No difference in abundance of macroinvertebrate infauna or epifauna for soils from the AOC and a reference site. Activity of epifauna significantly greater at the pit area than at the background site.	Macroinvertebrate abundance and community structure not at risk from soils at the site.
		Survival of macroinvertebrate infauna; evaluated using earthworm toxicity testing.	No reduction in survival.	Macroinvertebrate survival not at risk.
		Growth of macroinvertebrate infauna; evaluated using earthworm toxicity testing.	Slightly reduced growth in soil from the Southern Pit and the Suspect Filled Trench areas.	Macroinvertebrate growth at risk from metals in soils from the Suspect Pushout Area.

TABLE 2.17 Risk Characterization Summary for Terrestrial Vertebrates at the White Phosphorus Burning Pits AOC

Assessment Endpoint (AE)	Rationale for AE Selection	Measurement Endpoint	Results	Risk Characterization
Primary consumers	Serve an important role as the principal food source for higher-trophic-level predators. Represent potential for exposure through ingestion of vegetation and surface water, and ingestion of soil or sediment.	HQs calculated by comparing modeled daily doses of COPECs for the eastern cottontail and white-tailed deer to dose-based benchmark values.	Eastern cottontail: HQs ≥1 for Sb, Pb, and Hg. White-tailed deer: all HQs <1.	Risks to primary consumers, especially small mammals, from the contaminants at the AOC.
Secondary consumers (including omnivores)	Represent intermediate trophic level between primary consumers and tertiary consumers. Primary exposure routes include ingestion of primary consumers and surface water, and ingestion of soil.	HQs calculated by comparing modeled daily doses of COPECs for the American robin, tree swallow, and white-footed mouse to dose-based benchmark values.	American robin: HQs ≥1 for Cd, Cr, Pb, and Zn. Tree swallow: HQ ≥1 for Zn. White-footed mouse: all HQs <1.	Risks to secondary consumers, especially omnivorous birds, from metals in soils from the Northwest and Southwest Suspect Burning Areas and the Suspect Storage Area at the AOC.
Tertiary consumers	Represent the highest trophic level and are most likely to be affected by bioaccumulative contaminants. Exposure routes include ingestion of primary and secondary consumers, drinking surface water, and ingestion of soil.	HQs calculated by comparing modeled daily doses of COPECs for the American kestrel, red-tailed hawk, and red fox to dose-based benchmark values.	American kestrel: all HQs <1. Red-tailed hawk: all HQs <1. Red fox: all HQs <1.	No risks to tertiary consumers from the contaminants at the WPP AOC.

TABLE 2.18 Southern Pit Sample Locations, Intervals, and Corresponding Analytes

Field Sample ID (depth interval[a])	VOCs	PAH	SVOCs	Metals	CWA Degradation Compounds	Pesticides and PCBs	Explosive-Related Compounds and Perchlorate
SP-1 (0-1 ft)	√	√	√	√	√	√	√
SP-1,1-2 (1-2 ft)	√		√	√			
SP-1,2-4 (2-4 ft)	√		√	√			
SP-2 (0-1 ft)	√	√	√	√	√	√	√
SP-2,1-2 (1-2 ft)	√		√	√			
SP-2,2-4 (2-4 ft)	√		√	√			
SP-2,4-6 (4-6 ft)	√		√	√			
SP-3 (0-1 ft)	√	√	√	√	√	√	√
SP-3,1-2 (1-2 ft)	√		√	√			
SP-3,2-4 (2-4 ft)	√		√	√			
SP-4-WALL (0-1 ft)	√	√	√	√	√	√	√
SP-5-WALL (0-1 ft)	√	√	√	√	√	√	√
SP-6-WALL (0-1 ft)	√	√	√	√	√	√	√
SP-7-WALL (0-1 ft)	√	√	√	√	√	√	√

[a] Metric equivalents of sample depths are: 0-1ft = 0-0.3 m, 1-2 ft = 0.3-0.6 m, 2-4 ft = 0.6-1.2 m, and 4-6 ft = 1.2-1.8 m.

TABLE 2.19 Northern Pit Sample Locations, Intervals, and Corresponding Analytes

Field Sample ID (depth interval)	VOCs	PAH	SVOCs	Metals	CWA Degradation Compounds	Pesticides and PCBs	Explosive-Related Compounds and Perchlorate
NP-1 (0-1 ft)	√	√	√	√	√	√	√
NP-1,1-2 (1-2 ft)	√		√	√			
NP-1,2-4 (2-4 ft)	√		√	√			
NP-2 (0-1 ft)	√	√	√	√	√	√	√
NP-2,1-2 (1-2 ft)	√		√	√			
NP-2,2-4 (2-4 ft)	√		√	√			
NP-3 (0-1 ft)	√	√	√	√	√	√	√
NP-3,1-2 (1-2 ft)	√		√	√			
NP-3,2-4 (2-4 ft)	√		√	√			
NP-3,4-6 (4-6 ft)	√		√	√			
NP-4 (0-1 ft)	√	√	√	√	√	√	√
NP-4,1-2 (1-2 ft)	√		√	√			
NP-4,2-4 (2-4 ft)	√		√	√			
NP-4,4-6 (2-4 ft)[b]	√		√	√			
NP-5-WALL (0-1 ft)	√	√	√	√	√	√	√
NP-6-WALL (0-1 ft)	√	√	√	√	√	√	√
NP-7-WALL (0-1 ft)	√	√	√	√	√	√	√
NP-8-WALL (0-1 ft)	√	√	√	√	√	√	√
NP-9-WALL (0-1 ft)	√	√	√	√	√	√	√

[a] Metric equivalents of sample depths are: 0-1ft = 0-0.3 m, 1-2 ft = 0.3-0.6 m, 2-4 ft = 0.6-1.2 m, and 4-6 ft = 1.2-1.8 m.

[b] Blind duplicate of NP-4,2-4.

TABLE 2.20 Non-Burn-Pit Sample Locations, Intervals, and Corresponding Analytes

Sample ID (sample interval 0-1 ft below ground surface unless otherwise noted)[a]	Metals	Explosive-Related Compounds and Perchlorate	VOCs	Chemical Warfare Agent Degradation Compounds
SO-1, SO-2	√			
SO-3	√	√	√	√
SO-4, SO-5	√			
SO-6	√	√	√	√
SO-7, SO-9	√			
SO-10	√	√	√	√
SO-11 to SO-13	√			
SO-14, SO-15	√	√	√	√
SO-16	√			
SO-17	√	√	√	√
SO-18	√			
SO-19	√	√	√	√
SO-20	√			
SO-21	√	√	√	√
SO-22 to SO-26	√			
PO-1,0-1	√			
PO-1,1-2 (1-2 ft)	√			
PO-1,2-4 (2-4 ft)	√			

[a] Metric equivalents of sample depths are: 0-1ft = 0-0.3 m, 1-2 ft = 0.3-0.6 m, and 2-4 ft = 0.6-1.2 m.

TABLE 2.21 X-Ray Fluorescence Measurement Results[a]

Field ID #	Pb (mg/kg)	Zn (mg/kg)	Field ID #	Pb (mg/kg)	Zn (mg/kg)
G1-1	25	272	G2-1	14	106
G1-1a	98	418	G2-2	20	58
G1-2	73	493	G2-3	12	38
G1-3	77	232	G2-4	7	18
G1-4	98	396	G2-5	18	56
G1-5	75	270	G2-6	26	92
G1-6	71	310	G2-7	4	54
G1-7	90	453	G2-8	15	35
G1-8	64	249	G2-9	8	55
G1-9	65	276	G2-10	7	48
G1-10	68	575	G2-11	25	113
G1-11	328	988	G2-12	20	61
G1-12	152	171	G2-13	22	49
G1-13	78	241	G2-14	23	42
G1-14	105	407	G2-15	16	64
G1-15	100	428	G2-16	20	113
G1-16	48	462	G2-17	16	45
G1-16a	53	477	G2-18	26	3
G1-17	147	459	G2-19	7	43
G1-18	226	255	G2-20	10	56
G1-19	74	344	G2-21	7	55
G1-20	184	682	G2-22	24	66
G1-21	191	605	G2-23	37	113
G1-22	17	104	G2-24	54	236
G1-23	155	231	G2-25	15	49
G1-24	115	656	G2-30	12	108
G1-25	320	851	G2-26	7	15
G1-26	121	358	G2-27	10	30
G1-27	135	656	G2-28	25	87
G1-28	52	418	G2-29	37	198
G1-29	90	555	G2-29a	47	206
G1-30	96	534	G2-31	43	138
G1-31	140	675	G2-32	46	202
G1-32	106	370	G2-33	14	23
G1-33	61	519	G2-34	11	37
G1-34	125	713	G2-35	29	8
G1-35	44	178	G2-36	36	149
G1-36	100	756	G2-37	33	162
G1-37	97	529	G2-38	15	121
G1-38	66	170	G2-39	149	604
G1-39	64	427	G2-40	69	365
G1-40	77	436	G2-41	109	617
G1-40a	102	802	G2-42	54	229
G1-41	84	440	G2-43	61	210

TABLE 2.21 (Cont.)

Field ID #	Pb (mg/kg)	Zn (mg/kg)	Field ID #	Pb (mg/kg)	Zn (mg/kg)
G3-1	34	101	G3-42	17	45
G3-2	20	73	G3-43	25	24
G3-3	13	78	G3-44	16	63
G3-4	22	94	G3-45	18	42
G3-5	23	75	G3-46	15	33
G3-6	23	100	NP-27	71	312
G3-7	36	127	NP-26	140	474
G3-8	24	141	NP-25	65	254
G3-9	26	77	NP-24	62	448
G3-10	25	119	NP-23	39	215
G3-11	38	124	NP-23a	39	207
G3-12	21	131	NP-22	74	245
G3-13	10	53	NP-21	23	90
G3-14	18	59	NP-20	15	44
G3-15	10	44	NP-19	15	55
G3-16	17	81	NP-18	45	155
G3-17	28	61	NP-17	24	47
G3-18	20	91	NP-16	23	155
G3-19	18	79	NP-15	35	164
G3-20	30	94	NP-14	57	216
G3-21	21	41	NP-13	588	1221
G3-22	16	46	NP-13a	659	1207
G3-23	17	66	NP-12	38	134
G3-24	14	36	NP-10	292	990
G3-24a	18	73	NP-8	35	162
G3-25	26	58	NP-7	4078	1324
G3-26	27	72	NP-6	591	3262
G3-27	21	49	NP-5	27	121
G3-28	19	34	NP-4	47	167
G3-29	13	48	NP-3	27	145
G3-30	25	61	NP-2	45	233
G3-31	23	61	NP-1	39	146
G3-32	19	45	XRWPP2	79	553
G3-33	21	57	XRWPP7	14	83
G3-34	20	49	XRWPP8	14	117
G3-35	12	55	XRWPP10	14	879
G3-36	8	40	XRWPP11	26	253
G3-37	19	63	XRWPP12	93	984
G3-38	18	42	XRWPP13	22	150
G3-39	22	50	XRWPP14	69	412
G3-40	16	47	XRWPP15	66	545
G3-41	15	45			

[a] Intrusive samples were collected as close to the highlighted XRF sample locations as field conditions (presence/absence of metallic anomalies) permitted.

TABLE 2.22 Analytes Retained after Refinement Steps

Analyte
Acenaphthylene
Anthracene
Antimony
Barium
Benzo(b)fluoranthene
Benzo(a)anthracene
Benzo(a)pyrene
Benzo(g,h,i)perylene
Benzo(k)fluoranthene
Cadmium
Chromium
Copper
Chrysene
Dieldrin
Fluoranthene
Lead
Mercury
Nickel
PCB-1254
Phenanthrene
Selenium
Thallium
Zinc

TABLE 2.23 Highest Concentrations of Retained COPECs Detected in Northern Pit Samples

Analyte	Maximum Concentration Detected in Northern Pit	Sample Location (unless otherwise indicated, sample interval is 0-1 ft [0-0.3 m] below ground surface)
Acenaphthylene[a]	2,000 μg/kg (J)[b]	NP-6-WALL
Anthracene	11 μg/kg (K)	NP-4
Antimony[a]	101 mg/kg (N) (B)	NP-6-WALL
Barium	206 mg/kg (N*)	NP-8-WALL
Benzo(b)fluoranthene	860 μg/kg (E)	NP-4
Benzo(a)anthracene	51 μg/kg (E)	NP-7-WALL
Benzo(a)pyrene	200 μg/kg (E)	NP-6-WALL
Benzo(g,h,i)perylene	Not detected	
Benzo(k)fluoranthene[a]	1,200 μg/kg (J)	NP-6-WALL
Cadmium[a]	9.8 mg/kg	NP-6-WALL
Chromium	23.5 mg/kg (B)	NP-6-WALL
Copper	205 mg/kg	NP-6-WALL
Chrysene	81 μg/kg (E)	NP-4
Dieldrin	2.7 μg/kg (J)	NP-4
Fluoranthene[a]	3,900 μg/kg (E)	NP-6-WALL
Lead	7,900 mg/kg	NP-6-WALL
Mercury	0.045 mg/kg	NP-8-WALL
Nickel	16 mg/kg	NP-7-WALL
PCBs	Not detected	
Phenanthrene	120 μg/kg (E)	NP-6-WALL
Selenium	0.76 mg/kg (J)	NP-6-WALL
Thallium	0.32 mg/kg (J)	NP-7-WALL
Zinc[a]	5,110 mg/kg	NP-7-WALL

[a] This represents the maximum concentration of the noted compound detected in all soil samples (burn pit and non-burn-pit samples) collected from the site.

[b] The data qualifiers in parentheses are defined in Table 2.34.

TABLE 2.24 Maximum Detected Concentrations for Retained COPECs Detected in Southern Burn Pit Soil Samples

Analyte	Maximum Concentration	Sample Location (unless otherwise indicated, sample interval is 0-1 ft [0-0.3 m] below ground surface)
Acenaphthylene	72 μg/kg (J)[a]	SP-4-WALL
Anthracene	120 μg/kg (J)	SP-7-WALL
Antimony	2.6 mg/kg (JN), (BL)	SP-2
Barium[b]	1,540 mg/kg (N*) (L)	SP-7-WALL
Benzo(b)fluoranthene[b]	870 μg/kg (E)	SP-7-WALL
Benzo(a)anthracene[b]	240 μg/kg (J)	SP-5-WALL
Benzo(a)pyrene[b]	220 μg/kg (E)	SP-7-WALL
Benzo(g,h,i)perylene[b]	1,200 μg/kg (E)	SP-7-WALL
Benzo(k)fluoranthene	200 μg/kg	SP-2
Cadmium	2.8 mg/kg	SP-6-WALL
Chromium[b]	283 mg/kg (J)	SP-7-WALL
Copper[b]	491 mg/kg	SP-2
Chrysene[b]	160 μg/kg (J)	SP-5-WALL
Dieldrin[b]	6.8 μg/kg	SP-2
Fluoranthene	500 μg/kg (J)	SP-5-WALL
Lead	131 mg/kg (B)	SP-2
Mercury	0.049 mg/kg	SP-2
Nickel	16.8 mg/kg	SP-2,4-6
PCB-1254[b]	460 μg/kg (E)	SP-6-WALL
Phenanthrene[b]	530 μg/kg (J)	SP-5-WALL
Selenium	0.69 mg/kg (J)	SP-1
Thallium	Not detected in Southern Burn Pit	
Zinc	977 mg/kg (N)	SP-2 (1-2 ft [0.3-0.6 m] below ground surface)

[a] The data qualifiers in parentheses are defined in Table 2.34.

[b] This represents the maximum concentration of the noted compound detected in all soil samples collected from the site.

TABLE 2.25 Maximum Detected Concentrations for Analytes Retained after Refinement Steps and Corresponding Non-Burn-Pit Soil Sampling Locations

Analyte	Maximum Concentration	Sample Location (sample interval is 0-1 ft [0-0.3 m] below ground surface)
Acenaphthylene	Not tested	
Anthracene	Not tested	
Antimony	26.9 mg	SO-12
Barium	447 mg/kg	SO-11
Benzo(b)fluoranthene	Not tested	
Benzo(a)anthracene	Not tested	
Benzo(a)pyrene	Not tested	
Benzo(g,h,i)perylene	Not tested	
Benzo(k)fluoranthene	Not tested	
Cadmium	3.8 mg/kg	SO-17
Chromium	59.1 mg/kg (N), (J)[a]	SO-11
Copper	226 mg/kg	SO-13
Chrysene	Not tested	
Dieldrin	Not tested	
Fluoranthene	Not tested	
Lead[b]	13,400 mg/kg	SO-3
Mercury[b]	0.1504 mg/kg	SO-13
Nickel[b]	18.6 mg/kg	SO-11
PCB-1254	Not tested	
Phenanthrene	Not tested	
Selenium[b]	2.3 mg/kg	SO-13
Thallium[b]	1.5 mg/kg	SO-11
Zinc	1,810 mg/kg	SO-11

[a] The data qualifiers in parentheses are defined in Table 2.34.

[b] This represents the maximum concentration of the noted compound detected in all soil samples collected from the site.

TABLE 2.26 XRF Sediment Sample Results[a] (mg/kg)

XRF Sample ID (interval 0-6 in. [0-15.24 cm])	Pb	Zn	Intrusive Sample ID
sedxrf1	46.69	68.62	
sedxrf2	48.56	78.96	
sedxrf3	51.89	79.85	
sedxrf3	38	55.66	
sedxrf4	41.41	72.43	
sedxrf6	62.32	244.11	
sedxrf7	72.33	177.22	
sedxrf8	64.45	139.17	
sedxrf9	68.21	208.23	
sedxrf9 dup	68.81	202.65	
sedxrf10	72.67	216.16	
sedxrf11	50.86	344.07	SED1
sedxrf11	65.29	226.07	SED1
sedxrf12	70.63	153.69	
sedxrf13	62.89	117.7	
sedxrf14	100.38	90.42	
sedxrf15	98.5	2,928.24	SED2
sedxrf15 dup	95.72	2,943.08	SED2
sedxrf16	358.12	222.6	SED3
sedxrf17	56.77	111.77	
sedxrf18	443.4	1,261.8	SED4
sedxrf18 dup	443.66	1,301.36	SED4
sedxrf19	115.57	190.88	
sedxrf20	86.6	165.12	
sedxrf21	131.28	100.4	SED5
sedxrf22	58.65	92.54	
sedxrf23	105.01	122.2	
sedxrf24	42.22	78.13	
sedxrf25	41.55	90.25	

[a] Highlighted XRF sample locations were selected for additional sampling/ analysis by off-site laboratory analyses.

TABLE 2.27 Sediment Sample Locations and Corresponding Analytes

Field Sample ID	VOCs	White Phosphorus	SVOCs	Metals	CWA Degradation Compounds	Perchlorate	Explosive-Related Compounds
SED1				√			
SED2	√	√	√	√	√	√	√
SED3	√	√	√	√	√	√	√
SED4	√	√	√	√	√	√	√
SED5				√			
SED6	√	√	√	√	√	√	√
SED7	√	√	√	√	√	√	√

TABLE 2.28 Maximum Concentrations of Constituents of Potential Ecological Concern Detected in Sediment Samples[a]

Analyte	Location	Maximum Concentration	Units	No. Detects	Sediment SEV (µg/kg)	Hq_{max}
Aluminum	SED6	11,900	mg/kg	7	NA[b]	NA
Antimony	SED7	1.8	mg/kg	7	150,000	0.01
Arsenic	SED4	10	mg/kg	7	8,200	1.22
Barium	SED6	50.4	mg/kg	7	NA	NA
Beryllium	SED4	1.6	mg/kg	7	NA	NA
Cadmium	SED6	0.46	mg/kg	5	1,200	0.38
Chromium	SED1	16.4	mg/kg	7	260,000	0.06
Cobalt	SED4	5.5	mg/kg	7	NA	NA
Copper	SED6	39.7	mg/kg	7	34,000	1.17
Iron	SED4	32,000	mg/kg	7	NA	NA
Lead	SED5	48.9	mg/kg	7	46,700	1.05
Magnesium	SED3	1,532	mg/kg	7	NA	NA
Manganese	SED4	79.5	mg/kg	7	NA	NA
Mercury	SED6	0.028	mg/kg	4	150	0.19
Nickel	SED6	13.9	mg/kg	7	20,900	0.67
Nitrobenzene	SED6	110	µg/kg	3	NA	NA
Thallium	SED1	0.72 (J)[c]	mg/kg	2	NA	NA
Vanadium	SED6	21.9	mg/kg	7	NA	NA
Zinc	SED2	220	mg/kg	7	150,000	1.47
1,1-Biphenyl	SED2	47	µg/kg	1	NA	NA
Benzaldehyde	SED2	250	µg/kg	1	NA	NA
Benzyl butyl phthalate	SED6	290	µg/kg	1	63	4.60

[a] Highlighted rows indicate analytes with maximum concentrations that exceeded the SEV, resulting in HQ >1.

[b] NA = not applicable.

[c] The data qualifier in parentheses is defined in Table 2.34.

TABLE 2.29 Surface Water Sampling Locations and Corresponding Analytes

Field Sample ID	VOCs	White Phosphorus	Metals	CWA Degradation Compounds	Perchlorate	Explosive-Related Compounds
WPSW6	√	√	√	√	√	√
WPSW7	√	√	√	√	√	√
WPSW8	√	√	√	√	√	√
WPSW9	√	√	√	√	√	√
WPSW10	√	√	√	√	√	√

TABLE 2.30 Maximum Concentrations of Contaminants of Potential Ecological Concern Detected in Surface Water Samples[a]

Analyte	Location	Maximum Concentration (μg/L)	No. of Detects	Surface Water SEV (μg/L)	HQ_{max}
Aluminum	WPSW9	1,480	5	25	59.20
Antimony	WPSW9	0.6	5	30	0.02
Arsenic	WPSW7	2.8	5	874	0.00
Barium	WPSW7	86.9	5	10,000	0.01
Beryllium	WPSW9	0.11	5	5.3	0.02
Cadmium	WPSW8	0.17	1	0.25	0.68
Chromium	WPSW9	1.9	4	11	0.17
Cobalt	WPSW7	3.8	5	35,000	0.00
Copper	WPSW9	6.2	5	9.01	0.69
Iron	WPSW7	5,630	5	320	17.59
Lead	WPSW9	24.1	5	2.54	9.49
Magnesium	WPSW7	16,200	5	NA[b]	NA
Manganese	WPSW7	2,010	5	14,500	0.14
Nickel	WPSW9	4.5	5	52.31	0.09
Selenium	WPSW10	0.98	5	5	0.20
Silver	WPSW9	0.033	1	0.12	0.28
Thallium	WPSW6	0.09 (J)[c]	1	40	0.00
Vanadium	WPSW9	3	5	10,000	0.00
Zinc	WPSW9	71.8	5	118.82	0.60
bis(2-Ethylhexyl) phthalate	WPSW6	7.9	1	30	0.26
Acetone	WPSW7	7.5	1	9,000,000	0.00
Chloromethane	WPSW7	0.48	4	NA	NA

[a] Highlighted rows indicate analytes with maximum concentrations that exceeded the SEV, resulting in HQ >1.

[b] NA = not applicable.

[c] The data qualifier in parentheses is defined in Table 2.34.

TABLE 2.31 Monitoring Wells and Corresponding Analytes

Field Sample ID	VOCs	Metals	Explosive-Related Compounds	Perchlorate	CWA Degradation Compounds	White Phosphorus	Cyanide
P5	√	√	√	√	√	√	√
JF9-3	√	√	√	√	√	√	√
TH3	√	√	√	√	√	√	√
P6	√	√	√	√	√	√	√
P8	√	√	√	√	√	√	√
JF10-1	√			√			
JF12-1	√			√			
JF11-1	√			√			
JF9-1	√			√			
TH1	√	√	√	√	√	√	√
JF12-3	√	√	√	√	√	√	√
JF11-3	√	√	√	√	√	√	√
JF10-3	√	√	√	√	√	√	√
P7	√	√	√	√	√	√	√

TABLE 2.32 Metals Detected in Monitoring Well Samples (μg/L)

Analyte Name	04A-P5 Result	Lab Flag[a]	Detection Limit	Validation Flag[a]	04A-JF9-3 Result	Lab Flag[a]	Detection Limit	Validation Flag[a]
Aluminum	134		0.050		1,980		0.050	
Antimony	1	UN	0.050		0.18	NJ	0.050	
Arsenic	0.5	U	0.50		0.7		0.050	
Barium	18.6		0.050		48		0.050	
Beryllium	0.096	J	0.050		0.36	J	0.050	
Cadmium	0.5	U	0.50		0.23	J	0.050	
Calcium	7,140		0.050		13,100		0.050	
Chromium	0.79	J	0.050	B	6.6		0.050	
Cobalt	0.86		0.050		17.9		0.050	
Copper	0.49	J	0.050		5.4		0.050	
Iron	107		0.050		1,600		0.050	
Lead	0.27	NJ	0.050	B	25	N	0.050	
Magnesium	1,590		0.050		4,330		0.050	
Manganese	2.5		0.050		73.4		0.050	
Mercury	0.2	U	0.20		0.2	U	0.20	
Nickel	1.4		0.050		14.2		0.050	
Potassium	150	J	0.050		855		0.050	
Selenium	2.5	UN	0.050		2.5	UN	0.050	
Silver	0.5	U	0.50		0.5	U	0.50	
Sodium	4,240		0.050		11,200		0.050	
Thallium	0.5	U	0.50		0.5	U	0.50	
Vanadium	0.5	U	0.50		2.5		0.050	
Zinc	9.2	E	0.050		30.6	E	0.050	

Analyte Name	04A-TH 3 Result	Lab Flag[a]	Detection Limit	Validation Flag[a]	04A-P 6 Result	Lab Flag[a]	Detection Limit	Validation Flag[a]
Aluminum	2,370		0.050		4,050		0.050	
Antimony	0.092	NJ	0.050		0.21	NJ	0.050	
Arsenic	0.61		0.050		1.3		0.050	
Barium	24.5		0.050		54.8		0.050	
Beryllium	0.12	J	0.050		0.19	J	0.050	
Cadmium	0.5	U	0.50		0.5	U	0.50	
Calcium	61,300		0.050		37,900		0.050	
Chromium	5.2		0.050		6.2		0.050	
Cobalt	3.3		0.050		9.8		0.050	
Copper	2.4		0.050		10.1		0.050	
Iron	1,720		0.050		4,440		0.050	
Lead	3	N	0.050		4.1	N	0.050	
Magnesium	3,270		0.050		9,940		0.050	
Manganese	22.1		0.050		91.4		0.050	
Mercury	0.2	U	0.20		0.2	U	0.20	
Nickel	2.6		0.050		5.4		0.050	
Potassium	896		0.050		1,820		0.050	
Selenium	0.33	NJ	0.050		0.72	NJ	0.050	
Silver	0.5	U	0.50		0.5	U	0.50	
Sodium	15,900		0.050		29,200		0.050	
Thallium	0.5	U	0.50		0.5	U	0.50	
Vanadium	3.4		0.050		6.7		0.050	
Zinc	11.4	E	0.050		18.8	E	0.050	

TABLE 2.32 (Cont.)

Analyte Name	04A-P8 Result	Lab Flag[a]	Detection Limit	Validation Flag[a]	04A-TH1 Result	Lab Flag[a]	Detection Limit	Validation Flag[a]
Aluminum	451		0.050		166		0.050	
Antimony	0.11	NJ	0.050		0.13	NJ	0.050	LB
Arsenic	0.12	J	0.050		0.5	U	0.50	
Barium	37.5		0.050		48		0.050	
Beryllium	0.53		0.050		0.26	J	0.050	
Cadmium	0.68		0.050		0.17	J	0.050	
Calcium	32,800		0.050		3,420		0.050	
Chromium	0.92	J	0.050	B	0.9	J	0.050	B
Cobalt	22.6		0.050		8.8		0.050	
Copper	1.2		0.050		1.3		0.050	
Iron	189		0.050		125		0.050	
Lead	0.58	N	0.050	B	3.5	N	0.050	L
Magnesium	23,300		0.050		6,610		0.050	
Manganese	152		0.050		47.6		0.050	
Mercury	0.2	U	0.20		0.2	U	0.20	
Nickel	26.6		0.050		11.1		0.050	
Potassium	430	J	0.050		548		0.050	
Selenium	1.1	NJ	0.050		2.5	UN	0.050	L
Silver	0.5	U	0.50		0.5	U	0.50	
Sodium	12,400		0.050		8,580		0.050	
Thallium	0.5	U	0.50		0.5	U	0.50	
Vanadium	0.6		0.050	K	0.5	U	0.50	
Zinc	46.3	E	0.050		18.3	E	0.050	

Analyte Name	04A-JF 12-3 Result	Lab Flag[a]	Detection Limit	Validation Flag[a]	04A-JF 11-3 Result	Lab Flag[a]	Detection Limit	Validation Flag[a]
Aluminum	38.2		0.050		159		0.050	
Antimony	1.1	N	0.050	L	1	UN	0.050	L
Arsenic	0.18	J	0.50		0.22	J	0.50	
Barium	42.5		0.050		63.4		0.050	
Beryllium	0.04	J	0.050		0.078	J	0.050	
Cadmium	0.5	U	0.050		0.37	J	0.050	
Calcium	6,370		0.050		2,810		0.050	
Chromium	0.78	J	0.050	B	1.6		0.050	
Cobalt	2.7		0.050		14.6		0.050	
Copper	0.63	J	0.050		1.5		0.050	
Iron	19,500		0.050		9,340		0.050	
Lead	0.16	NJ	0.050	BL	2.8	N	0.050	L
Magnesium	9,110		0.050		2,070		0.050	
Manganese	853		0.050		1,170		0.050	
Mercury	0.2	U	0.20		0.2	U	0.20	
Nickel	18.4		0.050		32.3		0.050	
Potassium	2,410		0.050		792		0.050	
Selenium	0.28	NJ	0.050	L	2.5	UN	0.050	L
Silver	0.5	U	0.50		0.5	U	0.50	
Sodium	55,300		0.050		14,700		0.050	
Thallium	0.5	U	0.50		0.5	U	0.50	
Vanadium	0.5	U	0.50		0.5	U	0.50	
Zinc	3	E	0.050	B	25.3	E	0.050	J

TABLE 2.32 (Cont.)

Analyte Name	04A-JF 12-3 Result	Lab Flag[a]	Detection Limit	Validation Flag[a]	04A-JF 11-3 Result	Lab Flag[a]	Detection Limit	Validation Flag[a]
Mercury	0.2	U	0.20		0.2	U	0.20	
Nickel	18.4		0.050		32.3		0.050	
Potassium	2,410		0.050		792		0.050	
Selenium	0.28	NJ	0.050	L	2.5	UN	0.050	L
Silver	0.5	U	0.50		0.5	U	0.50	
Sodium	55,300		0.050		14,700		0.050	
Thallium	0.5	U	0.50		0.5	U	0.50	
Vanadium	0.5	U	0.50		0.5	U	0.50	
Zinc	3	E	0.050	B	25.3	E	0.050	J

Analyte Name	04A-JF10-3 Result	Lab Flag[a]	Detection Limit	Validation Flag[a]	04A-P7 Result	Lab Flag[a]	Detection Limit	Validation Flag[a]
Aluminum	1,320		0.050		429		0.050	
Antimony	0.13	NJ	0.050	BL	0.7	NJ	0.050	L
Arsenic	1.5		0.50		0.97		0.50	
Barium	106		0.050		8.1		0.050	
Beryllium	0.5	U	0.050		1.2		0.050	
Cadmium	0.5	U	0.050		0.24	J	0.050	
Calcium	215,000		0.050		6,990		0.050	
Chromium	0.44	J	0.050	B	0.28	J	0.050	B
Cobalt	0.13	J	0.050		13.3		0.050	
Copper	1	U	0.050		5.3		0.050	
Iron	41		0.050		8,720		0.050	
Lead	0.18	NJ	0.050	BL	13.3	N	0.050	L
Magnesium	281		0.050		7,540		0.050	
Manganese	0.81		0.050		264		0.050	
Mercury	0.2	U	0.20		0.2	U	0.20	
Nickel	13.2		0.050		22.5		0.050	
Potassium	9,560		0.050		596		0.050	
Selenium	1.1	NJ	0.050	L	0.47	NJ	0.050	L
Silver	0.5	U	0.50		0.5	U	0.50	
Sodium	161,000		0.050		12,300		0.050	
Thallium	0.5	U	0.50		0.5	U	0.50	
Vanadium	1.2		0.50	K	0.5	U	0.50	
Zinc	1.8	E	0.050	B	39.3	E	0.050	J

[a] The lab and validation flags are defined in Table 2.34.

TABLE 2.33 Perchlorate and Volatile Organic Compounds Detected in Monitoring Wells, Rinse Blanks, and Trip Blanks (μg/L)

Field Sample ID	Analyte Name	Result	Detection Limit	Validation Flag[a]
04A-RINSE BLANK 1	2-Butanone	21	1.5	B
04A-JF10-1	Toluene	1.2	0.30	J,B+AI999
04A-RINSE BLANK 2	Ethylbenzene	1.2	0.34	
04A-RINSE BLANK 2	Toluene	2.7	0.30	J
04A-RINSE BLANK 2	Total xylenes	4.3	0.35	J
04A-JF12-1	Toluene	1.1	0.30	J,B
04A-JF9-1	Dichlorodifluoromethane	0.58	0.25	
04A-JF12-3	Toluene	1.3	0.30	J,B
04A-JF11-3	Toluene	1.8	0.30	J,B
04A-JF10-3	Bromoform	5.1	0.23	L
04A-JF10-3	Chloroform	5.1	0.26	L
04A-JF10-3	Trichloroethene	4	0.31	L
04A-JF10-3 DL	2-Butanone	77	15	L,B
04A-JF10-3 DL	Bromoform	55	2.3	L
04A-JF10-3 DL	Chloroform	36	2.6	L
04A-P7	Trichloroethene	10	0.31	J
04A-P17 (alias for 04A-P7)	Trichloroethene	11	0.31	J
TRIP BLANK	Methylene chloride	2.1	0.21	J,B
04A-P8	Perchlorate	29.0	1.0	
04A-TH1	Perchlorate	1.0	1.0	

[a] The validation flags are defined in Table 2.34.

TABLE 2.34 Definitions of Lab and Validation Flags

Flag Type	Flag	Chemical Type	Explanation
LAB FLAG	U	Organics	Indicates that the compound was analyzed for but not detected
LAB FLAG	U	Inorganics	Indicates that the compound was analyzed for but not detected
LAB FLAG	BQL	Organics	Below Quantitation Limit
LAB FLAG	BQL	Inorganics	Below Quantitation Limit
LAB FLAG	B	Organics	Indicates that the analyte was found in the associated blank as well as in the sample
LAB FLAG	D	Organics	Indicates that the analyte was reported from a diluted analysis
LAB FLAG	E	Organics	Indicates that the concentration detected exceeded the calibration range of the instrument
LAB FLAG	J	Organics	Value is less than the reporting limit but greater than the MDL
LAB FLAG	P	Organics	Indicates that there is greater than 25% difference for detected pesticide/Arochlor results between the two GC columns
LAB FLAG	B	Inorganics	Indicates that the reported value was less than the reporting limit but greater than or equal to the IDL/MDL
LAB FLAG	E	Inorganics	Indicate that the reported value is estimated because of the possible presence of interference (I.e. the serial dilution not within control limits)
LAB FLAG	H	Inorganics	Indicates that the element was found in the associated blank as well as in the sample and the value is greater than or equal to the reporting limit
LAB FLAG	N	Inorganics	Spiked sample recovery not within control limits
LAB FLAG	*	Inorganics	Duplicate analysis not within control limits
Validation Flag	U	Organics	Indicates that the compound was analyzed for, but not detected at or above the Contract Required Quantitation Limit (CRQL).
Validation Flag	J	Organics	The associated numerical value is an estimated quantity, due to variance from quality control limits.
Validation Flag	UJ	Organics	The compound was analyzed for, but not detected. The sample quantitation limit is an estimated quantity due to variance from quality control limits.
Validation Flag	UL	Organics	The compound was analyzed for, but not detected. The sample quantitation limit is an estimated quantity and may be biased low, due to variance from quality control limits.
Validation Flag	B	Organics	Designates that the reported result was found to be below the respective method or field blank limit.
Validation Flag	L	Organics	The reported value may be biased low, due to variance from quality control limits.
Validation Flag	K	Organics	The reported value may be biased high, due to variance from quality control limits.
Validation Flag	E	Organics	Reported value is estimated due to quantitation above the calibration range.
Validation Flag	D	Organics	Reported result taken from diluted sample analysis.
Validation Flag	R	Organics	Reported value is unusable and rejected due to variance from quality control limits.
Validation Flag	NA	Organics	Not analyzed.
Validation Flag	U	Inorganics	Indicates analyte not detected at or above the Contract Required Detection Limit (CRDL).
Validation Flag	B	Inorganics	Designates that the reported result was found to be below the respective method or field blank limit.
Validation Flag	J	Inorganics	The reported value is estimated due to variance from quality control limits.
Validation Flag	UJ	Inorganics	The compound was analyzed for, but not detected. The sample quantitation limit is an estimate due to variance from quality control limits.
Validation Flag	UL	Inorganics	The compound was analyzed for, but not detected. The sample quantitation limit is an estimated quantity and may be biased low, due to variance from quality control limits.
Validation Flag	L	Inorganics	The reported value may be biased low, due to variance from quality control limits.
Validation Flag	K	Inorganics	The reported value may be biased high, due to variance from quality control limits.
Validation Flag	E	Inorganics	Reported value is estimated because of the presence of interference.
Validation Flag	R	Inorganics	Reported value is unusable and rejected due to variance from quality control limits.
Validation Flag	NA	Inorganics	Not analyzed.

TABLE 2.35 Comparison of Soil Samples Collected in 2004 to Maximum Concentrations from Previous Studies

Retained COPEC for Soil	Maximum Concentration	Comparison of Results for Circa 2004 Samples to Results of Previous Studies (summarized in Table 2.11)
Acenaphthylene	66 µg/kg	Not reported in Table 2.11
Antimony	101 mg/kg	>[a]
Benzo(b)fluoranthene	870 µg/kg	>
Benzo(g,h,i)perylene	1,200 µg/kg	Not reported in Table 2.11
Benzo(k)fluoranthene	1,200 µg/kg	>
Cadmium	9.8 mg/kg	>
Chromium	283 mg/kg	>
Copper	491 mg/kg	>
Dieldrin	6.8 µg/kg	Not reported in Table 2.11
Fluoranthene	3,900 µg/kg	>
Lead	13,400 mg/kg	>
Nickel	18.6 mg/kg	>
PCB-1254	460 µg/kg	>
Phenanthrene	530 µg/kg	Not reported in Table 2.11
Thallium	1.5 mg/kg	Not reported in Table 2.11
Zinc	5,110 mg/kg	>

[a] Exceeds previous maximum concentration reported for the WPP in previous studies (Table 2.11).

TABLE 2.36 Summary of Preliminary Screening Results[a]

Analyte	Concentration-Based SEVs Exceeded?			Dose-Based SEVs Exceeded?						Consider further as COPEC?
	Soil	Surface Water	Sediment	Eastern Cottontail	White-Footed Mouse	Red Fox	American Robin	Red-Tailed Hawk	Mallard	
Inorganics										
Aluminum	X	X	?	X	X	X	X	X	X	Yes
Antimony	X	O	O	X	X	X	?	?	?	Yes
Arsenic	O	O	X	X	X	X	O	O	O	Yes
Barium	X	X	?	X	X	O	X	O	O	Yes
Beryllium	O	O	?	O	O	O	?	?	?	Yes
Cadmium	X	O	O	X	O	X	X	X	O	Yes
Calcium	?	O	?	?	?	?	?	?	?	Yes
Chromium	X	O	O	X	X	X	X	X	O	Yes
Cobalt	O	O	X	O	O	O	O	O	O	Yes
Copper	X	O	X	X	X	X	X	O	O	Yes
Iron	X	X	?	?	?	?	?	?	?	Yes
Lead	X	X	X	X	X	X	X	X	O	Yes
Magnesium	X	O	?	?	?	?	?	?	?	Yes
Manganese	O	X	?	O	O	O	O	O	O	Yes
Mercury	X	ND	O	O	O	O	O	O	O	Yes
Nickel	X	O	O	O	O	O	O	O	O	Yes
Potassium	?	O	?	?	?	?	?	?	?	Yes
Selenium	X	O	ND	O	O	X	X	O	O	Yes
Silver	O	O	ND	?	?	?	O	O	O	Yes
Sodium	?	O	?	?	?	?	?	?	?	Yes
Thallium	X	O	?	X	X	X	?	?	?	Yes
Vanadium	O	O	?	X	X	X	X	O	O	Yes
Zinc	X	O	X	X	X	X	X	X	X	Yes

TABLE 2.36 (Cont.)

Analyte	Concentration-Based SEVs Exceeded?			Dose-Based SEVs Exceeded?						Consider further as COPEC?
	Soil	Surface Water	Sediment	Eastern Cottontail	White-Footed Mouse	Red Fox	American Robin	Red-Tailed Hawk	Mallard	
Organics										
1,1-Biphenyl	ND	ND	O	E	E	E	E	E	?	Yes
2-Hexanone	?	ND	ND	?	?	?	?	?	E	Yes
4,4-DDD[b]	O	ND	ND	O	O	O	O	O	E	No
4,4-DDE	O	ND	ND	O	O	O	X	O	E	Yes
4,4-DDT	O	ND	ND	O	O	O	X	X	E	Yes
Acenaphthene	X	ND	ND	O	O	O	?	?	E	Yes
Acenaphthylene	X	ND	ND	?	?	?	?	?	E	Yes
Acetone	O	O	X	O	O	O	?	?	?	Yes
Acetophenone	O	ND	ND	?	?	?	?	?	E	Yes
α-BHC	O	ND	ND	?	?	?	?	?	E	Yes
Anthracene	X	ND	ND	O	O	O	?	?	E	Yes
Benzaldehyde	ND	ND	?	E	E	E	E	E	?	Yes
Benzene	O	ND	ND	O	O	O	?	?	E	Yes
Benzo(a)anthracene	X	ND	ND	?	?	?	?	?	E	Yes
Benzo(a)pyrene	X	ND	ND	O	O	O	?	?	E	Yes
Benzo(b)fluoranthene	X	ND	ND	?	?	?	?	?	E	Yes
Benzo(g,h,i)perylene	X	ND	ND	?	?	?	?	?	E	Yes
Benzo(k)fluoranthene	X	ND	ND	?	?	?	?	?	E	Yes
Benzyl butyl phthalate	ND	ND	X	E	E	E	E	E	?	Yes
bis(2-Ethylhexyl) phthalate	O	O	O	O	X	O	X	X	X	Yes
Carbon disulfide	O	ND	O	?	?	?	?	?	?	Yes
Chloromethane	O	O		?	?	?	?	?	?	Yes
Chrysene	X	ND	O	?	?	?	?	?	?	Yes

TABLE 2.36 (Cont.)

Analyte	Concentration-Based SEVs Exceeded?			Dose-Based SEVs Exceeded?						Consider further as COPEC?
	Soil	Surface Water	Sediment	Eastern Cottontail	White-Footed Mouse	Red Fox	American Robin	Red-Tailed Hawk	Mallard	
cis-1,2-Dichloroethene	O	ND	ND	O	O	O	?	?	E	Yes
Dibenz(a,h)anthracene	O	ND	ND	?	?	?	?	?	E	Yes
Dibenzofuran	?	ND	ND	?	?	?	?	?	E	Yes
Dieldrin	X	ND	ND	O	O	O	O	O	E	Yes
di-n-Butyl phthalate	O	ND	ND	O	O	O	X	O	E	Yes
Endrin aldehyde	O	ND	ND	O	O	O	O	O	E	No
Fluoranthene	X	ND	ND	O	O	O	X	X	E	Yes
Fluorene	O	ND	ND	O	O	O	?	?	E	Yes
γ-Chlordane	O	ND	ND	O	O	O	O	O	E	No
Indeno(1,2,3-cd)pyrene	O	ND	ND	?	?	?	?	?	E	Yes
Methylene chloride	O	ND	O	O	O	O	?	?	?	Yes
Naphthalene	O	ND	ND	O	O	O	?	?	E	Yes
Nitrobenzene	O	ND	O	O	O	O	?	?	?	Yes
PCB-1254	O	ND	ND	O	O	O	O	O	E	No
Phenanthrene	X	ND	ND	?	?	?	?	?	E	Yes
Phenol	O	ND	ND	O	O	O	?	?	E	Yes
Pyrene	O	ND	ND	O	O	O	O	O	E	No
Toluene	O	ND	O	O	O	O	?	?	?	Yes
Trichloroethene	O	ND	ND	O	O	O	?	?	E	Yes

[a] X = SEV was exceeded, ? = no SEV was available for comparison, O = SEV was not exceeded, ND = not detected, and E = no complete exposure pathway was present.

[b] Highlighted compounds indicate that the concentrations are considered safe for all assessment endpoints evaluated.

TABLE 2.37 Final List of Constituents Retained as COPECs, by Medium, for the White Phosphorus Burning Pits AOC[a]

	Retained as COPEC?		
Analyte	Soil	Surface Water	Sediment
Inorganics			
Aluminum	No	No	No
Antimony	Yes	No	No
Arsenic	Yes	Yes	No
Barium	No	Yes	No
Beryllium	No	No	No
Cadmium	Yes	No	No
Calcium	No	No	No
Chromium	Yes	No	No
Cobalt	No	No	No
Copper	Yes	No	No
Iron	No	No	No
Lead	Yes	Yes	No
Magnesium	No	No	No
Manganese	No	No	No
Mercury	No	No	No
Nickel	No	No	No
Potassium	No	No	No
Selenium	No	No	No
Silver	No	No	No
Sodium	No	No	No
Thallium	Yes	No	No
Vanadium	No	No	No
Zinc	Yes	No	Yes
Organics			
1,1-Biphenyl	No	No	No
2-Hexanone	Yes	No	No
4,4-DDD	No	No	No
4,4-DDE	No	No	No
4,4-DDT	No	No	No
Acenaphthene	No	No	No
Acenaphthylene	Yes	No	No
Acetone	No	No	Yes
Acetophenone	No	No	No
α-BHC	No	No	No
Anthracene	No	No	No
Benzaldehyde	No	No	Yes
Benzene	No	No	No

TABLE 2.37 (Cont.)

	Retained as COPEC?		
Analyte	Soil	Surface Water	Sediment
Benzo(a)anthracene	No	No	No
Benzo(a)pyrene	No	No	No
Benzo(b)fluoranthene	Yes	No	No
Benzo(g,h,i)perylene	Yes	No	No
Benzo(k)fluoranthene	Yes	No	No
Benzyl butyl phthalate	No	No	Yes
bis(2-Ethylhexyl) phthalate	Yes	No	No
Carbon disulfide	No	No	No
Chloromethane	No	No	No
Chrysene	No	No	No
cis-1,2-dichloroethene	No	No	No
Dibenz(a,h)anthracene	No	No	No
Dibenzofuran	No	No	No
Dieldrin	Yes	No	No
di-n-Butyl phthalate	No	No	No
Endrin aldehyde	No	No	No
Fluoranthene	Yes	No	No
Fluorene	No	No	No
γ-Chlordane	No	No	No
Indeno(1,2,3-c,d)pyrene	No	No	No
Methylene chloride	No	No	No
Naphthalene	No	No	No
Nitrobenzene	No	No	No
PCB-1254	No	No	No
Phenanthrene	Yes	No	No
Phenol	No	No	No
Pyrene	No	No	No
Toluene	No	No	No
Trichloroethene	No	No	No

[a] Highlighted cells indicate the retained constituents and the media in which constituents were retained as COPECs following refinement of the initial screening.

TABLE 3.1 Lead Concentrations (mg/kg) in 2004 Soil Samples[a]

Sample Location	Sample Depth (ft)[b]	Lead Concentration	Sample Location	Sample Depth (ft)	Lead Concentration
SO-1	0 - 1	56.6	NP-2	0 - 1	19.3
SO-2	0 - 1	29.2	NP-2	1 - 2	11.2
SO-3	0 - 1	13,400	NP-2	2 - 4	15.9
SO-4	0 - 1	57.8	NP-3	0 - 1	33.7
SO-5	0 - 1	136	NP-3	1 - 2	67
SO-6	0 - 1	64.2	NP-3	2 - 4	12.0
SO-7	0 - 1	47.9	NP-3	4 - 6	60.1
SO-8	0 - 1	85.5	NP-4	0 - 1	57.3
SO-9	0 - 1	306	NP-4	1 - 2	9.0
SO-10	0 - 1	16.7	NP-4	2 - 4	6.3
SO-11	0 - 1	784	NP-5-Wall	0 - 1	12.3
SO-12	0 - 1	1,800	NP-6-Wall	0 - 1	7,900
SO-13	0 - 1	336	NP-7-Wall	0 - 1	1,770
SO-14	0 - 1	371	NP-8-Wall	0 - 1	881
SO-15	0 - 1	116	NP-9-Wall	0 - 1	185
SO-16	0 - 1	84	SP-1	0 - 1	11.7
SO-17	0 - 1	142	SP-1	1 - 2	11.2
SO-18	0 - 1	29.5	SP-1	2 - 4	8.9
SO-19	0 - 1	14.4	SP-2	0 - 1	131
SO-20	0 - 1	31.2	SP-2	1 - 2	11.6
SO-21	0 - 1	18.8	SP-2	2 - 4	9.5
SO-22	0 - 1	16.6	SP-2	4 - 6	7.6
SO-23	0 - 1	14.4	SP-3	0 - 1	15.3
SO-24	0 - 1	9.4	SP-3	1 - 2	13.1
SO-25	0 - 1	14.6	SP-3	2 - 4	7.7
SO-26	0 - 1	8.6	SP-4-Wall	0 - 1	17.3
PO-1	0 -1	24.4	SP-5-Wall	0 - 1	44.1
PO-1	1 -2	9.5	SP-6-Wall	0 - 1	38.6
PO-1	2 - 4	7.0	SP-7-Wall	0 - 1	73.7
NP-1	0 - 1	31.6			
NP-1	1 - 2	8.5			
NP-1	2 - 4	16.3			

[a] Highlighted sample locations and values indicate lead levels at concentrations above screening value of 400 mg/kg.

[b] Metric equivalents for sample depths are: 0-1 ft = 0-0.3 m, 1-2 ft = 0.3-0.6 m, 2-4 ft = 0.6-1.2 m, and 4-6 ft = 1.2-1.8 m.

TABLE 4.1 Summary of Screening Analysis for Land Use Controls

Land Use Control Measure	Effectiveness	Implementability	Cost
Access Restriction	The J-Field site is fenced and entry is controlled by security guards. These measures are effective at mitigating public exposure to on-site contamination.	Access restriction, guards, and other measures are easy to implement; resources are readily available.	Low
Ownership and Use or Deed Restrictions	APG is owned by the federal government. The U.S. Army has custody of APG and is expected to maintain this custody and accountability into the future.	Ownership and use or deed restrictions are easy to implement; resources are readily available	Low
Monitoring	No groundwater monitoring program is currently in place at the WPP AOC. Any long-term monitoring (if necessary) will be added to the current J-Field long-term monitoring program.	Monitoring is easy to implement; resources are readily available.	Moderate

TABLE 4.2 Summary of Screening Analysis for In-Situ Containment Technologies

In-Situ Containment Technology	Effectiveness	Implementability	Cost
Surface Controls/ Diversions	Can effectively reduce contaminant mobility at the site. Such measures alone, however, may not be effective. Does not reduce contaminant toxicity or volume.	Can be implemented with conventional equipment and procedures; resources are readily available.	Low
Caps	Can effectively limit airborne emissions (e.g., dust), precipitation-enhanced percolation and leaching, and contaminant resuspension via surface water runoff. Does not reduce contaminant toxicity or volume. In addition, because portions of J-Field are designated as a floodplain, the potential for damage from flood waters exists.	Can be implemented with conventional equipment and procedures; resources are readily available. UXO survey of the affected area might be required.	Low to Moderate

TABLE 4.3 Summary of Screening Analysis for Removal with On-Site or Off-Site Disposal

Removal Measure	Effectiveness	Implementability	Cost
Excavation with On-Site or Off-Site Disposal	Can remove the source of contamination limiting contaminant mobility. Is not effective as a stand-alone technology to reduce toxicity or volume, but can facilitate treatment and/or disposal.	Can be implemented by using conventional equipment and procedures; resources are readily available. UXO surveys and CWA screening would be required. Soil could be treated on-site and reused or disposed at off-site facility. Subtitle D landfills are available in the region.	Moderate to High (if entire WPP AOC surveyed for UXO)

TABLE 4.4 Summary of Screening Analysis for Ex-Situ Treatment Technologies

In-Situ Treatment Technology	Effectiveness	Implementability	Cost
Stabilization/Fixation	Effective at limiting mobility of metals. Contaminant mobility would be reduced but contaminant toxicity would not. Final volume of waste would increase.	Can be implemented with readily available equipment and materials. May be required by disposal facility depending on hazard waste characterization.	Moderate
Vitrification	Effective at reducing mobility and toxicity of metals. Volume would be reduced.	Can be implemented with readily available equipment and materials.	High
Soil Washing	Effective at reducing toxicity, mobility, and volume of metals.	Can be implemented with readily available equipment and materials. Waste products would require additional treatment.	High
Reduction/Oxidation	Effective at reducing contaminant toxicity, mobility, and volume. Applicable to soils contaminated with metals.	Can be implemented with readily available equipment and materials.	High

TABLE 4.5 Summary of Potentially Applicable Technologies

General Response Action	Measure/Technology Type	Evaluation Result	Comments
No Action	Not applicable	Retained	Provides a baseline for comparison with action alternatives.
Institutional Control	Access restriction	Retained	Can effectively limit access at the site and can be used to support other response actions.
	Ownership and use or deed restrictions	Retained	Can minimize exposures at the site by limiting use of the contaminated area (e.g., requiring digging permits) and can be used to support other response actions.
	Monitoring	Not Applicable	Any additional groundwater monitoring for the WPP AOC (if necessary) will be added to the current J-Field long-term monitoring program.
	Engineering controls	Retained	Can preclude exposure to contaminated soil.
In-Situ Containment	Surface control/caps	Retained	Can limit contaminant mobility by directing surface water runoff from contaminated areas. Caps can limit airborne emissions, precipitation-enhanced percolation and leaching, and contaminant resuspension via surface water runoff.
Removal	Excavation with treatment and on-site disposal	Rejected	Can effectively reduce volume and mobility of contaminants. Can be implemented with some difficulty due to required UXO clearance prior to excavation. Not considered cost-effective compared with off-site disposal.
	Excavation with off-site disposal	Retained	Can effectively reduce volume and mobility of contaminants. Can be implemented with some difficulty due to required UXO clearance prior to excavation. A determination of hazard class for the contaminated soil would be required prior to disposal.
Ex-Situ Treatment	Stabilization/Fixation	Retained	Can reduce contaminant mobility. Waste volume would increase. Depending on the classification of the contaminated soil, stabilization/fixation could be required prior to off-site disposal.
	Vitrification	Rejected	Can reduce toxicity, mobility, and volume of contaminants in soil. High unit costs due to small soil volume to be treated.
	Soil Washing	Rejected	Can reduce toxicity, mobility, and volume of contaminants in soil. High unit costs due to small soil volume to be treated. Waste products would require additional treatment.
	Reduction/Oxidation	Rejected	Can reduce toxicity, mobility, and volume of contaminants in soil. High unit costs due to small soil volume to be treated.

TABLE 7.1 CERCLA Evaluation Criteria for Alternatives 1, 2, 3, and 5

CERCLA Evaluation Criteria	Alternative 1 No Action	Alternative 2 LUCs	Alternative 3 Capping and LUCs	Alternative 5 Excavation and LUCs
Protection of HH and Environment	☆	☆	☆	☆
ARAR Compliance	●	●	●	☆
Effectiveness and Permanence	☆	☆	☆	☆
Reduction of Toxicity, Mobility or Volume	●	●	●	☆
Short-term Effectiveness	☆	☆	☆	☆
Implementability	☆	☆	☆	☆
Cost	$47,000	$356,000	$1,069,000	$5,100,000

☆ Meets Criteriion ● Does not Meet Criterion

APPENDIX A:

LOCATION- AND ACTION-SPECIFIC ARARS AND TBC GUIDANCE

TABLE A.1 Location-Specific ARARs and TBC Guidance — White Phosphorus Burning Pits AOC, J-Field

Location	Law/Regulation	Description	ARAR/TBC Status
Floodplain	Federal – Resource Conservation and Recovery Act (RCRA): Resource Conservation and Recovery Act Location Standards 40 CFR 264.18(b)	Requires treatment, storage or disposal facilities (TSD) facilities to be designed, constructed, operated and maintained to avoid wash-out on a 100 year floodplain.	**ARAR** – Relevant and appropriate if soils are stored in any area within the 100-year floodplain. The WPP AOC is largely within the 100-year floodplain.
	Federal – Floodplain Management Executive Order 11988 40 CFR 6.302 (b)	Requires actions that occur in floodplains to avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial value.	**TBC** – Should be considered if soils are stored in any area within the 100-year floodplain. The WPP AOC is largely within the 100-year floodplain.
Wetlands	Federal – Wetlands Protection 40 CFR Part 6 Appendix A – Statement of Procedures on Floodplain Management and Wetlands Protection Executive Order 11990	Requires that a wetlands assessment be performed in an area undergoing construction or development. Proposed projects must be conducted in a manner that minimizes harm to the wetlands. Mitigation measures must be met. Restoration or preservation of the wetlands must be undertaken where appropriate.	**TBC** – Should be considered if remedial actions are planned within a wetland. Portions of the WPP AOC could be considered wetlands.
	State – Maryland Non-tidal Wetlands Regulations: COMAR 26.23.01-.04	Outlines authorized uses of and prohibited activities in wetlands.	**ARAR** – The substantive requirements are applicable, if remedial actions occurring at the WPP AOC require discharge of fill material into any wetlands.
	State – Maryland Environment Code, Title 16 – Wetlands and Riparian Rights	Regulates permitting* and reporting of filling and/or dredging operations in wetlands.	**ARAR** – The substantive requirements are applicable, if remedial actions occurring at the WPP AOC require discharge of fill material into any wetlands.
	State – Chesapeake Bay Commission: COMAR 27.01.09.01-.05	Regulates permitting* and reporting of filling and/or dredging operations in wetlands.	**ARAR** – The substantive requirements are applicable, if remedial actions occurring at the WPP AOC require discharge of fill material into any wetlands.

TABLE A.1 (Cont.)

Location	Law/Regulation	Description	ARAR/TBC Status
Endangered Species	Federal – Endangered Species Act 16 USC 1531 50 CFR 402 Migratory Bird Treaty Act: 16 USC 703 et seq. Bald and Golden Eagle Protection Act: 16 USC 668 et seq.	Requires action to conserve threatened or endangered species and their habitats.	**ARAR** – The substantive requirements are applicable. Bald eagles (i.e., threatened species) do not currently nest within WPP AOC; however, they are present on the Installation. There are no other known threatened or endangered species living within this site.
	State – Maryland Threatened and Endangered Species Regulations: COMAR 08.03.08.01 and 08.03.08.11.	Requires action to conserve threatened or endangered species and their habitats.	**TBC** – The substantive requirements are applicable. Bald eagles (i.e., threatened species) do not currently nest within WPP AOC; however, they are present on the Installation. There are no other known threatened or endangered species living within this site.
	Maryland Endangered Species Act of 1971, Maryland Non-game and Endangered Species Conservation Action of 1975	Requires action to conserve threatened or endangered species and their habitat.	**TBC** – Should be considered because bald eagles are present on the Installation, even though they are not currently nesting within the WPP AOC.
Coastal Zone	Federal – Coastal Zone Management Act of 1972	Designed to encourage State to develop management plans to protect and preserve the coastal zone, and ensure that Federal actions are consistent with these management plans.	**ARAR** – Relevant and appropriate, J-Field is located on the Chesapeake Bay. Activities are not anticipated to impact the coastal zone.
	State - Maryland Natural Resources Article, Title 8, Subtitle 18	Establishes land use policies for the Chesapeake Bay Critical Area, including limiting impervious areas, establishing buffers, and establishing controls to prevent runoff of pollutants.	**ARAR** – The substantive requirements are applicable if remedial actions occur at the WPP AOC.
Historic Structures and Archeological Resources	Federal – National Archeological and Historic Preservation Act: 16 USC 469 Federal - National Historic Landmarks Program: 36 CFR 65	Federal agencies must take action to recover and preserve artifacts within areas where action may cause irreparable harm, loss, or destruction of significant items.	**TBC** – Historic structures and archeological resources are not anticipated to be present at the WPP AOC.

* Federal and State permits are not necessary under CERCLA's permit exemption, provided that the remedy is performed on site and the substantive requirements of the permit are met.

ARAR - Applicable or Relevant and Appropriate Requirement
CFR - Code of Federal Regulations
COMAR - Code of Maryland Annotated Regulations
RCRA - Resource Conservation and Recovery Act
TBC - To-Be-Considered
USC - United States Code
USEPA - U.S. Environmental Protection Agency

TABLE A.2 Action-Specific ARARs and TBC Guidance — White Phosphorus Burning Pits AOC, J-Field

Action	Law/Regulation	Requirement of Law/Regulation	ARAR/TBC Status
Sampling and Analysis	COMAR 26.13.03.02	Specific requirements for identifying hazardous wastes. Establishes analytical requirements for testing and evaluating solid, hazardous, and water wastes.	**ARAR** – Applicable for identifying hazardous waste (if generated).
Discharges to Surface Water	40 CFR 122.26, 122.41, 122.44, 122.45, and 122.48	Requirements ensure that stormwater discharges from remedial action activities do not violate surface water quality standards. Also, establishes standards for permit* compliance, system operations and maintenance, and monitoring.	**ARAR** – The substantive requirements of the permit program are applicable for stormwater discharge during clearing, grubbing, excavation, and stream diversion activities.
	COMAR 26.17.02	Establishes state requirements for stormwater management.	**ARAR** – The substantive requirements are applicable to excavation work.
Munitions and UXO Identification	40 CFR 261.2(a)(2)(iv), and 266.200 – 266.206, Subpart M [reference 40 CFR 260-270]	Regulations which identify when military munitions become a solid waste and if hazardous.	**ARAR** – Applicable if UXO is discovered during excavation and/or clearing activities at the WPP AOC.
Munitions Response Program	DoD Policy to Implement the EPA MMR	DoD policy to implement the MMR outlines DoD procedures for the identification of and response to munitions residues.	**TBC** – Should be considered if UXO is discovered during excavation and/or clearing activities at the WPP AOC.
	TM-9-1375-213-12	Defines the minimum safe distance between emitters of electromagnetic radiation in the radio frequency range and UXO clearance/demolition activities.	**TBC** – If UXOs are discovered during excavation and/or clearing activities at the WPP AOC.
	TM-5-855-1	Defines protective measures to be taken to reduce blast shock and fragmentation damage.	**TBC** – If UXOs are discovered during excavation and/or clearing activities at the WPP AOC.
	DA PAM 50-6 DA PAM 385-61 DA PAM 40-137	Defines procedures for emergency decontamination of site workers.	**TBC** – If UXOs are discovered during excavation and/or clearing activities at the WPP AOC.
	DoD 6055.9-STD	Requires specialized personnel in detection, removal, and disposal of ordnance and explosives (OE); stipulates required safety precautions and procedures for detonation/disposal; establishes depth of remediation based on land use.	**TBC** – If UXOs are discovered during excavation and/or clearing activities at the WPP AOC.

TABLE A.2 (Cont.)

Action	Law/Regulation	Requirement of Law/Regulation	ARAR/TBC Status
	USAT CESP 385-02 AR 385-64 DA PAM 385-64	UXO safety guidelines for explosives and ammunition.	**ARAR** – Potentially applicable if UXOs are discovered during excavation and/or clearing activities at the WPP AOC. (Note: DA PM 385-64 is a TBC).
General Remediation	40 CFR 262 COMAR 26.13.03.02.01-.05 and A.07	Establishes standards for generators of hazardous waste.	**ARAR** – The substantive requirements are applicable, if hazardous waste is generated.
On-Site Storage and Treatment	RCRA Treatment, Storage, and Disposal of Hazardous Waste COMAR 26.13.05	Standards and requirements for facilities that treat, store, and dispose of hazardous waste. Requirements include: General Facility Standards Emergency Preparedness and Prevention Contingency Plan and Emergency Procedures Manifest System Use and Management of Containers Closure and Post Closure	**ARAR** – The substantive requirements are applicable, if excavated soils are generated and classified as hazardous waste, and then stored on site beyond the accumulation times specified in COMAR 26.13.05E.
	RCRA Treatment, Storage, and Disposal of Hazardous Waste 40 CFR 264 Subparts S and EE 40 CFR 265 COMAR 26.13.05.12	Provides requirements for handling waste at the following facility types: Temporary Units (TUs) Staging Piles Hazardous Waste Munitions and Explosive Storage	**ARAR** – The substantive requirements are applicable to the storage and treatment of soils contaminated with hazardous wastes (if generated).
	COMAR 26.13.05.09	Provides requirements for the management of hazardous waste in containers.	**ARAR** - The substantive requirements are applicable to the on-site storage of media in containers (if hazardous waste is generated).
Off-Site Disposal of Hazardous Waste	RCRA Land Disposal Restrictions: 40 CFR 268 Subparts A through E	Identifies hazardous wastes that are restricted from land disposal and defines those limited circumstances under which an otherwise restricted waste may continue to be land disposed.	**ARAR** - Applicable if soils/sediments are disposed off site in a landfill as hazardous waste.
Packaging, Labeling, and Storage	RCRA Hazardous Waste Generation 40 CFR 262 Subparts A through D COMAR26.13.03.01-.06	Specifies requirements for hazardous waste packaging, labeling, manifesting, record keeping, and accumulation time.	**ARAR** – The substantive requirements are applicable for the on-site accumulation of hazardous waste (if generated).

TABLE A.2 (Cont.)

Action	Law/Regulation	Requirement of Law/Regulation	ARAR/TBC Status
	USDOT Hazardous Materials Transportation Regulations 49 CFR 171-173 and 177-180.	Establishes classification, packaging, and labeling requirements for shipments of hazardous materials.	**ARAR** – Potentially applicable if soils and media containing munitions residues or decontamination water are disposed off site as hazardous waste.
Transportation	Transportation of Solid Waste Military Munitions – 40 CFR 266.203	Specifies standards applicable to the transportation of solid waste military munitions.	**ARAR** – Applicable for the off-site transportation of media containing munitions residues.
	RCRA Hazardous Waste Transportation 40 CFR 263, Subparts A, B, and C COMAR 26.13.03-05	Specifies requirements for hazardous waste manifest compliance, record keeping, and hazardous waste discharges during hazardous waste transport.	**ARAR** – Applicable if hazardous waste or media containing munitions residues are transported off site.
	40 CFR 262.20(f)	This section excludes from the requirement of Subpart B (The Manifest) transport of hazardous wastes on a public right-of-way within or along the border of contiguous property under control of the same person.	**ARAR** – Applicable if hazardous waste or media containing munitions residues are transported off site.
Air Emissions	40 CFR 50.7 COMAR 26.11.06.01 and .03	Requires reasonable precautions be implemented to prevent particulate matter from fugitive dust and emissions from becoming airborne. Prohibits the discharge of visible dust emissions beyond the lot line of the property.	**ARAR** - Applicable to clearing, grubbing, and excavation activities.
	40 CFR 50.12	Establishes national primary and secondary ambient air quality standards for lead and its compounds.	**ARAR** - Applicable to fugitive dust emissions during clearing, grubbing, and excavation activities.
	COMAR 26.11.04.01-.04	Air quality standards for ambient air.	**ARAR** - Applicable for on site disturbances which generate dust.
	Maryland Non-Point Source Pollution Control Laws (Section 4-101)	Specifies acceptable emission levels.	**TBC** - Should be considered for on site disturbances which generate dust.
Erosion and Sediment Control	COMAR 26.17.01	Specifies erosion and sediment control principles, methods, and practices to be employed at sites where disturbance exceeds 5,000 square feet of land area or 100 cubic yards of earth*.	**ARAR** – The substantive requirements are applicable for on-site excavation work and other soil disturbances.
	COMAR 26.17.01.05	Provides for the review of Erosion and Sediment Control Plans by the MDE for Federal projects	**ARAR** – Applicable for the submission of an Erosion and Sediment Control Plan, including revisions to the existing plan.

TABLE A.2 (Cont.)

Action	Law/Regulation	Requirement of Law/Regulation	ARAR/TBC Status
	COMAR 26.17.01.05	Requirement to prepare and Erosion and Sediment Control Plan.	**ARAR** – Applicable for on-site excavation work and other soil disturbances.
	COMAR 26.17.01.06	Training and certification requirements for individuals in charge of on-site sediment control/site disturbances.	**ARAR** – Applicable for on-site personnel assigned to supervise site soil disturbance and sediment control works.
RCRA Landfill Cap Regulations	40 CFR 264.310	Provides requirements for closure and post-closure care of hazardous landfills.	**ARAR** – Relevant and appropriate for soil containment alternatives if soil is determined to be a hazardous waste.
Consolidation of Wastes under a RCRA Cap	CAMU Rule (58 FR 8679)	Regulations regarding on-site consolidation of hazardous wastes and operational requirements for cap.	**ARAR** – Relevant and appropriate for soil containment alternatives if soil is determined to be a hazardous waste.
	CAMU Amendments (67 FR 2962 through 3029)	Amends the CAMU regulations for staging piles to allow for mixing, blending, or other similar physical operations that prepare wastes for subsequent management or treatment.	**ARAR** – Relevant and appropriate for soil containment alternatives if soil is determined to be a hazardous waste and mixing of wastes is performed as part of the action.

* Federal and State permits are not necessary under CERCLA's permit exemption, provided that the remedy is performed on site and the substantive requirements of the permit are met.

ARAR - Applicable or Relevant and Appropriate Requirement
CFR - Code of Federal Regulations
COMAR - Code of Maryland Annotated Regulations
DoD - U.S. Department of Defense
MDE - Maryland Department of the Environment
MMR - Military Munitions Rule
RCRA - Resource Conservation and Recovery Act
TBC - To-Be-Considered
USC - United States Code
USEPA - U.S. Environmental Protection Agency
UXO - Unexploded Ordnance

APPENDIX B:

COST ESTIMATES PREPARED USING THE RACER MODEL

APPENDIX B: COST ESTIMATES PREPARED USING THE RACER MODEL

Appendix B includes output from the RACER model (Earth Tech 2007) used to provide costing information for the five remedial alternatives detailed in Sections 5 and 6 of this FFS. The output includes two different reports: an Estimate Documentation Report and a Folder Cost Summary Report. TheEstimate Documentation Report shows the total phase costs and list the assumptions (model inputs) used to derive those costs.

The Folder Cost Summary Report provides detailed information about the first-year costs for each alternative from Alternative 5 to 1. Included in the first year cost detail are the land use control administrative costs and five-year review costs for the first year, but not for subsequent years. Therefore, the total alternative cost presented for each alternative in the Folder Cost Summary does not represent the total 30-year cost, but only the first-year cost.

ALTERNATIVE 1 ESTIMATE DOCUMENTATION REPORT

Estimate Documentation Report

System:

RACER Version: 9.0.0
Database Location: C:\Documents and Settings\martino.DIS\Application Data\Earth Tech\RACER 9.0\Racer.mdb

Folder:

Folder Name: Final WPP FS July 07

Project Documentation:

Project ID: WPP FS
Project Name: WPP Feasibility Study Alternative 1
Project Category: None

Location
State / Country: MARYLAND
City: ABERDEEN PROVING GROUND

Location Modifiers	Default	User
Material:	*1.04*	1.04
Labor:	*0.984*	0.984
Equipment:	*0.993*	0.993

Options
Database: System Costs
Cost Database Date: 2007
Report Option: Fiscal

Estimate Documentation Report

Alternative Documentation:

Alternative ID: Alternative 1
Alternative Name: Alternative 1 No Action, Five Year Reviews only
Alternative Type: None

Phase Names

SI: ☐
RI/FS: ☐
RD: ☐
IRA: ☐
RA(C): ☐
RA(O): ☐
LTM: ☑
Site Closeout: ☐

Documentation

Description: Alternative 1 involves No Action with 5 Year Reviews occurring for 30 years.

Support Team: Louis Martino and Williams Davies From Argonne
Lisa Myers From Myers Engineering
John Wrobel and Amy Burgess from DSHE APG.

References: Argonne National Laboratory, J-Field, White Phosphorus Burning Pits, Remedial Investigation Report, Volume I Contamination Assessment and Ecological Risk Report Final, December 2006.

Argonne National Laboratory White Phosphorus Pits Focused Feasibility Study Draft January 2007.

Argonne National Laboratory White Phosphorus Pits Focused Feasibility Study Draft Final March 2007.

EA (EA Engineering, Science and Technology, Inc.), 2006. J-Field White Phosphorus Pits, Remedial Investigation Report Volume II: Baseline Human Health Risk Assessment, Aberdeen Proving Ground, Maryland, March.

Estimator Information

Estimator Name: Louis Martino
Estimator Title: Environmental Systems Engineer
Agency/Org./Office: Argonne
Business Address: Suite 6000 955 L'Enfant Plaza
SW Washington DC 200244
Telephone Number: 202-488-2422
Email Address: martinol@anl.gov
Estimate Prepared Date: 01/05/2007

Estimator Signature: ____________________ **Date:** ____________

Estimate Documentation Report

Reviewer Information

Reviewer Name:
Reviewer Title:
Agency/Org./Office:
Business Address:
Telephone Number:
Email Address:
Date Reviewed:

Reviewer Signature: ______________________ **Date:** ____________

Estimated Costs:

Phase Names		Direct Cost	Marked-up Cost
LTM		$14,485	$47,030
	Total Cost:	$14,485	$47,030

Estimate Documentation Report

Phase Documentation:

Phase Type: Long Term Monitoring
Phase Name: LTM
Description: 5 year reviews associated with the "No Action" remedy.

Media/Waste Type
Primary: Soil
Secondary: Groundwater

Contaminant
Primary: Metals
Secondary: Volatile Organic Compounds (VOCs)

Start Date: January, 2008

Rate Groups
Labor: System Labor Rate
Analysis: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
Five-Year Review	Yes	100	0

Total Marked-up Cost: $47,030

Technologies:

Estimate Documentation Report

Technology Name: **Five-Year Review (# 1)**

Description	Default	Value	UOM
System Definition			
Required Parameters			
Site Complexity		Low	n/a
Document Review		Yes	n/a
Interviews		No	n/a
Site Inspection		Yes	n/a
Report		Yes	n/a
Travel		No	n/a
Rebound Study		No	n/a
Start Date		January-2013	n/a
No. Reviews		6	EA
Safety Level		D	n/a
Document Review			
Required Parameters			
5-Year Review Check List		Yes	n/a
Record of Decision		Yes	n/a
Remedial Action Design & Construction		No	n/a
Close-Out Report		No	n/a
Operations & Maintenance Manuals & Reports		No	n/a
Consent Decree or Settlement Records		No	n/a
Ground Water Monitoring & Reports		No	n/a
Remedial Action Required		No	n/a
Previous 5-Year Review Reports		Yes	n/a
Site Inspection			
Required Parameters			
General Site Inspection		Yes	n/a
Containment System Inspection		No	n/a
Monitoring Systems Inspection		No	n/a
Treatment Systems Inspection		No	n/a
Regulatory Compliance		No	n/a
Site Visit Documentation (Photos, Diagrams, etc.)		Yes	n/a
Report			
Required Parameters			

Estimate Documentation Report

Technology Name: **Five-Year Review (# 1)**

Description	*Default*	*Value*	*UOM*
Report			
Required Parameters			
Introduction		No	n/a
Remedial Objectives		No	n/a
ARARs Review		Yes	n/a
Summary of Site Visit		Yes	n/a
Areas of Non Compliance		No	n/a
Technology Recommendations		No	n/a
Statement of Protectiveness		Yes	n/a
Next Review		No	n/a
Implementation Requirements		No	n/a

Comments: For the 5-year review we defined the system to involve document review, site inspection and report writing. We assumed the site would have low complexity. Document review would consist of a review of 5 year review checklist, the Decision Document and previous 5 year review reports. Site inspections tasks would include a general site inspection and site visit documentation. The report included ARAR review, summary of site visit and a statement of protectiveness.

ALTERNATIVE 2 ESTIMATE DOCUMENTATION REPORT

Estimate Documentation Report

System:

RACER Version: 9.0.0
Database Location: C:\Documents and Settings\martino.DIS\Application Data\Earth Tech\RACER 9.0\Racer.mdb

Folder:

Folder Name: Final WPP FS July 07

Project Documentation:

Project ID: WPP FS
Project Name: WPP Feasibility Study Alternative 2
Project Category: None

Location
State / Country: MARYLAND
City: ABERDEEN PROVING GROUND

Location Modifiers	Default	User
Material:	*1.04*	1.04
Labor:	*0.984*	0.984
Equipment:	*0.993*	0.993

Options
Database: System Costs
Cost Database Date: 2007
Report Option: Fiscal

Description This project involves cost estimation for alternative 2 associated with a focused feasibility study for the White Phosphorus Burning Pits located at J-Field, APG. Alternative 2 involves the LUCs and the performance of 5 year reviews for 30 years.

Estimate Documentation Report

Alternative Documentation:

Alternative ID: Alternative 2
Alternative Name: Alternative 2 Land Use Controls
Alternative Type: None

Phase Names

SI: ☐
RI/FS: ☐
RD: ☑
IRA: ☐
RA(C): ☑
RA(O): ☐
LTM: ☑
Site Closeout: ☐

Documentation

Description: Alternative 2 involves LUCs and 5 Year Reviews occurring for 30 years.

Support Team: Louis Martino and Williams Davies from Argonne
Lisa Myers from Myers Engineering
Amy Burgess and John Wrobel from APG DSHE

References: Argonne National Laboratory J-Field, White Phosphorus Burning Pits, Remedial Investigation Report, Volume I Contamination Assessment and Ecological Risk Report Final, December 2006.

Argonne National Laboratory J-Field, White Phosphorus Pits Focused Feasibility Study Draft, January 2007

Argonne National Laboratory White Phosphorus Pits Focused Feasibility Study Draft Final March 2007.

EA (EA Engineering, Science and Technology, Inc.), 2006. J-Field White Phosphorus Pits, Remedial Investigation Report Volume II: Baseline Human Health Risk Assessment, Aberdeen Proving Ground, Maryland, March.

Estimator Information

Estimator Name: Louis Martino
Estimator Title: Environmental Systems Engineer
Agency/Org./Office: Argonne
Business Address: Suite 6000 955 L'Enfant Plaza
SW Washington DC 200244
Telephone Number: 202-488-2422
Email Address: martinol@anl.gov
Estimate Prepared Date: 01/05/2007

Estimator Signature: ______________________ **Date:** ____________

Estimate Documentation Report

Reviewer Information

Reviewer Name:
Reviewer Title:
Agency/Org./Office:
Business Address:
Telephone Number:
Email Address:
Date Reviewed:

Reviewer Signature: ______________________ **Date:** ____________

Estimated Costs:

Phase Names		Direct Cost	Marked-up Cost
LTM		$123,595	$355,861
	Total Cost:	$123,595	$355,861

Estimate Documentation Report

Phase Documentation:

Phase Type: Long Term Monitoring
Phase Name: LTM
Description: Alternative 2, LUCs, 5 Yr Reviews

Media/Waste Type
Primary: Soil
Secondary: Groundwater

Contaminant
Primary: Metals
Secondary: Volatile Organic Compounds (VOCs)

Start Date: January, 2008

Rate Groups
Labor: System Labor Rate
Analysis: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
ADMINISTRATIVE LAND USE CONTROLS	Yes	100	0
Five-Year Review	Yes	100	0

Total Marked-up Cost: $355,861

Technologies:

Estimate Documentation Report

Technology Name: **Administrative Land Use Controls (# 1)**
User Name: **ADMINISTRATIVE LAND USE CONTROLS**

Description	Default	Value	UOM
System Definition			
Required Parameters			
Rename Model		ADMINISTRATIVE LAND USE CONTROLS	n/a
Planning Documents		Yes	n/a
Planning Documents: Start Date		2008	n/a
Implementation		Yes	n/a
Implementation: Start Date		2008	n/a
Monitoring & Enforcement		Yes	n/a
Monitoring & Enforcement: Start Date		2008	n/a
Modification/Termination		No	n/a
Type of Site		Active Government Installation	n/a
Planning Documents			
Required Parameters			
LUC Assurance Plan (LUCAP)		No	n/a
LUC Implementation Plan (LUCIP)		Yes	n/a
LUC Implementation Plan (LUCIP): Number		1	EA
LUC Implementation Plan (LUCIP): Plan Complexity		Low	n/a
Long-term Stewardship (LTS) Plan		No	n/a
Memorandum of Agreements (MOA)		No	n/a
Installation (or City) Master Plan		Yes	n/a
Installation (or City) Master Plan: Plan Complexity		Low	n/a
Construction Permitting		No	n/a
Geographic Information Systems (GIS)/Overlay Maps		Yes	n/a
Geographic Information Systems (GIS)/Overlay Maps: Number		1	EA
Geographic Information Systems (GIS)/Overlay Maps: Plan Complexity		Low	n/a
Planning Meetings			
Required Parameters			
LUCIP: Number of Meetings		1	EA
LUCIP: Number of People		1	EA
LUCIP: Number of Days		1	EA
LUCIP: Airfare Cost		0	$

Estimate Documentation Report

Technology Name: **Administrative Land Use Controls (# 1)**
User Name: **ADMINISTRATIVE LAND USE CONTROLS**

Description	Default	Value	UOM
Planning Meetings			
Required Parameters			
LUCIP: Mileage to Meeting Site		0	MI
Master Plan: Number of Meetings		1	EA
Master Plan: Number of People		1	EA
Master Plan: Number of Days		1	EA
Master Plan: Airfare Cost		0	$
Master Plan: Mileage to Meeting Site		0	MI
GIS/Overlay Maps: Number of Meetings		1	EA
GIS/Overlay Maps: Number of People		1	EA
GIS/Overlay Maps: Number of Days		1	EA
GIS/Overlay Maps: Airfare Cost		0	$
GIS/Overlay Maps: Mileage to Meeting Site		0	MI
Implementation			
Required Parameters			
Modify Installation (or City) Master Plan		Yes	n/a
Modify Installation (or City) Master Plan: Task Complexity		Low	n/a
Deed Notification		No	n/a
Negotiating Easements		No	n/a
Restrictive Covenants		No	n/a
Equitable Servitudes		No	n/a
Access Control Signs		Yes	n/a
Access Control Signs: Number		4	EA
Access Control Signs: Task Complexity		Medium	n/a
Utility Notification Service		No	n/a
Geographic Information Systems (GIS)/Overlay Maps		Yes	n/a
Geographic Information Systems (GIS)/Overlay Maps: Number		1	EA
Geographic Information Systems (GIS)/Overlay Maps: Task Complexity		Low	n/a
Develop Finding of Suitablility to Transfer (FOST)		No	n/a
Monitoring & Enforcement			
Required Parameters			
Duration of Monitoring/Enforcement		30	Years

Estimate Documentation Report

Technology Name: **Administrative Land Use Controls (# 1)**
User Name: **ADMINISTRATIVE LAND USE CONTROLS**

Description	*Default*	*Value*	*UOM*
Monitoring & Enforcement			
Required Parameters			
Notice Letters		Yes	n/a
Notice Letters: Number		10	EA
Notice Letters: Frequency		Annually	n/a
Guard Service/Security		No	n/a
Reports & Certifications		No	n/a
Site Visits/Inspections		No	n/a

Comments: We designated the site as an active government installation. Default system definition options were used; only "Modification Termination" was not activated. Using the default system, costs would result from creating planning documents, participating in planning meetings, implementing agreed-upon plans and minimal monitoring and enforcement. For the planning document tab, we assumed that a LUC Implementation Plan (LUCIP), Installation Master Plan (IMP) and Geographic Information System (GIS) Overlay Maps would create costs to the project. These plans would have low complexity. Planning document related costs would result from limited to minimal adjustments to the LUCIP, IMP and the existing GIS. We assume that 1 planning meeting would be required to obtain EPA and MDE input for the needed modifications to the IMP and GIS and to assist in the development of the LUCIP. We assumed implementation efforts would be limited to efforts to modify the IMP and the GIS (efforts with a low level of complexity) and erection of signage. We assumed that Monitoring and Enforcement would be limited to the periodic notification of APG organizations via notice letters.

Estimate Documentation Report

Technology Name: **Five-Year Review (# 1)**

Description	*Default*	*Value*	*UOM*
System Definition			
Required Parameters			
Site Complexity		Low	n/a
Document Review		Yes	n/a
Interviews		No	n/a
Site Inspection		Yes	n/a
Report		Yes	n/a
Travel		No	n/a
Rebound Study		No	n/a
Start Date		January-2013	n/a
No. Reviews		6	EA
Safety Level		D	n/a
Document Review			
Required Parameters			
5-Year Review Check List		Yes	n/a
Record of Decision		Yes	n/a
Remedial Action Design & Construction		No	n/a
Close-Out Report		No	n/a
Operations & Maintenance Manuals & Reports		No	n/a
Consent Decree or Settlement Records		No	n/a
Ground Water Monitoring & Reports		No	n/a
Remedial Action Required		No	n/a
Previous 5-Year Review Reports		Yes	n/a
Site Inspection			
Required Parameters			
General Site Inspection		Yes	n/a
Containment System Inspection		No	n/a
Monitoring Systems Inspection		No	n/a
Treatment Systems Inspection		No	n/a
Regulatory Compliance		No	n/a
Site Visit Documentation (Photos, Diagrams, etc.)		Yes	n/a
Report			
Required Parameters			

Estimate Documentation Report

Technology Name: **Five-Year Review (# 1)**

Description	*Default*	*Value*	*UOM*
Report			
Required Parameters			
Introduction		No	n/a
Remedial Objectives		No	n/a
ARARs Review		Yes	n/a
Summary of Site Visit		Yes	n/a
Areas of Non Compliance		No	n/a
Technology Recommendations		No	n/a
Statement of Protectiveness		Yes	n/a
Next Review		No	n/a
Implementation Requirements		No	n/a

Comments: For the 5-year review we defined the system to involve document review, site inspection and report writing. We assumed the site would have low complexity. Document review would consist of a review of 5 year review checklist, the Decision Document and previous 5 year review reports. Site inspections tasks would include a general site inspection and site visit documentation. The report included ARAR review, summary of site visit and a statement of protectiveness.

ALTERNATIVE 3 ESTIMATE DOCUMENTATION REPORT

Estimate Documentation Report

System:

RACER Version: 9.0.0
Database Location: C:\Documents and Settings\martino.DIS\Application Data\Earth Tech\RACER 9.0\Racer.mdb

Folder:

Folder Name: Final WPP FS July 07

Project Documentation:

Project ID: WPP FS
Project Name: WPP Feasibility Study Alternative 3
Project Category: None

Location
State / Country: MARYLAND
City: ABERDEEN PROVING GROUND

Location Modifiers	Default	User
Material:	*1.04*	1.04
Labor:	*0.984*	0.984
Equipment:	*0.993*	0.993

Options
Database: System Costs
Cost Database Date: 2007
Report Option: Fiscal

Description

This project involves cost estimation for alternative 3 associated with a focused feasibility study for the White Phosphorus Burning Pits located at J-Field, APG. This alternative involves the installation of a soil blanket as a cap, the implementation of LUCs and the performance of 5 year reviews for 30 years.

Estimate Documentation Report

Alternative Documentation:

Alternative ID: Alternative 3
Alternative Name: Alternative 3 Capping with a Soil Blanket
Alternative Type: None

Phase Names

- **SI:** ☐
- **RI/FS:** ☐
- **RD:** ☑
- **IRA:** ☐
- **RA(C):** ☑
- **RA(O):** ☑
- **LTM:** ☑
- **Site Closeout:** ☐

Documentation

Description: Alternative 3 involves filling the burn pits to grade and capping with a soil blanket. Alternative 3 also involves LUCs and 5 Year Reviews occurring for 30 years.

Support Team: Louis Martino and Williams Davies from Argonne
Lisa Myers from Meyers Engineering
John Wrobel and Amy Burgess from APG DSHE

References: Argonne National Laboratory, 2006. J-Field, White Phosphorus Burning Pits, Remedial Investigation Report, Volume I Contamination Assessment and Ecological Risk Report Final, December.

Argonne National Laboratory 2007 White Phosphorus Pits Focused Feasibility Study Draft, January

Argonne National Laboratory White Phosphorus Pits Focused Feasibility Study Draft Final March 2007.

EA (EA Engineering, Science and Technology, Inc.), 2006. J-Field White Phosphorus Pits, Remedial Investigation Report Volume II: Baseline Human Health Risk Assessment, Aberdeen Proving Ground, Maryland, March.

Estimator Information

Estimator Name: Louis Martino
Estimator Title: Environmental Systems Engineer
Agency/Org./Office: Argonne
Business Address: Suite 6000 955 L'Enfant Plaza
SW Washington DC 200244
Telephone Number: 202-488-2422
Email Address: martinol@anl.gov
Estimate Prepared Date: 01/05/2007

Estimator Signature: ______________________ **Date:** ____________

Estimate Documentation Report

Reviewer Information

Reviewer Name:
Reviewer Title:
Agency/Org./Office:
Business Address:
Telephone Number:
Email Address:
Date Reviewed:

Reviewer Signature: ______________________ **Date:** ____________

Estimated Costs:

Phase Names		Direct Cost	Marked-up Cost
RD		$0	$14,225
Capping		$340,826	$538,639
RA(O)		$92,558	$160,624
LTM		$123,595	$355,861
	Total Cost:	$556,978	$1,069,350

Estimate Documentation Report

Phase Documentation:

Phase Type: Design Percent Method
Phase Name: RD
Description: Cap design

Total Capital Costs are the marked up costs for the Phase, excluding the Professional Labor Management, Administrative Land Use Controls, and Operations and Maintenance technologies. Only the first year costs are included for cost-over-time technologies.

Phase Name	Phase Date	Design Approach	Total Capital Cost	Design %	Design Costs	Design Cost Year
Capping	January, 2008	Ex Situ Removal - Performance-Based On-site Treatment or Disposal	$284,499	5.00	$14,225	2008

Total Design Cost: $14,225

Estimate Documentation Report

Phase Documentation:

Phase Type: Remedial Action
Phase Name: Capping
Description: MEC removal in specific areas followed by filling to grade and capping.

Media/Waste Type
Primary: Soil
Secondary: Groundwater

Contaminant
Primary: Metals
Secondary: Volatile Organic Compounds (VOCs)

Approach: Ex Situ
Start Date: January, 2008

Rate Groups
Labor: System Labor Rate
Analysis: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
Capping	Yes	100	0
Load and Haul	Yes	100	0
MEC Removal Action	Yes	100	0
Professional Labor Management	Yes	100	0

Total Marked-up Cost: $538,639

Technologies:

Estimate Documentation Report

Technology Name: **Capping (# 1)**

Description	*Default*	*Value*	*UOM*
System Definition			
Required Parameters			
Type of Cap		Standard Cover	n/a
Scope Area		0.234192	AC
Scope Length		102	FT
Scope Width		100	FT
Passive Gas Vent System		No	n/a
Safety Level		D	n/a
General			
Secondary Parameters			
Side Slope of Cap	3	3	n/a
Horizontal Length of Side Slope	25	25	FT
Horizontal Length of Top Slope	25	25	FT
Standard Cover			
Secondary Parameters			
Source of Topsoil		Off-site	n/a
Depth of (Soil Layer or Hydraulic Asphalt Concrete)		24	IN
Soil Cover: Source of Fill		Off-site	n/a
Flexible Membrane Liner		No	n/a
Compacted Clay Layer		No	n/a
Depth of Compacted Clay Layer		0	IN
Source of Clay		On-site	n/a
Depth of Leveling Layer		6	IN
Leveling Layer: Source of Fill		Off-site	n/a

Comments: The cover would involve two separate areas: the Northern Burn Pit and the Pushout Area west of the Southern Burn Pit. There would be two separate covers because these two areas are separated by approximately 100 feet. We have used the costs associated with a geotextile/compacted clay construction. Assumedly geotextile layer would likely be used to both separate the contaminated soil from the cleanfill and/or to create an barrier to burrowing animals.

Estimate Documentation Report

Technology Name: **Load and Haul (# 1)**

Description	*Default*	*Value*	*UOM*
System Definition			
Required Parameters			
Truck Type		Highway	n/a
Volume		1,915	CY
One-way Haul Distance		30	MI
Dump Charge		0	$/CY
Safety Level		D	n/a

Comments: Load and Haul technology used to account for costs associated with bringing clean fill to the site in order to level the Northern and Southern Burn Pits (not to haul soil to an off-site disposal site).
North Pit 4,044 square feet-5 feet of clean fill = 20, 224 cubic feet
Northern Pit drainage feature 500 square feet-5 feet of clean fill = 2,500 cubic feet
South Pit 5,796.1 square feet-5 feet of clean fill = 28,983.5 cubic feet
About 1,915 cubic yards of clean fill would be required to bring the burn pits and the drainage feature up to grade.

Estimate Documentation Report

Technology Name: **MEC Removal Action (# 1)**

Description	Default	Value	UOM
System Definition			
Required Parameters			
Site Visit		Yes	n/a
Surveying		No	n/a
Vegetation Removal		Yes	n/a
UXO Mapping		Yes	n/a
UXO Removal		Yes	n/a
Site Management		Yes	n/a
Reporting and Stakeholder Involvement		Yes	n/a
Multiple Areas of Concern		No	n/a
Safety Level		E	n/a
Removal Area			
Required Parameters			
Removal Area		1	Acres
Search Depth		4	FT
Topography		Flat with gorges or gullies	n/a
Vegetation		Heavy grass with numerous shrubs	n/a
Air to Air		No	n/a
Air to Ground		No	n/a
Artillery		Yes	n/a
Bombing		No	n/a
Burial Pits		No	n/a
Guided Missiles		No	n/a
Hand Grenade		No	n/a
OB/OD		Yes	n/a
Other		No	n/a
Mortar		No	n/a
Multiple / Combined Use		No	n/a
Rifle Grenade, Anti-Tank Rocket		No	n/a
Small Arms		No	n/a
Bombs, High Explosive		Yes	n/a
Bombs (WP, Incendiary, Photoflash)		Yes	n/a

Estimate Documentation Report

Technology Name: **MEC Removal Action (# 1)**

Description	Default	Value	UOM
Removal Area			
Required Parameters			
Bombs, Practice		Yes	n/a
Hand Grenades, Live		Yes	n/a
Hand Grenades, Practice		Yes	n/a
Ground Rockets, Rifle Grenades, Live		Yes	n/a
Ground Rockets, Rifle Grenades, Practice		Yes	n/a
Medium Caliber (20mm, 25mm, 30mm)		Yes	n/a
Large caliber (37 mm and larger)		Yes	n/a
Mortars		Yes	n/a
Aerial Rockets (Live)		Yes	n/a
Aerial Rockets, Practice		Yes	n/a
Guided Missiles		Yes	n/a
Pyrotechnics		Yes	n/a
Small Arms		Yes	n/a
Other		Yes	n/a
Land Mines		Yes	n/a
Demolition Materials		Yes	n/a
Anomaly Density	300	500	n/a
Percent Scrap	90	90	%
Total Anomalies	500	500	n/a
Vegetation Removal			
Secondary Parameters			
Heavy Removal		0	Acres
Moderate Removal	0.25	0.25	Acres
Light Removal	0.5	0.5	Acres
No Removal	0.25	0.25	Acres
Total Area	1	n/a	Acres
UXO Mapping			
Secondary Parameters			
Geophysics: Area	1	1	Acres
Geophysics: Towed Array		65	%
Geophysics: Navigational Tool		Satellite	n/a

Estimate Documentation Report

Technology Name: **MEC Removal Action (# 1)**

Description	Default	Value	UOM
UXO Mapping			
Secondary Parameters			
Geophysics: Number of Teams		1	EA
Geophysics: Duration		1	Days
Mag & Flag: Area		0	Acres
Mag & Flag: Number of Teams		0	EA
Mag & Flag: Duration		0	Days
Mag & Flag: Ordnance Locator		Schonstedt Model GA-72CV, hand held	n/a
Surface Clearance: Area	1	1	Acres
Surface Clearance: Number of Teams		1	EA
Surface Clearance: Duration		1	Days
UXO Removal			
Secondary Parameters			
Ordnance Destruction: Electrical	30	0	%
Ordnance Destruction: Non-electrical		0	%
Ordnance Destruction: In-grid Consolidation	70	100	%
Ordnance Destruction: Total	100	100	%
Operation Duration	7	7	Days
Number of Teams	1	1	EA
Number of Backhoes	1	1	EA
Explosives Type		TNT	n/a
Explosives	50	50	LB
Detonation Cord (1000 FT Roll)	15	15	EA
Initiator	50	50	n/a
Site Management			
Secondary Parameters			
Senior UXO Supervisor	12	12	Days
Project Manager	12	12	Days
UXO Supervisor		0	Days
Quality Control Supervisor	12	12	Days
Safety Supervisor	12	12	Days
Reporting and Stakeholder Involvement			
Secondary Parameters			

Estimate Documentation Report

Technology Name: **MEC Removal Action (# 1)**

Description	*Default*	*Value*	*UOM*
Reporting and Stakeholder Involvement			
Secondary Parameters			
Level of Detail Required in Reporting		Moderate	n/a
Level of Stakeholder Involvement		Moderate	n/a
Number of Community Meetings		2	EA
Work Plan Report		Yes	n/a
Explosive Safety Submission Report		Yes	n/a

Comments: Under the System Definition Tab we assumed that UXO would not be surveyed in with a surveying instrument.

Under the Site Management Tab we assumed that a Project Manager only would be required to manage the UXO team.

Under the Reporting and Stakeholder Involvement Tab and Vegetation Removal Tab we assumed moderate involvement and complexity and moderate to light removal respectively.

Under the Removal Area Tab we used the smallest removal area provided (1 acre) and we assumed the following:
UXO removal would occur to a depth of 4 feet. The WPP is an OB/OD area and is located on an Artillery Range. All types of ordnance could be present. The maximum number of anomalies (500) was assumed and 100% of the anomalies would be scrap. We assume that the activity will not involve the identification and removal of metallic items from the burn pits or the sidewalls and pushout area of the WPP because said areas will be covered with soil and the cap. Rather, the MEC Removal Action is meant to address staging areas for equipment and ordnance clearance as needed to key the toe of the cap into native soil.

For the UXO Mapping Tab we assume the following:
No geophysics will be performed. A 1 acre area (the smallest area allowed by the model) would be surveyed via "mag and flag" methods, requiring 1 day of work. Surface clearance would then occur requiring 15 days.

Under the UXO removal Tab we assumed that 100% of the UXO discovered would be consolidated (referred to as "grid consolidation") in order to represent a likely scenario involving grid consolidation by civilizn EOD teams followed by ordnance destruction by US Army EOD teams.

Estimate Documentation Report

Technology Name: **Professional Labor Management (# 1)**

Description	*Default*	*Value*	*UOM*
System Definition			
Required Parameters			
Method		Percentage Method	n/a
RA Complexity		Moderate	n/a
Percentage Defaults			
Secondary Parameters			
Project Management Percent		7.5	%
Project Management Weighted Dollar Amount		19,248	$
Planning Documents Percent		7	%
Planning Documents Weighted Dollar Amount		17,965	$
Construction Oversight Percent		6	%
Construction Oversight Weighted Dollar Amount		15,399	$
Reporting Percent		1	%
Reporting Weighted Dollar Amount		2,566	$
As-Built Drawings Percent		1	%
As-Built Drawings Weighted Dollar Amount		2,566	$
Public Notice Percent		0.3	%
Public Notice Weighted Dollar Amount		769.9382	$
Permitting Percent		10	%
Permitting Weighted Dollar Amount		25,665	$

Comments:

Estimate Documentation Report

Phase Documentation:

Phase Type: Operations & Maintenance
Phase Name: RA(O)
Description: Cap maintenance

Media/Waste Type
Primary: Soil
Secondary: Groundwater

Contaminant
Primary: Metals
Secondary: Volatile Organic Compounds (VOCs)

Start Date: January, 2008

Rate Groups
Labor: System Labor Rate
Analysis: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
Operations and Maintenance	Yes	100	0

Total Marked-up Cost: $160,624

Technologies:

Estimate Documentation Report

Technology Name: **Operations and Maintenance**

Description	Default	Value	UOM
Start Date/Duration			
Required Parameters			
Startup		No	n/a
O&M Start Date		January-2008	n/a
Duration Units		Years, Months	n/a
Duration		30	Years
Duration		0	Months
Technology Starting Points			
Required Parameters			
Treatment Train Duration:		360	Months

Technology Name *	Start Point	End Point
Capping	0	360

* O&M parameters for the technologies listed are provided in the end of the O&M phase.

Description	Default	Value	UOM
Labor and Safety			
Required Parameters			
Operations Labor		Moderately Low	n/a
Maintenance Labor		Low	n/a
Professional Labor (Third Party)		Exclude from Estimate	n/a
Health and Safety Level		D	n/a
Analytical			
Required Parameters			
Sampling Frequency		Quarterly	n/a
Water Analytical Template		None	n/a
Air Analytical Template		None	n/a
Soil Analytical Template		None	n/a
Contractor Travel			
Secondary Parameters			
Operators		No	n/a
Professional		No	n/a
Heating Requirements			
Secondary Parameters			
Process Stream		No	n/a
Air		No	n/a

Estimate Documentation Report

Technology Name: **Operations and Maintenance**

Description	*Default*	*Value*	*UOM*
Heating Requirements			
Secondary Parameters			
Water		No	n/a
Facility		No	n/a
Runtime Percentages			
Secondary Parameters			
Total Treatment Train O&M Duration:		360	Months

12-month Period	Run-time Pcnt.
1	97
2	97
3	97
4	97
5	97
6	97
7	97
8	97
9	97
10	97
11	97
12	97
13	97
14	97
15	97
16	97
17	97
18	97
19	97
20	97
21	97
22	97
23	97
24	97
25	97
26	97
27	97
28	97
29	97
30	97

Comments:

Estimate Documentation Report

Technology Name: **Capping (# 1) - (O&M Parameters)**

Description	*Default*	*Value*	*UOM*
System Definition			
Required Parameters			
Type of Cap		Geosynthetic/Composite Cover	n/a
Scope Area		0.234192	AC

Comments: The cover would involve two separate areas: the Northern Burn Pit and the Pushout Area west of the Southern Burn Pit. There would be two separate covers because these two areas are separated by approximately 100 feet. We have used the costs associated with a geotextile/compacted clay construction. Assumedly geotextile layer would likely be used to both separate the contaminated soil from the cleanfill and/or to create an barrier to burrowing animals.

Estimate Documentation Report

Phase Documentation:

Phase Type: Long Term Monitoring
Phase Name: LTM
Description: 5 year reviews and LUCs associated with the remedy.

Media/Waste Type
Primary: Soil
Secondary: Groundwater

Contaminant
Primary: Metals
Secondary: Volatile Organic Compounds (VOCs)

Start Date: January, 2008

Rate Groups
Labor: System Labor Rate
Analysis: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
ADMINISTRATIVE LAND USE CONTROLS	Yes	100	0
Five-Year Review	Yes	100	0

Total Marked-up Cost: $355,861

Technologies:

Estimate Documentation Report

Technology Name: **Administrative Land Use Controls (# 1)**
User Name: **ADMINISTRATIVE LAND USE CONTROLS**

Description	Default	Value	UOM
System Definition			
Required Parameters			
Rename Model		ADMINISTRATIVE LAND USE CONTROLS	n/a
Planning Documents		Yes	n/a
Planning Documents: Start Date		2008	n/a
Implementation		Yes	n/a
Implementation: Start Date		2008	n/a
Monitoring & Enforcement		Yes	n/a
Monitoring & Enforcement: Start Date		2008	n/a
Modification/Termination		No	n/a
Type of Site		Active Government Installation	n/a
Planning Documents			
Required Parameters			
LUC Assurance Plan (LUCAP)		No	n/a
LUC Implementation Plan (LUCIP)		Yes	n/a
LUC Implementation Plan (LUCIP): Number		1	EA
LUC Implementation Plan (LUCIP): Plan Complexity		Low	n/a
Long-term Stewardship (LTS) Plan		No	n/a
Memorandum of Agreements (MOA)		No	n/a
Installation (or City) Master Plan		Yes	n/a
Installation (or City) Master Plan: Plan Complexity		Low	n/a
Construction Permitting		No	n/a
Geographic Information Systems (GIS)/Overlay Maps		Yes	n/a
Geographic Information Systems (GIS)/Overlay Maps: Number		1	EA
Geographic Information Systems (GIS)/Overlay Maps: Plan Complexity		Low	n/a
Planning Meetings			
Required Parameters			
LUCIP: Number of Meetings		1	EA
LUCIP: Number of People		1	EA
LUCIP: Number of Days		1	EA
LUCIP: Airfare Cost		0	$

Estimate Documentation Report

Technology Name: **Administrative Land Use Controls (# 1)**
User Name: **ADMINISTRATIVE LAND USE CONTROLS**

Description	*Default*	*Value*	*UOM*
Planning Meetings			
Required Parameters			
LUCIP: Mileage to Meeting Site		0	MI
Master Plan: Number of Meetings		1	EA
Master Plan: Number of People		1	EA
Master Plan: Number of Days		1	EA
Master Plan: Airfare Cost		0	$
Master Plan: Mileage to Meeting Site		0	MI
GIS/Overlay Maps: Number of Meetings		1	EA
GIS/Overlay Maps: Number of People		1	EA
GIS/Overlay Maps: Number of Days		1	EA
GIS/Overlay Maps: Airfare Cost		0	$
GIS/Overlay Maps: Mileage to Meeting Site		0	MI
Implementation			
Required Parameters			
Modify Installation (or City) Master Plan		Yes	n/a
Modify Installation (or City) Master Plan: Task Complexity		Low	n/a
Deed Notification		No	n/a
Negotiating Easements		No	n/a
Restrictive Covenants		No	n/a
Equitable Servitudes		No	n/a
Access Control Signs		Yes	n/a
Access Control Signs: Number		4	EA
Access Control Signs: Task Complexity		Medium	n/a
Utility Notification Service		No	n/a
Geographic Information Systems (GIS)/Overlay Maps		Yes	n/a
Geographic Information Systems (GIS)/Overlay Maps: Number		1	EA
Geographic Information Systems (GIS)/Overlay Maps: Task Complexity		Low	n/a
Develop Finding of Suitablility to Transfer (FOST)		No	n/a
Monitoring & Enforcement			
Required Parameters			
Duration of Monitoring/Enforcement		30	Years

Estimate Documentation Report

Technology Name: **Administrative Land Use Controls (# 1)**
User Name: **ADMINISTRATIVE LAND USE CONTROLS**

Description	*Default*	*Value*	*UOM*
Monitoring & Enforcement			
Required Parameters			
Notice Letters		Yes	n/a
Notice Letters: Number		10	EA
Notice Letters: Frequency		Annually	n/a
Guard Service/Security		No	n/a
Reports & Certifications		No	n/a
Site Visits/Inspections		No	n/a

Comments: We designated the site as an active government installation. Default system definition options were used; only "Modification Termination" was not activated. Using the default system, costs would result from creating planning documents, participating in planning meetings, implementing agreed-upon plans and minimal monitoring and enforcement. For the planning document tab, we assumed that a LUC Implementation Plan (LUCIP), Installation Master Plan (IMP) and Geographic Information System (GIS) Overlay Maps would create costs to the project. These plans would have low complexity. Planning document related costs would result from limited to minimal adjustments to the LUCIP, IMP and the existing GIS. We assume that 1 planning meeting would be required to obtain EPA and MDE input for the needed modifications to the IMP and GIS and to assist in the development of the LUCIP. We assumed implementation efforts would be limited to efforts to modify the IMP and the GIS (efforts with a low level of complexity) and erection of signage. We assumed that Monitoring and Enforcement would be limited to the periodic notification of APG organizations via notice letters.

Estimate Documentation Report

Technology Name: **Five-Year Review (# 1)**

Description	Default	Value	UOM
System Definition			
Required Parameters			
Site Complexity		Low	n/a
Document Review		Yes	n/a
Interviews		No	n/a
Site Inspection		Yes	n/a
Report		Yes	n/a
Travel		No	n/a
Rebound Study		No	n/a
Start Date		January-2013	n/a
No. Reviews		6	EA
Safety Level		D	n/a
Document Review			
Required Parameters			
5-Year Review Check List		Yes	n/a
Record of Decision		Yes	n/a
Remedial Action Design & Construction		No	n/a
Close-Out Report		No	n/a
Operations & Maintenance Manuals & Reports		No	n/a
Consent Decree or Settlement Records		No	n/a
Ground Water Monitoring & Reports		No	n/a
Remedial Action Required		No	n/a
Previous 5-Year Review Reports		Yes	n/a
Site Inspection			
Required Parameters			
General Site Inspection		Yes	n/a
Containment System Inspection		No	n/a
Monitoring Systems Inspection		No	n/a
Treatment Systems Inspection		No	n/a
Regulatory Compliance		No	n/a
Site Visit Documentation (Photos, Diagrams, etc.)		Yes	n/a
Report			
Required Parameters			

Estimate Documentation Report

Technology Name: **Five-Year Review (# 1)**

Description	*Default*	*Value*	*UOM*
Report			
Required Parameters			
Introduction		No	n/a
Remedial Objectives		No	n/a
ARARs Review		Yes	n/a
Summary of Site Visit		Yes	n/a
Areas of Non Compliance		No	n/a
Technology Recommendations		No	n/a
Statement of Protectiveness		Yes	n/a
Next Review		No	n/a
Implementation Requirements		No	n/a

Comments: For the 5-year review we defined the system to involve document review, site inspection and report writing. We assumed the site would have low complexity. Document review would consist of a review of 5 year review checklist, the Decision Document and previous 5 year review reports. Site inspections tasks would include a general site inspection and site visit documentation. The report included ARAR review, summary of site visit and a statement of protectiveness.

ALTERNATIVE 4 ESTIMATE DOCUMENTATION REPORT

Estimate Documentation Report

System:

RACER Version: 9.0.0
Database Location: C:\Documents and Settings\martino.DIS\Application Data\Earth Tech\RACER 9.0\Racer.mdb

Folder:

Folder Name: Final WPP FS July 07

Project Documentation:

Project ID: WPP FS
Project Name: WPP Feasibility Study Alternative 4
Project Category: None

Location
State / Country: MARYLAND
City: ABERDEEN PROVING GROUND

Location Modifiers	Default	User
Material:	*1.04*	1.04
Labor:	*0.984*	0.984
Equipment:	*0.993*	0.993

Options
Database: System Costs
Cost Database Date: 2007
Report Option: Fiscal

Description

This project involves cost estimation for alternative 4 associated with a focused feasibility study for the White Phosphorus Burning Pits located at J-Field, APG. This alternative involves implementing LUCs, the installation of a multi-layered RCRA-type cap and the performance of 5 year reviews for 30 years.

Estimate Documentation Report

Alternative Documentation:

Alternative ID: Alternative 4
Alternative Name: Alternative 4 Capping with a RCRA-type Cap
Alternative Type: None

Phase Names

- **SI:** ☐
- **RI/FS:** ☐
- **RD:** ☑
- **IRA:** ☐
- **RA(C):** ☑
- **RA(O):** ☑
- **LTM:** ☑
- **Site Closeout:** ☐

Documentation

Description: Alternative 4 involves filling the burn pits to grade and capping with a RCRA-type cap. Alternative 4 also involves LUCs and 5 Year Reviews occurring for 30 years.

Support Team: Louis Martino and Williams Davies
Lisa Myers from Myers Engineering
John Wrobel and Amy Burgess from APG DSHE

References: Argonne National Laboratory, 2006 J-Field, White Phosphorus Burning Pits, Remedial Investigation Report, Volume I Contamination Assessment and Ecological Risk Report Final, December.

Argonne National Laboratory, 2007 White Phosphorus Pits Focused Feasibility Study Draft January.

Argonne National Laboratory White Phosphorus Pits Focused Feasibility Study Draft Final March 2007.

EA (EA Engineering, Science and Technology, Inc.), 2006. J-Field White Phosphorus Pits, Remedial Investigation Report Volume II: Baseline Human Health Risk Assessment, Aberdeen Proving Ground, Maryland, March.

Estimator Information

Estimator Name: Louis Martino
Estimator Title: Environmental Systems Engineer
Agency/Org./Office: Argonne
Business Address: Suite 6000 955 L'Enfant Plaza
SW Washington DC 200244
Telephone Number: 202-488-2422
Email Address: martinol@anl.gov
Estimate Prepared Date: 01/05/2007

Estimator Signature: ______________________ **Date:** ____________

Estimate Documentation Report

Reviewer Information

Reviewer Name:
Reviewer Title:
Agency/Org./Office:
Business Address:
Telephone Number:
Email Address:
Date Reviewed:

Reviewer Signature: ______________________ **Date:** ____________

Estimated Costs:

Phase Names		Direct Cost	Marked-up Cost
RD		$0	$15,367
Capping		$362,911	$577,947
RA(O)		$92,558	$160,624
LTM		$123,595	$355,861
	Total Cost:	$579,063	$1,109,799

Estimate Documentation Report

Phase Documentation:

Phase Type: Design Percent Method
Phase Name: RD
Description: Cap design

Total Capital Costs are the marked up costs for the Phase, excluding the Professional Labor Management, Administrative Land Use Controls, and Operations and Maintenance technologies. Only the first year costs are included for cost-over-time technologies.

Phase Name	Phase Date	Design Approach	Total Capital Cost	Design %	Design Costs	Design Cost Year
Capping	January, 2008	Ex Situ Removal - Performance-Based On-site Treatment or Disposal	$307,338	5.00	$15,367	2008

Total Design Cost: $15,367

Estimate Documentation Report

Phase Documentation:

Phase Type: Remedial Action
Phase Name: Capping
Description: MEC removal in specific areas followed by filling to grade and capping.

Media/Waste Type
Primary: Soil
Secondary: Groundwater

Contaminant
Primary: Metals
Secondary: Volatile Organic Compounds (VOCs)

Approach: Ex Situ
Start Date: January, 2008

Rate Groups
Labor: System Labor Rate
Analysis: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
Capping	Yes	100	0
Load and Haul	Yes	100	0
MEC Removal Action	Yes	100	0
Professional Labor Management	Yes	100	0

Total Marked-up Cost: $577,947

Technologies:

Estimate Documentation Report

Technology Name: **Capping (# 1)**

Description	*Default*	*Value*	*UOM*
System Definition			
Required Parameters			
Type of Cap		Geosynthetic/Composite Cover	n/a
Scope Area		0.234192	AC
Scope Length		102	FT
Scope Width		100	FT
Passive Gas Vent System		No	n/a
Safety Level		D	n/a
General			
Secondary Parameters			
Side Slope of Cap	3	3	n/a
Horizontal Length of Side Slope	25	25	FT
Horizontal Length of Top Slope	25	25	FT
Geosynthetic/Composite Cover			
Secondary Parameters			
Source of Topsoil		Off-site	n/a
Depth of (Soil Layer or Hydraulic Asphalt Concrete)		18	IN
Soil Cover: Source of Fill		Off-site	n/a
Flexible Membrane Liner		Yes	n/a
Type of Flexible Membrane Liner		40 Mil HDPE	n/a
Compacted Clay Layer		Yes	n/a
Clay Type		Geosynthetic Clay Liner	n/a
Depth of Leveling Layer		6	IN
Leveling Layer: Source of Fill		Off-site	n/a

Comments: The cover would involve two separate areas: the Northern Burn Pit and the Pushout Area west of the Southern Burn Pit. There would be two separate covers because these two areas are separated by approximately 100 feet. We have used the costs associated with a geotextile/compacted clay construction. Assumedly geotextile layer would likely be used to both separate the contaminated soil from the cleanfill and/or to create an barrier to burrowing animals.

Estimate Documentation Report

Technology Name: **Load and Haul (# 1)**

Description	*Default*	*Value*	*UOM*
System Definition			
Required Parameters			
Truck Type		Highway	n/a
Volume		1,915	CY
One-way Haul Distance		30	MI
Dump Charge		0	$/CY
Safety Level		D	n/a

Comments: Load and Haul technology used to account for costs associated with bringing clean fill to the site in order to level the Northern and Southern Burn Pits (not to haul soil to an off-site disposal site).
North Pit 4,044 square feet-5 feet of clean fill = 20, 224 cubic feet
Northern Pit drainage feature 500 square feet-5 feet of clean fill = 2,500 cubic feet
South Pit 5,796.1 square feet-5 feet of clean fill = 28,983.5 cubic feet
About 1,915 cubic yards of clean fill would be required to bring the burn pits and the drainage feature up to grade.

Estimate Documentation Report

Technology Name: **MEC Removal Action (# 1)**

Description	Default	Value	UOM
System Definition			
Required Parameters			
Site Visit		Yes	n/a
Surveying		No	n/a
Vegetation Removal		Yes	n/a
UXO Mapping		Yes	n/a
UXO Removal		Yes	n/a
Site Management		Yes	n/a
Reporting and Stakeholder Involvement		Yes	n/a
Multiple Areas of Concern		No	n/a
Safety Level		E	n/a
Removal Area			
Required Parameters			
Removal Area		1	Acres
Search Depth		4	FT
Topography		Flat with gorges or gullies	n/a
Vegetation		Heavy grass with numerous shrubs	n/a
Air to Air		No	n/a
Air to Ground		No	n/a
Artillery		Yes	n/a
Bombing		No	n/a
Burial Pits		No	n/a
Guided Missiles		No	n/a
Hand Grenade		No	n/a
OB/OD		Yes	n/a
Other		No	n/a
Mortar		No	n/a
Multiple / Combined Use		No	n/a
Rifle Grenade, Anti-Tank Rocket		No	n/a
Small Arms		No	n/a
Bombs, High Explosive		Yes	n/a
Bombs (WP, Incendiary, Photoflash)		Yes	n/a

Estimate Documentation Report

Technology Name: **MEC Removal Action (# 1)**

Description	Default	Value	UOM
Removal Area			
Required Parameters			
Bombs, Practice		Yes	n/a
Hand Grenades, Live		Yes	n/a
Hand Grenades, Practice		Yes	n/a
Ground Rockets, Rifle Grenades, Live		Yes	n/a
Ground Rockets, Rifle Grenades, Practice		Yes	n/a
Medium Caliber (20mm, 25mm, 30mm)		Yes	n/a
Large caliber (37 mm and larger)		Yes	n/a
Mortars		Yes	n/a
Aerial Rockets (Live)		Yes	n/a
Aerial Rockets, Practice		Yes	n/a
Guided Missiles		Yes	n/a
Pyrotechnics		Yes	n/a
Small Arms		Yes	n/a
Other		Yes	n/a
Land Mines		Yes	n/a
Demolition Materials		Yes	n/a
Anomaly Density	300	500	n/a
Percent Scrap	90	90	%
Total Anomalies	500	500	n/a
Vegetation Removal			
Secondary Parameters			
Heavy Removal		0	Acres
Moderate Removal	0.25	0.25	Acres
Light Removal	0.5	0.5	Acres
No Removal	0.25	0.25	Acres
Total Area	1	n/a	Acres
UXO Mapping			
Secondary Parameters			
Geophysics: Area	1	1	Acres
Geophysics: Towed Array		65	%
Geophysics: Navigational Tool		Satellite	n/a

Estimate Documentation Report

Technology Name: **MEC Removal Action (# 1)**

Description	Default	Value	UOM
UXO Mapping			
Secondary Parameters			
Geophysics: Number of Teams		1	EA
Geophysics: Duration		1	Days
Mag & Flag: Area		0	Acres
Mag & Flag: Number of Teams		0	EA
Mag & Flag: Duration		0	Days
Mag & Flag: Ordnance Locator		Schonstedt Model GA-72CV, hand held	n/a
Surface Clearance: Area	1	1	Acres
Surface Clearance: Number of Teams		1	EA
Surface Clearance: Duration		1	Days
UXO Removal			
Secondary Parameters			
Ordnance Destruction: Electrical	30	0	%
Ordnance Destruction: Non-electrical		0	%
Ordnance Destruction: In-grid Consolidation	70	100	%
Ordnance Destruction: Total	100	100	%
Operation Duration	7	7	Days
Number of Teams	1	1	EA
Number of Backhoes	1	1	EA
Explosives Type		TNT	n/a
Explosives	50	50	LB
Detonation Cord (1000 FT Roll)	15	15	EA
Initiator	50	50	n/a
Site Management			
Secondary Parameters			
Senior UXO Supervisor	12	12	Days
Project Manager	12	12	Days
UXO Supervisor		0	Days
Quality Control Supervisor	12	12	Days
Safety Supervisor	12	12	Days
Reporting and Stakeholder Involvement			
Secondary Parameters			

Estimate Documentation Report

Technology Name: **MEC Removal Action (# 1)**

Description	*Default*	*Value*	*UOM*
Reporting and Stakeholder Involvement			
Secondary Parameters			
Level of Detail Required in Reporting		Moderate	n/a
Level of Stakeholder Involvement		Moderate	n/a
Number of Community Meetings		2	EA
Work Plan Report		Yes	n/a
Explosive Safety Submission Report		Yes	n/a

Comments: Under the System Definition Tab we assume that UXO would not be surveyed in with a surveying instrument.

Under the Site Management Tab we assume that a Project Manager only would be required to manage the UXO team.

Under the Reporting and Stakeholder Involvement Tab and Vegetation Removal Tab we assumed moderate involvement and complexity and moderate to light removal respectively.

Under the Removal Area Tab we used the smallest removal area provided (1 acre) and we assumed the following:
UXO removal would occur to a depth of 4 feet. The WPP is an OB/OD area and is located on an Artillery Range. All types of ordnance could be present. The maximum number of anomalies (500) was assumed and 100% of the anomalies would be scrap. We assume that the activity will not involve the identification and removal of metallic items from the burn pits or the sidewalls and pushout area of the WPP because said areas will be covered with soil and the cap. Rather, the MEC Removal Action is meant to address staging areas for equipment and ordnance clearance as needed to key the toe of the cap into native soil.

For the UXO Mapping Tab we assume the following:
No geophysics will be performed. A 1 acre area (the smallest area allowed by the model) would be surveyed via “mag and flag” methods, requiring 1 day of work. Surface clearance would then occur requiring 15 days.

Under the UXO removal Tab we assumed that 100% of the UXO discovered would be consolidated (referred to as “grid consolidation”) in order to represent a likely scenario involving grid consolidation by civilizn EOD teams followed by ordnance destruction by US Army EOD teams.

Estimate Documentation Report

Technology Name: **Professional Labor Management (# 1)**

Description	Default	Value	UOM
System Definition			
Required Parameters			
Method		Percentage Method	n/a
RA Complexity		Moderate	n/a
Percentage Defaults			
Secondary Parameters			
Project Management Percent		7.5	%
Project Management Weighted Dollar Amount		20,496	$
Planning Documents Percent		7	%
Planning Documents Weighted Dollar Amount		19,129	$
Construction Oversight Percent		6	%
Construction Oversight Weighted Dollar Amount		16,397	$
Reporting Percent		1	%
Reporting Weighted Dollar Amount		2,733	$
As-Built Drawings Percent		1	%
As-Built Drawings Weighted Dollar Amount		2,733	$
Public Notice Percent		0.3	%
Public Notice Weighted Dollar Amount		819.8297	$
Permitting Percent		10	%
Permitting Weighted Dollar Amount		27,328	$

Comments:

Estimate Documentation Report

Phase Documentation:

Phase Type: Operations & Maintenance
Phase Name: RA(O)
Description: Cap maintenance

Media/Waste Type
Primary: Soil
Secondary: Groundwater

Contaminant
Primary: Metals
Secondary: Volatile Organic Compounds (VOCs)

Start Date: January, 2008

Rate Groups
Labor: System Labor Rate
Analysis: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
Operations and Maintenance	Yes	100	0

Total Marked-up Cost: $160,624

Technologies:

Estimate Documentation Report

Technology Name: **Operations and Maintenance**

Description	Default	Value	UOM
Start Date/Duration			
Required Parameters			
Startup		No	n/a
O&M Start Date		January-2008	n/a
Duration Units		Years, Months	n/a
Duration		30	Years
Duration		0	Months
Technology Starting Points			
Required Parameters			
Treatment Train Duration:		360	Months

Technology Name *	Start Point	End Point
Capping	0	360

* O&M parameters for the technologies listed are provided in the end of the O&M phase.

Description	Default	Value	UOM
Labor and Safety			
Required Parameters			
Operations Labor		Moderately Low	n/a
Maintenance Labor		Low	n/a
Professional Labor (Third Party)		Exclude from Estimate	n/a
Health and Safety Level		D	n/a
Analytical			
Required Parameters			
Sampling Frequency		Quarterly	n/a
Water Analytical Template		None	n/a
Air Analytical Template		None	n/a
Soil Analytical Template		None	n/a
Contractor Travel			
Secondary Parameters			
Operators		No	n/a
Professional		No	n/a
Heating Requirements			
Secondary Parameters			
Process Stream		No	n/a
Air		No	n/a

Estimate Documentation Report

Technology Name: **Operations and Maintenance**

Description	*Default*	*Value*	*UOM*
Heating Requirements			
Secondary Parameters			
Water		No	n/a
Facility		No	n/a
Runtime Percentages			
Secondary Parameters			
Total Treatment Train O&M Duration:		360	Months

12-month Period	**Run-time Pcnt.**
27	97
28	97
29	97
30	97
1	97
2	97
3	97
4	97
5	97
6	97
7	97
8	97
9	97
10	97
11	97
12	97
13	97
14	97
15	97
16	97
17	97
18	97
19	97
20	97
21	97
22	97
23	97
24	97
25	97
26	97

Comments:

Estimate Documentation Report

Technology Name: **Capping (# 1) - (O&M Parameters)**

Description	*Default*	*Value*	*UOM*
System Definition			
Required Parameters			
Type of Cap		Geosynthetic/Composite Cover	n/a
Scope Area		0.234192	AC

Comments: The cover would involve two separate areas: the Northern Burn Pit and the Pushout Area west of the Southern Burn Pit. There would be two separate covers because these two areas are separated by approximately 100 feet. We have used the costs associated with a geotextile/compacted clay construction. Assumedly geotextile layer would likely be used to both separate the contaminated soil from the cleanfill and/or to create an barrier to burrowing animals.

Estimate Documentation Report

Phase Documentation:

Phase Type: Long Term Monitoring
Phase Name: LTM
Description: 5 year reviews and LUCs associated with the remedy.

Media/Waste Type
Primary: Soil
Secondary: Groundwater

Contaminant
Primary: Metals
Secondary: Volatile Organic Compounds (VOCs)

Start Date: January, 2008

Rate Groups
Labor: System Labor Rate
Analysis: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
ADMINISTRATIVE LAND USE CONTROLS	Yes	100	0
Five-Year Review	Yes	100	0

Total Marked-up Cost: $355,861

Technologies:

Estimate Documentation Report

Technology Name: **Administrative Land Use Controls (# 1)**
User Name: **ADMINISTRATIVE LAND USE CONTROLS**

Description	Default	Value	UOM
System Definition			
Required Parameters			
Rename Model		ADMINISTRATIVE LAND USE CONTROLS	n/a
Planning Documents		Yes	n/a
Planning Documents: Start Date		2008	n/a
Implementation		Yes	n/a
Implementation: Start Date		2008	n/a
Monitoring & Enforcement		Yes	n/a
Monitoring & Enforcement: Start Date		2008	n/a
Modification/Termination		No	n/a
Type of Site		Active Government Installation	n/a
Planning Documents			
Required Parameters			
LUC Assurance Plan (LUCAP)		No	n/a
LUC Implementation Plan (LUCIP)		Yes	n/a
LUC Implementation Plan (LUCIP): Number		1	EA
LUC Implementation Plan (LUCIP): Plan Complexity		Low	n/a
Long-term Stewardship (LTS) Plan		No	n/a
Memorandum of Agreements (MOA)		No	n/a
Installation (or City) Master Plan		Yes	n/a
Installation (or City) Master Plan: Plan Complexity		Low	n/a
Construction Permitting		No	n/a
Geographic Information Systems (GIS)/Overlay Maps		Yes	n/a
Geographic Information Systems (GIS)/Overlay Maps: Number		1	EA
Geographic Information Systems (GIS)/Overlay Maps: Plan Complexity		Low	n/a
Planning Meetings			
Required Parameters			
LUCIP: Number of Meetings		1	EA
LUCIP: Number of People		1	EA
LUCIP: Number of Days		1	EA
LUCIP: Airfare Cost		0	$

Estimate Documentation Report

Technology Name: **Administrative Land Use Controls (# 1)**
User Name: **ADMINISTRATIVE LAND USE CONTROLS**

Description	Default	Value	UOM
Planning Meetings			
Required Parameters			
LUCIP: Mileage to Meeting Site		0	MI
Master Plan: Number of Meetings		1	EA
Master Plan: Number of People		1	EA
Master Plan: Number of Days		1	EA
Master Plan: Airfare Cost		0	$
Master Plan: Mileage to Meeting Site		0	MI
GIS/Overlay Maps: Number of Meetings		1	EA
GIS/Overlay Maps: Number of People		1	EA
GIS/Overlay Maps: Number of Days		1	EA
GIS/Overlay Maps: Airfare Cost		0	$
GIS/Overlay Maps: Mileage to Meeting Site		0	MI
Implementation			
Required Parameters			
Modify Installation (or City) Master Plan		Yes	n/a
Modify Installation (or City) Master Plan: Task Complexity		Low	n/a
Deed Notification		No	n/a
Negotiating Easements		No	n/a
Restrictive Covenants		No	n/a
Equitable Servitudes		No	n/a
Access Control Signs		Yes	n/a
Access Control Signs: Number		4	EA
Access Control Signs: Task Complexity		Medium	n/a
Utility Notification Service		No	n/a
Geographic Information Systems (GIS)/Overlay Maps		Yes	n/a
Geographic Information Systems (GIS)/Overlay Maps: Number		1	EA
Geographic Information Systems (GIS)/Overlay Maps: Task Complexity		Low	n/a
Develop Finding of Suitablility to Transfer (FOST)		No	n/a
Monitoring & Enforcement			
Required Parameters			
Duration of Monitoring/Enforcement		30	Years

Estimate Documentation Report

Technology Name: **Administrative Land Use Controls (# 1)**
User Name: **ADMINISTRATIVE LAND USE CONTROLS**

Description	*Default*	*Value*	*UOM*
Monitoring & Enforcement			
Required Parameters			
Notice Letters		Yes	n/a
Notice Letters: Number		10	EA
Notice Letters: Frequency		Annually	n/a
Guard Service/Security		No	n/a
Reports & Certifications		No	n/a
Site Visits/Inspections		No	n/a

Comments: We designated the site as an active government installation. Default system definition options were used; only "Modification Termination" was not activated. Using the default system, costs would result from creating planning documents, participating in planning meetings, implementing agreed-upon plans and minimal monitoring and enforcement. For the planning document tab, we assumed that a LUC Implementation Plan (LUCIP), Installation Master Plan (IMP) and Geographic Information System (GIS) Overlay Maps would create costs to the project. These plans would have low complexity. Planning document related costs would result from limited to minimal adjustments to the LUCIP, IMP and the existing GIS. We assume that 1 planning meeting would be required to obtain EPA and MDE input for the needed modifications to the IMP and GIS and to assist in the development of the LUCIP. We assumed implementation efforts would be limited to efforts to modify the IMP and the GIS (efforts with a low level of complexity) and erection of signage. We assumed that Monitoring and Enforcement would be limited to the periodic notification of APG organizations via notice letters.

Estimate Documentation Report

Technology Name: **Five-Year Review (# 1)**

Description	Default	Value	UOM
System Definition			
Required Parameters			
Site Complexity		Low	n/a
Document Review		Yes	n/a
Interviews		No	n/a
Site Inspection		Yes	n/a
Report		Yes	n/a
Travel		No	n/a
Rebound Study		No	n/a
Start Date		January-2013	n/a
No. Reviews		6	EA
Safety Level		D	n/a
Document Review			
Required Parameters			
5-Year Review Check List		Yes	n/a
Record of Decision		Yes	n/a
Remedial Action Design & Construction		No	n/a
Close-Out Report		No	n/a
Operations & Maintenance Manuals & Reports		No	n/a
Consent Decree or Settlement Records		No	n/a
Ground Water Monitoring & Reports		No	n/a
Remedial Action Required		No	n/a
Previous 5-Year Review Reports		Yes	n/a
Site Inspection			
Required Parameters			
General Site Inspection		Yes	n/a
Containment System Inspection		No	n/a
Monitoring Systems Inspection		No	n/a
Treatment Systems Inspection		No	n/a
Regulatory Compliance		No	n/a
Site Visit Documentation (Photos, Diagrams, etc.)		Yes	n/a
Report			
Required Parameters			

Estimate Documentation Report

Technology Name: **Five-Year Review (# 1)**

Description	*Default*	*Value*	*UOM*
Report			
Required Parameters			
Introduction		No	n/a
Remedial Objectives		No	n/a
ARARs Review		Yes	n/a
Summary of Site Visit		Yes	n/a
Areas of Non Compliance		No	n/a
Technology Recommendations		No	n/a
Statement of Protectiveness		Yes	n/a
Next Review		No	n/a
Implementation Requirements		No	n/a

Comments: For the 5-year review we defined the system to involve document review, site inspection and report writing. We assumed the site would have low complexity. Document review would consist of a review of 5 year review checklist, the Decision Document and previous 5 year review reports. Site inspections tasks would include a general site inspection and site visit documentation. The report included ARAR review, summary of site visit and a statement of protectiveness.

ALTERNATIVE 5 ESTIMATE DOCUMENTATION REPORT

Estimate Documentation Report

System:

RACER Version: 9.0.0
Database Location: C:\Documents and Settings\martino.DIS\Application Data\Earth Tech\RACER 9.0\Racer.mdb

Folder:

Folder Name: Final WPP FS July 07

Project Documentation:

Project ID: WPP FS
Project Name: WPP Feasibility Study Alternative 5
Project Category: None

Location
State / Country: MARYLAND
City: ABERDEEN PROVING GROUND

Location Modifiers	Default	User
Material:	*1.04*	1.04
Labor:	*0.984*	0.984
Equipment:	*0.993*	0.993

Options
Database: System Costs
Cost Database Date: 2007
Report Option: Fiscal

Description

This project involves cost estimation for alternative 5 associated with a focused feasibility study for the White Phosphorus Burning Pits located at J-Field, APG. This alternative involves the implementation of LUCs, the performance of 5 year reviews for 30 years, the excavation of soil contaminated above threshold levels and the removal of ordnance and explosives from the entire WPP site and portions of the WPP shoreline.

Estimate Documentation Report

Alternative Documentation:

Alternative ID: Alternative 5
Alternative Name: Alt 5 Excavation, Off-site Disposal, LUCs 5 yr rev
Alternative Type: None

Phase Names

SI: ☐
RI/FS: ☐
RD: ☑
IRA: ☐
RA(C): ☑
RA(O): ☐
LTM: ☑
Site Closeout: ☐

Documentation

Description: Alternative 5 involves excavating those areas contaminated with lead above 400 mg/kg. Because, per the request of APG, this Alternative is meant to address what APG refers to as a "free release" option, Alternative 5 also involves the removal of all UXO from the 5.5 acre WPP site. However, since groundwater could remain contaminated, Alternative 5 also involves LUCs and 5 Year Reviews occurring for 30 years.

Support Team: Louis Martino and Williams Davies From Argonne
Lisa Myers from Myers Engineering
John Wrobel and Amy Burgess from APG DSHE.

References: Argonne National Laboratory, 2006. J-Field, White Phosphorus Burning Pits, Remedial Investigation Report, Volume I Contamination Assessment and Ecological Risk Report Final, December.

Argonne National Laboratory, 2007 White Phosphorus Pits Focused Feasibility Study, Draft January.

Argonne National Laboratory White Phosphorus Pits Focused Feasibility Study Draft Final March 2007.

EA (EA Engineering, Science and Technology, Inc.), 2006. J-Field White Phosphorus Pits, Remedial Investigation Report Volume II: Baseline Human Health Risk Assessment, Aberdeen Proving Ground, Maryland, March.

Estimator Information

Estimator Name: Louis Martino
Estimator Title: Environmental Systems Engineer
Agency/Org./Office: Argonne
Business Address: Suite 6000 955 L'Enfant Plaza
SW Washington DC 200244
Telephone Number: 202-488-2422
Email Address: martinol@anl.gov

Estimate Documentation Report

Estimate Prepared Date: 01/05/2007

Estimator Signature: ______________________ **Date:** __________

Reviewer Information

Reviewer Name:
Reviewer Title:
Agency/Org./Office:
Business Address:
Telephone Number:
Email Address:
Date Reviewed:

Reviewer Signature: ______________________ **Date:** __________

Estimated Costs:

Phase Names	Direct Cost	Marked-up Cost
RD	$0	$15,367
Soil excavation and UXO removal	$2,615,102	$3,572,621
LTM	$550,136	$1,500,502
Total Cost:	$3,165,238	$5,088,490

Estimate Documentation Report

Phase Documentation:

Phase Type: Design Percent Method
Phase Name: RD
Description: Planning for soil excavation and UXO removal

Total Capital Costs are the marked up costs for the Phase, excluding the Professional Labor Management, Administrative Land Use Controls, and Operations and Maintenance technologies. Only the first year costs are included for cost-over-time technologies.

Phase Name	Phase Date	Design Approach	Total Capital Cost	Design %	Design Costs	Design Cost Year
Soil excavation and UXO removal	January, 2008	Ex Situ Removal - Performance-Based On-site Treatment or Disposal	$2,308,170	5.00	$15,367	2008

Total Design Cost: $15,367

Estimate Documentation Report

Phase Documentation:

Phase Type: Remedial Action
Phase Name: Soil excavation and UXO removal
Description: Excavation of contaminated soil. MEC removal in 5 acres. MEC sifting in 0.5 acres. Followed by filling to grade .

Media/Waste Type
Primary: Soil
Secondary: Groundwater

Contaminant
Primary: Metals
Secondary: Volatile Organic Compounds (VOCs)

Approach: Ex Situ
Start Date: January, 2008

Rate Groups
Labor: System Labor Rate
Analysis: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
Load and Haul	Yes	100	0
MEC Removal Action	Yes	100	0
Professional Labor Management	Yes	100	0
MEC Sifting	Yes	100	0
Excavation	Yes	100	0
MEC Sifting	Yes	100	0
Residual Waste Management	Yes	100	0

Total Marked-up Cost: $3,572,621

Technologies:

Estimate Documentation Report

Technology Name: **Load and Haul (# 1)**

Description	*Default*	*Value*	*UOM*
System Definition			
Required Parameters			
Truck Type		Highway	n/a
Volume		1,915	CY
One-way Haul Distance		30	MI
Dump Charge		0	$/CY
Safety Level		D	n/a

Comments: Load and Haul technology used to account for costs associated with bringing clean fill to the site in order to level the Northern and Southern Burn Pits (not to haul soil to an off-site disposal site).
North Pit 4,044 square feet-5 feet of clean fill = 20, 224 cubic feet
Northern Pit drainage feature 500 square feet-5 feet of clean fill = 2,500 cubic feet
South Pit 5,796.1 square feet-5 feet of clean fill = 28,983.5 cubic feet
About 1,915 cubic yards of clean fill would be required to bring the burn pits and the drainage feature up to grade.

Estimate Documentation Report

Technology Name: **MEC Removal Action (# 1)**

Description	*Default*	*Value*	*UOM*
System Definition			
Required Parameters			
Site Visit		Yes	n/a
Surveying		No	n/a
Vegetation Removal		Yes	n/a
UXO Mapping		Yes	n/a
UXO Removal		Yes	n/a
Site Management		Yes	n/a
Reporting and Stakeholder Involvement		Yes	n/a
Multiple Areas of Concern		No	n/a
Safety Level		E	n/a
Removal Area			
Required Parameters			
Removal Area		5	Acres
Search Depth		4	FT
Topography		Flat with gorges or gullies	n/a
Vegetation		Heavy grass with numerous shrubs	n/a
Air to Air		No	n/a
Air to Ground		No	n/a
Artillery		Yes	n/a
Bombing		No	n/a
Burial Pits		No	n/a
Guided Missiles		No	n/a
Hand Grenade		No	n/a
OB/OD		Yes	n/a
Other		No	n/a
Mortar		No	n/a
Multiple / Combined Use		No	n/a
Rifle Grenade, Anti-Tank Rocket		No	n/a
Small Arms		No	n/a
Bombs, High Explosive		Yes	n/a
Bombs (WP, Incendiary, Photoflash)		Yes	n/a

Estimate Documentation Report

Technology Name: **MEC Removal Action (# 1)**

Description	Default	Value	UOM
Removal Area			
Required Parameters			
Bombs, Practice		Yes	n/a
Hand Grenades, Live		Yes	n/a
Hand Grenades, Practice		Yes	n/a
Ground Rockets, Rifle Grenades, Live		Yes	n/a
Ground Rockets, Rifle Grenades, Practice		Yes	n/a
Medium Caliber (20mm, 25mm, 30mm)		Yes	n/a
Large caliber (37 mm and larger)		Yes	n/a
Mortars		Yes	n/a
Aerial Rockets (Live)		Yes	n/a
Aerial Rockets, Practice		Yes	n/a
Guided Missiles		Yes	n/a
Pyrotechnics		Yes	n/a
Small Arms		Yes	n/a
Other		Yes	n/a
Land Mines		Yes	n/a
Demolition Materials		Yes	n/a
Anomaly Density	300	500	n/a
Percent Scrap	90	90	%
Total Anomalies	2,500	2,500	n/a
Vegetation Removal			
Secondary Parameters			
Heavy Removal		0	Acres
Moderate Removal	1.25	1.25	Acres
Light Removal	2.5	2.5	Acres
No Removal	1.25	1.25	Acres
Total Area	5	n/a	Acres
UXO Mapping			
Secondary Parameters			
Geophysics: Area	5	0	Acres
Geophysics: Towed Array		65	%
Geophysics: Navigational Tool		Satellite	n/a

Estimate Documentation Report

Technology Name: **MEC Removal Action (# 1)**

Description	Default	Value	UOM
UXO Mapping			
Secondary Parameters			
Geophysics: Number of Teams		0	EA
Geophysics: Duration		0	Days
Mag & Flag: Area		5	Acres
Mag & Flag: Number of Teams		1	EA
Mag & Flag: Duration		30	Days
Mag & Flag: Ordnance Locator		Schonstedt Model GA-72CV, hand held	n/a
Surface Clearance: Area	5	5	Acres
Surface Clearance: Number of Teams		1	EA
Surface Clearance: Duration		90	Days
UXO Removal			
Secondary Parameters			
Ordnance Destruction: Electrical	30	0	%
Ordnance Destruction: Non-electrical		0	%
Ordnance Destruction: In-grid Consolidation	70	100	%
Ordnance Destruction: Total	100	100	%
Operation Duration	31	31	Days
Number of Teams	1	1	EA
Number of Backhoes	1	1	EA
Explosives Type		TNT	n/a
Explosives	250	250	LB
Detonation Cord (1000 FT Roll)	75	75	EA
Initiator	250	250	n/a
Site Management			
Secondary Parameters			
Senior UXO Supervisor	152	152	Days
Project Manager	152	152	Days
UXO Supervisor		0	Days
Quality Control Supervisor	152	152	Days
Safety Supervisor	152	152	Days
Reporting and Stakeholder Involvement			
Secondary Parameters			

Estimate Documentation Report

Technology Name: **MEC Removal Action (# 1)**

Description	*Default*	*Value*	*UOM*
Reporting and Stakeholder Involvement			
Secondary Parameters			
Level of Detail Required in Reporting		Moderate	n/a
Level of Stakeholder Involvement		Moderate	n/a
Number of Community Meetings		2	EA
Work Plan Report		Yes	n/a
Explosive Safety Submission Report		Yes	n/a

Comments: Under the System Definition Tab we assume that UXO would not be surveyed in with a surveying instrument.

Under the Site Management Tab we assume that a Project Manager only would be required to manage the UXO team.

Under the Reporting and Stakeholder Involvement Tab and Vegetation Removal Tab we assumed moderate involvement and complexity and moderate to light removal respectively.

Under the Removal Area Tab we used a 5 acre area. The balance (0.5 acres) will be addressed with a MEC Sifting Technology. We assumed the following:
UXO removal would occur to a depth of 4 feet. The WPP is an OB/OD area and is located on an Artillery Range. All types of ordnance could be present. The default numbers of anomalies and % scrap were used.

For the UXO Mapping Tab we assume the following:
No geophysics will be performed. The area would be surveyed via "mag and flag" method. Estimates for flagging and then surface clearance were based upon professional judgement.

Under the UXO removal Tab we assumed that 100% of the UXO discovered would be consolidated (referred to as "grid consolidation") in order to represent a likely scenario involving grid consolidation by civilizn EOD teams followed by ordnance destruction by US Army EOD teams.

Estimate Documentation Report

Technology Name: **Professional Labor Management (# 1)**

Description	*Default*	*Value*	*UOM*
System Definition			
Required Parameters			
Method		Percentage Method	n/a
RA Complexity		Moderate	n/a
Percentage Defaults			
Secondary Parameters			
Project Management Percent		4	%
Project Management Weighted Dollar Amount		87,851	$
Planning Documents Percent		4	%
Planning Documents Weighted Dollar Amount		87,851	$
Construction Oversight Percent		5	%
Construction Oversight Weighted Dollar Amount		109,814	$
Reporting Percent		0.5	%
Reporting Weighted Dollar Amount		10,981	$
As-Built Drawings Percent		0.5	%
As-Built Drawings Weighted Dollar Amount		10,981	$
Public Notice Percent		0.07	%
Public Notice Weighted Dollar Amount		1,537	$
Permitting Percent		5	%
Permitting Weighted Dollar Amount		109,814	$

Comments:

Estimate Documentation Report

Technology Name: **MEC Sifting (# 1)**

Description	*Default*	*Value*	*UOM*
System Definition			
Required Parameters			
Site Visit		No	n/a
Site Preparation		Yes	n/a
Excavation		Yes	n/a
Sifting		Yes	n/a
Backfill		Yes	n/a
Site Management		No	n/a
Stakeholder Involvement		No	n/a
Sifting Area		0.5	AC
Vegetation		Barren or low grass	n/a
Soil Type		Gravel/Gravel-Sand Mixture	n/a
Include Per Diem		Yes	n/a
Safety Level		E	n/a
Site Preparation			
Required Parameters			
Vegetation Removal: Heavy Removal		0.2	AC
Vegetation Removal: Moderate Removal		0.2	AC
Vegetation Removal: Light Removal		0.1	AC
Vegetation Removal: No Removal	0.5	0	AC
Vegetation Removal: Total Area		0.5	AC
Surface Clearance	0.5	0.5	AC
Excavation			
Required Parameters			
Excavation Area	0.5	0.5	Acres
Excavation Depth	1	4	FT
Total Quantity to Excavate	3,227	3,227	CY
Vehicle Modification		Yes	n/a
Sifting			
Required Parameters			
Front End Loader	3	3	Days
Front End Loader: Vehicle Modification Required		Yes	n/a
Dump Truck	3	3	Days

Estimate Documentation Report

Technology Name: **MEC Sifting (# 1)**

Description	*Default*	*Value*	*UOM*
Sifting			
Required Parameters			
Dump Truck: Vehicle Modification Required		Yes	n/a
Soil to be Sifted	3,711	3,711	CY
Soil to be Hand Sorted	371	371	CY
Backfill			
Required Parameters			
Sifted Material to be Used as Backfill		100	%
Source of Additional Backfill		None	n/a
Site Restoration: Regrading	0.5	0.5	Acres
Site Restoration: Reseeding	0.5	0.5	Acres
Site Restoration: General Cleanup	0.5	0.5	Acres

Comments: MEC sifting to involve sifting for portions of both burning pits (0.25 acres) and portions of the pushout area (0.25 acres), locations where metallic anomolies are dense. The remainder of the WPP site (5 acres) are addressed with the MEC Removal Technology.

Estimate Documentation Report

Technology Name: **Excavation (# 1)**

Description	Default	Value	UOM
System Definition			
Required Parameters			
Excavation Length		40	FT
Excavation Width		42	FT
Excavation Depth		2	FT
Rock Requiring Blasting		No	n/a
Rock Requiring Ripping		No	n/a
% of Excavation		0	%
Drum Removal Required		No	n/a
Number of Drums to be Excavated		0	EA
Soil Type		Gravel/Gravel Sand Mixture	n/a
Sidewall Protection		Side Slope (Rise : Run)	n/a
Side Slope (Rise : Run) 1:		1.25	n/a
Excavation Dewatering Required		No	n/a
Duration of Dewatering		0	Days
Perform Ground Penetrating Radar		No	n/a
Number of Days for Performing Ground Penetrating Radar		0	Days
Number of Soil Samples		20	EA
Soil Analytical Template		System Soil-Metals	n/a
Safety Level		D	n/a
Excavation			
Secondary Parameters			
% of Excavated Material To Be Used as Backfill		50	%
Source of Additional Fill		Offsite	n/a
Existing Cover		Soil/Gravel	n/a
Replacement Cover		Soil/Gravel	n/a

Comments:

Estimate Documentation Report

Technology Name: **MEC Sifting (# 2)**

Description	Default	Value	UOM
System Definition			
Required Parameters			
Site Visit		No	n/a
Site Preparation		Yes	n/a
Excavation		Yes	n/a
Sifting		Yes	n/a
Backfill		No	n/a
Site Management		No	n/a
Stakeholder Involvement		No	n/a
Sifting Area		0.5	AC
Vegetation		Heavy grass with numerous shrubs	n/a
Soil Type		Gravel/Gravel-Sand Mixture	n/a
Include Per Diem		Yes	n/a
Safety Level		E	n/a
Site Preparation			
Required Parameters			
Vegetation Removal: Heavy Removal		0.5	AC
Vegetation Removal: Moderate Removal		0	AC
Vegetation Removal: Light Removal	0.5	0	AC
Vegetation Removal: No Removal		0	AC
Vegetation Removal: Total Area		0.5	AC
Surface Clearance	0.5	0.5	AC
Excavation			
Required Parameters			
Excavation Area	0.5	0.5	Acres
Excavation Depth	1	4	FT
Total Quantity to Excavate	3,227	3,227	CY
Vehicle Modification		Yes	n/a
Sifting			
Required Parameters			
Front End Loader	3	3	Days
Front End Loader: Vehicle Modification Required		Yes	n/a

Estimate Documentation Report

Technology Name: **MEC Sifting (# 2)**

Description	*Default*	*Value*	*UOM*
Sifting			
Required Parameters			
Dump Truck	3	3	Days
Dump Truck: Vehicle Modification Required		Yes	n/a
Soil to be Sifted	3,711	3,711	CY
Soil to be Hand Sorted	371	371	CY

Comments: MEC sifting # 2 involves the approximately 0.5 acre area along the WPP shoreline containing fuze adapters, metallic scrap and OE-related scrap. Because portions of this area will be submerged during the tidal cycle, the estimate may be low. Also, this 0.5 acre portion is not included in the 5.5 acre site extent included in the FS and RI narrative. The remainder of the WPP site (5 acres) are addressed with the MEC Removal Technology and with MEC sifting # 1 (0.5 acres).

Technology Name: **Residual Waste Management (# 1)**

Description	*Default*	*Value*	*UOM*
System Definition			
Required Parameters			
Safety Level		D	n/a
Disposal			
Required Parameters			
Non-Hazardous Bulk Solid: Total Quantity		87	CY
Non-Hazardous Bulk Solid: Distance to Disposal Facility		100	Miles
Non-Hazardous Bulk Solid: Waste Stabilization Required		No	n/a
Non-Hazardous Bulk Solid: Disposal Fee	131	131.3	$/CY
Non-Hazardous Bulk Solid: State Tax / Fees		0	$/CY

Comments:

Estimate Documentation Report

Phase Documentation:

Phase Type: Long Term Monitoring
Phase Name: LTM
Description: 5 year reviews and LUCs associated with the remedy.

Media/Waste Type
Primary: Soil
Secondary: Groundwater

Contaminant
Primary: Metals
Secondary: Volatile Organic Compounds (VOCs)

Start Date: January, 2008

Rate Groups
Labor: System Labor Rate
Analysis: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
ADMINISTRATIVE LAND USE CONTROLS	Yes	100	0
Five-Year Review	Yes	100	0

Total Marked-up Cost: $1,500,502

Technologies:

Estimate Documentation Report

Technology Name: Administrative Land Use Controls (# 1)
User Name: ADMINISTRATIVE LAND USE CONTROLS

Description	Default	Value	UOM
System Definition			
Required Parameters			
Rename Model		ADMINISTRATIVE LAND USE CONTROLS	n/a
Planning Documents		Yes	n/a
Planning Documents: Start Date		2008	n/a
Implementation		Yes	n/a
Implementation: Start Date		2008	n/a
Monitoring & Enforcement		Yes	n/a
Monitoring & Enforcement: Start Date		2008	n/a
Modification/Termination		Yes	n/a
Modification/Termination: Start Date		2008	n/a
Type of Site		Former Government Site	n/a
Planning Documents			
Required Parameters			
LUC Assurance Plan (LUCAP)		Yes	n/a
LUC Assurance Plan (LUCAP): Plan Complexity		Medium	n/a
LUC Implementation Plan (LUCIP)		Yes	n/a
LUC Implementation Plan (LUCIP): Number		1	EA
LUC Implementation Plan (LUCIP): Plan Complexity		Medium	n/a
Long-term Stewardship (LTS) Plan		Yes	n/a
Long-term Stewardship (LTS) Plan: Number		1	EA
Long-term Stewardship (LTS) Plan: Plan Complexity		Medium	n/a
Memorandum of Agreements (MOA)		Yes	n/a
Memorandum of Agreements (MOA): Number		1	EA
Memorandum of Agreements (MOA): Plan Complexity		Medium	n/a
Installation (or City) Master Plan		Yes	n/a
Installation (or City) Master Plan: Plan Complexity		Medium	n/a
Construction Permitting		Yes	n/a
Construction Permitting: Number		1	EA
Construction Permitting: Plan Complexity		Medium	n/a
Geographic Information Systems (GIS)/Overlay Maps		Yes	n/a

Estimate Documentation Report

Technology Name: **Administrative Land Use Controls (# 1)**
User Name: **ADMINISTRATIVE LAND USE CONTROLS**

Description	*Default*	*Value*	*UOM*
Planning Documents			
Required Parameters			
Geographic Information Systems (GIS)/Overlay Maps: Number		1	EA
Geographic Information Systems (GIS)/Overlay Maps: Plan Complexity		Medium	n/a
Planning Meetings			
Required Parameters			
LUCAP: Number of Meetings		2	EA
LUCAP: Number of People		2	EA
LUCAP: Number of Days		1	EA
LUCAP: Airfare Cost		0	$
LUCAP: Mileage to Meeting Site		0	MI
LUCIP: Number of Meetings		2	EA
LUCIP: Number of People		2	EA
LUCIP: Number of Days		1	EA
LUCIP: Airfare Cost		0	$
LUCIP: Mileage to Meeting Site		0	MI
LTS: Number of Meetings		2	EA
LTS: Number of People		2	EA
LTS: Number of Days		1	EA
LTS: Airfare Cost		0	$
LTS: Mileage to Meeting Site		0	MI
MOA: Number of Meetings		2	EA
MOA: Number of People		2	EA
MOA: Number of Days		1	EA
MOA: Airfare Cost		0	$
MOA: Mileage to Meeting Site		0	MI
Master Plan: Number of Meetings		2	EA
Master Plan: Number of People		2	EA
Master Plan: Number of Days		1	EA
Master Plan: Airfare Cost		0	$
Master Plan: Mileage to Meeting Site		0	MI

Estimate Documentation Report

Technology Name: **Administrative Land Use Controls (# 1)**
User Name: **ADMINISTRATIVE LAND USE CONTROLS**

Description	Default	Value	UOM
Planning Meetings			
Required Parameters			
Construction Permitting: Number of Meetings		2	EA
Construction Permitting: Number of People		2	EA
Construction Permitting: Number of Days		1	EA
Construction Permitting: Airfare Cost		0	$
Construction Permitting: Mileage to Meeting Site		0	MI
GIS/Overlay Maps: Number of Meetings		2	EA
GIS/Overlay Maps: Number of People		2	EA
GIS/Overlay Maps: Number of Days		1	EA
GIS/Overlay Maps: Airfare Cost		0	$
GIS/Overlay Maps: Mileage to Meeting Site		0	MI
Implementation			
Required Parameters			
Modify Installation (or City) Master Plan		Yes	n/a
Modify Installation (or City) Master Plan: Task Complexity		Medium	n/a
Deed Notification		Yes	n/a
Deed Notification: Number		1	EA
Deed Notification: Task Complexity		Medium	n/a
Negotiating Easements		Yes	n/a
Negotiating Easements: Number		1	EA
Negotiating Easements: Task Complexity		Medium	n/a
Restrictive Covenants		Yes	n/a
Restrictive Covenants: Number		1	EA
Restrictive Covenants: Task Complexity		Medium	n/a
Equitable Servitudes		Yes	n/a
Equitable Servitudes: Number		1	EA
Equitable Servitudes: Task Complexity		Medium	n/a
Access Control Signs		Yes	n/a
Access Control Signs: Number		4	EA
Access Control Signs: Task Complexity		Medium	n/a
Utility Notification Service		Yes	n/a

Estimate Documentation Report

Technology Name: **Administrative Land Use Controls (# 1)**
User Name: **ADMINISTRATIVE LAND USE CONTROLS**

Description	Default	Value	UOM
Implementation			
Required Parameters			
Access Control Signs: Number		1	EA
Access Control Signs: Task Complexity		Medium	n/a
Geographic Information Systems (GIS)/Overlay Maps		Yes	n/a
Geographic Information Systems (GIS)/Overlay Maps: Number		1	EA
Geographic Information Systems (GIS)/Overlay Maps: Task Complexity		Medium	n/a
Develop Finding of Suitablility to Transfer (FOST)		No	n/a
Monitoring & Enforcement			
Required Parameters			
Duration of Monitoring/Enforcement		30	Years
Notice Letters		Yes	n/a
Notice Letters: Number		10	EA
Notice Letters: Frequency		Annually	n/a
Guard Service/Security		No	n/a
Reports & Certifications		Yes	n/a
Reports & Certifications: Frequency		Annually	n/a
Site Visits/Inspections		Yes	n/a
Site Visits/Inspections: Number		1	EA
Site Visits/Inspections: Safety Level		D	n/a
Site Visits/Inspections: Duration		3	Days
Site Visits/Inspections: Number of People		2	EA
Site Visits/Inspections: Frequency		Biennially	n/a
Site Visits/Inspections: Airfare		0	$ Per Ticket
Site Visits/Inspections: Mileage		0	MI
Modify/Termination			
Required Parameters			
Document Evaluation		Yes	n/a
Document Evaluation: Number		1	EA
Document Evaluation: Plan Complexity		Medium	n/a
Modify LUC Documents		Yes	n/a

Estimate Documentation Report

Technology Name: **Administrative Land Use Controls (# 1)**
User Name: **ADMINISTRATIVE LAND USE CONTROLS**

Description	Default	Value	UOM
Modify/Termination			
Required Parameters			
Modify LUC Documents: Number		1	EA
Modify LUC Documents: Plan Complexity		Medium	n/a
Amend Decision Documents		Yes	n/a
Amend Decision Documents: Number		1	EA
Amend Decision Documents: Plan Complexity		Medium	n/a
Termination Letters		No	n/a

Comments: Default options for all tabs have been used with the assumption that the site is a former government installation. These options provide for the fact that deed restrictions and covenants would be required to help ensure that the remedy remains protective. In addition, these options provide for the continued monitoring and maintenance of the LUCs.

Estimate Documentation Report

Technology Name: **Five-Year Review (# 1)**

Description	Default	Value	UOM
System Definition			
Required Parameters			
Site Complexity		Low	n/a
Document Review		Yes	n/a
Interviews		No	n/a
Site Inspection		Yes	n/a
Report		Yes	n/a
Travel		No	n/a
Rebound Study		No	n/a
Start Date		January-2013	n/a
No. Reviews		6	EA
Safety Level		D	n/a
Document Review			
Required Parameters			
5-Year Review Check List		Yes	n/a
Record of Decision		Yes	n/a
Remedial Action Design & Construction		No	n/a
Close-Out Report		No	n/a
Operations & Maintenance Manuals & Reports		No	n/a
Consent Decree or Settlement Records		No	n/a
Ground Water Monitoring & Reports		No	n/a
Remedial Action Required		No	n/a
Previous 5-Year Review Reports		Yes	n/a
Site Inspection			
Required Parameters			
General Site Inspection		Yes	n/a
Containment System Inspection		No	n/a
Monitoring Systems Inspection		No	n/a
Treatment Systems Inspection		No	n/a
Regulatory Compliance		No	n/a
Site Visit Documentation (Photos, Diagrams, etc.)		Yes	n/a
Report			
Required Parameters			

Estimate Documentation Report

Technology Name: **Five-Year Review (# 1)**

Description	*Default*	*Value*	*UOM*
Report			
Required Parameters			
Introduction		No	n/a
Remedial Objectives		No	n/a
ARARs Review		Yes	n/a
Summary of Site Visit		Yes	n/a
Areas of Non Compliance		No	n/a
Technology Recommendations		No	n/a
Statement of Protectiveness		Yes	n/a
Next Review		No	n/a
Implementation Requirements		No	n/a

Comments: For the 5-year review we defined the system to involve document review, site inspection and report writing. We assumed the site would have low complexity. Document review would consist of a review of 5 year review checklist, the Decision Document and previous 5 year review reports. Site inspections tasks would include a general site inspection and site visit documentation. The report included ARAR review, summary of site visit and a statement of protectiveness.

FOLDER COST SUMMARY REPORT

Folder Cost Summary Report

System:

RACER Version: 9.0.0
Database Location: C:\Documents and Settings\martino.DIS\Application Data\Earth Tech\RACER 9.0\Racer.mdb

Folder:

Folder Name: Final WPP FS July 07

Project:

Project ID: WPP FS
Project Name: WPP Feasibility Study Alternative 5
Project Category: None

Location
State / Country: MARYLAND
City: ABERDEEN PROVING GROUND

Location Modifiers	Default	User
Material:	*1.04*	1.04
Labor:	*0.984*	0.984
Equipment:	*0.993*	0.993

Options
Database: System Costs
Cost Database Date: 2007
Report Option: Fiscal

Description

This project involves cost estimation for alternative 5 associated with a focused feasibility study for the White Phosphorus Burning Pits located at J-Field, APG. This alternative involves the implementation of LUCs, the performance of 5 year reviews for 30 years, the excavation of soil contaminated above threshold levels and the removal of ordnance and explosives from the entire WPP site and portions of the WPP shoreline.

Note: This report shows first year costs.

Folder Cost Summary Report

Alternative:

Alternative ID: Alternative 5
Alternative Name: Alt 5 Excavation, Off-site Disposal, LUCs 5 yr rev
Alternative Type: None

Phase Names

SI: ☐
RI/FS: ☐
RD: ☑
IRA: ☐
RA(C): ☑
RA(O): ☐
LTM: ☑
Site Closeout: ☐

Documentation

Description: Alternative 5 involves excavating those areas contaminated with lead above 400 mg/kg. Because, per the request of APG, this Alternative is meant to address what APG refers to as a "free release" option, Alternative 5 also involves the removal of all UXO from the 5.5 acre WPP site. However, since groundwater could remain contaminated, Alternative 5 also involves LUCs and 5 Year Reviews occurring for 30 years.

Support Team: Louis Martino and Williams Davies From Argonne
Lisa Myers from Myers Engineering
John Wrobel and Amy Burgess from APG DSHE.

References:

Argonne National Laboratory, 2006. J-Field, White Phosphorus Burning Pits, Remedial Investigation Report, Volume I Contamination Assessment and Ecological Risk Report Final, December.

Argonne National Laboratory, 2007 White Phosphorus Pits Focused Feasibility Study, Draft January.

Argonne National Laboratory White Phosphorus Pits Focused Feasibility Study Draft Final March 2007.

EA (EA Engineering, Science and Technology, Inc.), 2006. J-Field White Phosphorus Pits, Remedial Investigation Report Volume II: Baseline Human Health Risk Assessment, Aberdeen Proving Ground, Maryland, March.

Estimator Information

Estimator Name: Louis Martino
Estimator Title: Environmental Systems Engineer
Agency/Org./Office: Argonne
Business Address: Suite 6000 955 L'Enfant Plaza
SW Washington DC 200244
Telephone Number: 202-488-2422
Email Address: martinol@anl.gov
Estimate Prepared Date: 01/05/2007

Note: This report shows first year costs.

Folder Cost Summary Report

Estimator Signature: ______________________ **Date:** ____________

Reviewer Information
Reviewer Name:
Reviewer Title:
Agency/Org./Office:
Business Address:
Telephone Number:
Email Address:
Date Reviewed:

Reviewer Signature: ______________________ **Date:** ____________

Phase:

Phase Type: Design Percent Method
Phase Name: RD
Description: Planning for soil excavation and UXO removal

Total Capital Costs are the marked up costs for the Phase, excluding the Professional Labor Management, Administrative Land Use Controls, and Operations and Maintenance technologies. Only the first year costs are included for cost-over-time technologies.

Phase Name	Phase Date	Design Approach	Total Capital Cost	Design %	Design Costs	Design Cost Year
Soil excavation and UXO removal	January, 2008	Ex Situ Removal - Performance-Based On-site Treatment or Disposal	$2,308,170	5.00	$15,367	2008

Total Design Cost: $15,367

Note: This report shows first year costs.

Folder Cost Summary Report

Phase:

Phase Type: Remedial Action
Phase Name: Soil excavation and UXO removal
Description: Excavation of contaminated soil. MEC removal in 5 acres. MEC sifting in 0.5 acres. Followed by filling to grade .

Media/Waste Type
Primary: Soil
Secondary: Groundwater

Contaminant
Primary: Metals
Secondary: Volatile Organic Compounds (VOCs)

Approach: Ex Situ
Start Date: January, 2008

Rate Groups
Labor: System Labor Rate
Analysis: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
Load and Haul	Yes	100	0
MEC Removal Action	Yes	100	0
Professional Labor Management	Yes	100	0
MEC Sifting	Yes	100	0
Excavation	Yes	100	0
MEC Sifting	Yes	100	0
Residual Waste Management	Yes	100	0

Technologies:

Technology: Load and Haul (#1)

Comments: Load and Haul technology used to account for costs associated with bringing clean fill to the site in order to level the Northern and Southern Burn Pits (not to haul soil to an off-site disposal site).
North Pit 4,044 square feet-5 feet of clean fill = 20, 224 cubic feet
Northern Pit drainage feature 500 square feet-5 feet of clean fill = 2,500 cubic feet
South Pit 5,796.1 square feet-5 feet of clean fill = 28,983.5 cubic feet
About 1,915 cubic yards of clean fill would be required to bring the burn pits and the drainage feature up to grade.

Assembly		Direct Cost	Marked Up Cost
17030222	926, 2.0 CY, Wheel Loader	2,121	3,031

Note: This report shows first year costs.

Folder Cost Summary Report

17030287	20 CY, Semi Dump	21,575	30,849
	Total Load and Haul (#1)	**23,696**	**33,880**

Technology: MEC Removal Action (#1)

Comments: Under the System Definition Tab we assume that UXO would not be surveyed in with a surveying instrument.

Under the Site Management Tab we assume that a Project Manager only would be required to manage the UXO team.

Under the Reporting and Stakeholder Involvement Tab and Vegetation Removal Tab we assumed moderate involvement and complexity and moderate to light removal respectively.

Under the Removal Area Tab we used a 5 acre area. The balance (0.5 acres) will be addressed with a MEC Sifting Technology. We assumed the following:
UXO removal would occur to a depth of 4 feet. The WPP is an OB/OD area and is located on an Artillery Range. All types of ordnance could be present. The default numbers of anomalies and % scrap were used.

For the UXO Mapping Tab we assume the following:
No geophysics will be performed. The area would be surveyed via “mag and flag” method. Estimates for flagging and then surface clearance were based upon professional judgement.

Under the UXO removal Tab we assumed that 100% of the UXO discovered would be consolidated (referred to as “grid consolidation”) in order to represent a likely scenario involving grid consolidation by civilizn EOD teams followed by ordnance destruction by US Army EOD teams.

Assembly		**Direct Cost**	**Marked Up Cost**
Site Visit			
33010108	Sedan, Automobile, Rental	151	195
33010202	Per Diem (per person)	1,080	1,080
33040921	Senior UXO Supervisor (SUXOS)	2,519	2,519
33040923	UXO Project Manager	3,738	3,738
33040925	UXO Staff Engineer	2,815	2,815
33041101	Airfare	2,250	2,250
33240101	Other Direct Costs	500	644
Vegetation Removal			
17010401	Chipping brush, light brush	3,240	4,808
17010402	Chipping brush, medium brush	2,777	4,121
33010202	Per Diem (per person)	240	240
33040935	UXO Technician III (UXO Supervisor)	1,068	1,068
UXO Mapping			
33010202	Per Diem (per person)	176,040	176,040
33040223	Ordnance Locator, Schoenstedt, Model GA-72CD, week	12,645	16,279
33040651	4 X 4 Truck- Rental/Lease	26,483	34,395

Note: This report shows first year costs.

Folder Cost Summary Report

33040934	UXO Technician II	321,862	321,862
33040935	UXO Technician III (UXO Supervisor)	64,058	64,058
33041101	Airfare	5,250	5,250
33240101	Other Direct Costs	21,515	27,697
UXO Removal			
33010202	Per Diem (per person)	45,480	45,480
33040223	Ordnance Locator, Schoenstedt, Model GA-72CD, week	2,097	2,699
33040646	Backhoe - Rental/Lease	10,268	13,335
33040651	4 X 4 Truck- Rental/Lease	6,873	8,926
33040934	UXO Technician II	83,148	83,148
33040935	UXO Technician III (UXO Supervisor)	16,548	16,548
33041001	16oz Standard TNT Booster	2,201	2,833
33041002	50 gr/ft Det -Cord (1000 ft roll)	18,155	23,372
33041004	12 ft Lead Primadet Non- Electric Detonators	825	1,062
33240101	Other Direct Costs	7,006	9,019
Site Management			
33010202	Per Diem (per person)	127,680	127,680
33040651	4 X 4 Truck- Rental/Lease	67,091	87,134
33040921	Senior UXO Supervisor (SUXOS)	95,724	95,724
33040923	UXO Project Manager	142,045	142,045
33040930	UXO QC Specialist	90,309	90,309
33040931	UXO Safety Officer	90,234	90,234
33041101	Airfare	3,000	3,000
Stakeholder Involvement			
33040923	UXO Project Manager	1,121	1,121
33040935	UXO Technician III (UXO Supervisor)	641	641
33041302	Site Specific Workplan (Moderate Complexity)	23,288	23,288
33041305	Explosive Safety Submission (Moderate Complexity)	11,612	11,612
33041314	UXO Removal Report (Moderate Complexity)	28,462	28,462
	Total MEC Removal Action (#1)	**1,522,040**	**1,576,733**

Technology: Professional Labor Management (#1)

Assembly		**Direct Cost**	**Marked Up Cost**
Professional Labor Percentage			
33220138	Project Management Labor Cost	87,851	265,223
33220139	Planning Documents Labor Cost	87,851	265,223
33220140	Construction Oversight Labor Cost	109,814	331,529
33220141	Reporting Labor Cost	10,981	33,153
33220142	As-Built Drawings Labor Cost	10,981	33,153
33220143	Public Notice Labor Cost	1,537	4,641
33220144	Site Closure Activities Labor Cost	0	0
33220145	Permitting Labor Cost	109,814	331,529
33220146	Responsible Party Labor Cost	0	0
33220147	Reimbursement Claims Preparation Labor Cost	0	0
33220148	Other Labor Cost	0	0

Note: This report shows first year costs.

Folder Cost Summary Report

	Total Professional Labor Management (#1)	**418,829**	**1,264,451**

Technology: MEC Sifting (#1)

Comments: MEC sifting to involve sifting for portions of both burning pits (0.25 acres) and portions of the pushout area (0.25 acres), locations where metallic anomolies are dense. The remainder of the WPP site (5 acres) are addressed with the MEC Removal Technology.

Assembly		**Direct Cost**	**Marked Up Cost**
Site Preparation			
17010401	Chipping brush, light brush	1,080	1,603
17010402	Chipping brush, medium brush	1,389	2,061
17010403	Chipping brush, heavy brush	2,701	4,008
18050206	Erosion control, silt fence, polypropylene, 3' hig	974	1,433
33010114	Mobilization Equipment (Soils)	2,824	3,635
33010202	Per Diem (per person)	600	600
33040934	UXO Technician II	89	89
33040935	UXO Technician III (UXO Supervisor)	53	53
Excavation			
17030234	Crawler-mounted, 4.0 CY, Koehring 1166 Hydraulic E	5,051	6,895
33040515	UXO - Vehicle Modification	47,582	47,582
Sifting			
17030285	12 CY, Dump Truck	2,310	3,309
17030427	Sand Bags	790	1,018
17030436	0.75 CY Wheel Loader	7,718	11,425
33010202	Per Diem (per person)	5,760	5,760
33040515	UXO - Vehicle Modification	190,329	190,329
33040651	4 X 4 Truck- Rental/Lease	378	491
33040662	Trommel Screener	5,351	6,888
33040663	Grizzly Shaker Unit	3,210	4,133
33040934	UXO Technician II	6,661	6,661
33040935	UXO Technician III (UXO Supervisor)	4,004	4,004
33188402	Conveyors, Material Handling, horizontal belt, cen	6,785	9,038
33240101	Other Direct Costs	11,790	15,178
33341006	Man-Lift Rental, Scissor, 26' High, 1500# capacity	2,498	3,216
Backfill			
17030401	950, 3.00 CY, Backfill with Excavated Material	4,375	6,121
17040101	Cleaning Up, site debris clean up and removal	345	532
18050101	Area Preparation, 67% Level & 33% Slope	32	45
18050401	Seeding, 67% Level & 33% Slope, Hydroseeding	2,996	2,996
18050408	Fertilizer, Hydro Spread	181	249
33010115	Demobilize Equipment (Soils)	2,824	3,635
	Total MEC Sifting (#1)	**320,678**	**342,986**

Technology: Excavation (#1)

Assembly		**Direct Cost**	**Marked Up Cost**

Note: This report shows first year costs.

Folder Cost Summary Report

17030276	Excavate and load, bank measure, medium material,	466	697
17030415	On-Site Backfill for Large Excavations, Includes C	115	163
17030418	Delivered & Dumped, Backfill with Stone	1,066	1,380
17030423	Unclassified Fill, 6" Lifts, Off-Site, Includes De	752	990
33020401	Disposable Materials per Sample	177	228
33021102	Testing, moisture content (209a)	510	656
33021709	Testing, TAL metals (6010/7000s)	6,025	7,756
33080584	Plastic Laminate Waste Pile Cover	120	159
33170803	Decontaminate Heavy Equipment	359	565
	Total Excavation (#1)	**9,590**	**12,594**

Technology: MEC Sifting (#2)

Comments: MEC sifting # 2 involves the approximately 0.5 acre area along the WPP shoreline containing fuze adapters, metallic scrap and OE-related scrap. Because portions of this area will be submerged during the tidal cycle, the estimate may be low. Also, this 0.5 acre portion is not included in the 5.5 acre site extent included in the FS and RI narrative. The remainder of the WPP site (5 acres) are addressed with the MEC Removal Technology and with MEC sifting # 1 (0.5 acres).

Assembly		Direct Cost	Marked Up Cost
Site Preparation			
17010403	Chipping brush, heavy brush	2,701	4,008
18050206	Erosion control, silt fence, polypropylene, 3' hig	974	1,433
33010114	Mobilization Equipment (Soils)	2,824	3,635
33010202	Per Diem (per person)	600	600
33040934	UXO Technician II	89	89
33040935	UXO Technician III (UXO Supervisor)	53	53
Excavation			
17030234	Crawler-mounted, 4.0 CY, Koehring 1166 Hydraulic E	5,051	6,895
33040515	UXO - Vehicle Modification	47,582	47,582
Sifting			
17030285	12 CY, Dump Truck	2,310	3,309
17030427	Sand Bags	790	1,018
17030436	0.75 CY Wheel Loader	7,718	11,425
33010202	Per Diem (per person)	5,760	5,760
33040515	UXO - Vehicle Modification	190,329	190,329
33040651	4 X 4 Truck- Rental/Lease	378	491
33040662	Trommel Screener	5,351	6,888
33040663	Grizzly Shaker Unit	3,210	4,133
33040934	UXO Technician II	6,661	6,661
33040935	UXO Technician III (UXO Supervisor)	4,004	4,004
33188402	Conveyors, Material Handling, horizontal belt, cen	6,785	9,038
33240101	Other Direct Costs	11,790	15,178
33341006	Man-Lift Rental, Scissor, 26' High, 1500# capacity	2,498	3,216
	Total MEC Sifting (#2)	**307,458**	**325,745**

Note: This report shows first year costs.

Folder Cost Summary Report

Technology: Residual Waste Management (#1)

Assembly		Direct Cost	Marked Up Cost
33190205	Transport Bulk Solid Hazardous Waste, Maximum 20 C	910	910
33190317	Waste Stream Evaluation Fee, Not Including 50% Reb	478	616
33197270	Landfill Nonhazardous Solid Bulk Waste by CY	11,423	14,706
	Total Residual Waste Management (#1)	**12,811**	**16,231**
	Total Phase:	**2,615,102**	**3,572,621**

Note: This report shows first year costs.

Folder Cost Summary Report

Phase:

Phase Type: Long Term Monitoring
Phase Name: LTM
Description: 5 year reviews and LUCs associated with the remedy.

Media/Waste Type
Primary: Soil
Secondary: Groundwater

Contaminant
Primary: Metals
Secondary: Volatile Organic Compounds (VOCs)

Start Date: January, 2008

Rate Groups
Labor: System Labor Rate
Analysis: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
ADMINISTRATIVE LAND USE CONTROLS	Yes	100	0
Five-Year Review	Yes	100	0

Technologies:

Technology: ADMINISTRATIVE LAND USE CONTROLS (#1)

Comments: Default options for all tabs have been used with the assumption that the site is a former government installation. These options provide for the fact that deed restrictions and covenants would be required to help ensure that the remedy remains protective. In addition, these options provide for the continued monitoring and maintenance of the LUCs.

Assembly		Direct Cost	Marked Up Cost
Planning Docs			
33220102	Project Manager	18,753	56,615
33220105	Project Engineer	33,266	100,429
33220106	Staff Engineer	61,015	184,206
33220110	QA/QC Officer	9,669	29,192
33220114	Word Processing/Clerical	23,049	69,586

Note: This report shows first year costs.

Folder Cost Summary Report

33220115	Draftsman/CADD	23,764	71,743
33220503	Attorney, Partner, Real Estate	6,000	6,000
33220504	Attorney, Partner, Contracts	10,000	10,000
33220507	Attorney, Associate, Real Estate	6,000	6,000
33220508	Attorney, Associate, Contracts	14,800	14,800
33220509	Paralegal, Real Estate	4,000	4,000
33220510	Paralegal, Contracts	8,000	8,000
33240101	Other Direct Costs	4,238	5,456
Planning Meetings			
33010202	Per Diem (per person)	2,880	2,880
33220102	Project Manager	10,467	31,599
33220105	Project Engineer	7,427	22,421
33220114	Word Processing/Clerical	3,627	10,951
33220115	Draftsman/CADD	2,173	6,559
33240101	Other Direct Costs	592	763
Implementation			
33022037	Overnight Delivery, 8 oz Letter	345	444
33220102	Project Manager	3,663	11,060
33220105	Project Engineer	6,963	21,020
33220106	Staff Engineer	7,375	22,267
33220110	QA/QC Officer	1,820	5,494
33220114	Word Processing/Clerical	3,268	9,868
33220115	Draftsman/CADD	8,374	25,281
33220120	Computer Data Entry	3,383	10,213
33220505	Attorney, Senior Associate, Real Estate	3,500	3,500
33220509	Paralegal, Real Estate	1,600	1,600
33240101	Other Direct Costs	871	1,121
99040401	Construction Signs	1,198	1,542
99041202	Surveying - 3-man Crew	4,229	6,497
99041205	Portable GPS Set with Mapping, 5 cm Accuracy	728	937
99130602	Local Fees	400	515
Monitoring & Enforcement			
33022038	Overnight delivery service, 1 lb package	294	378
33220102	Project Manager	1,915	5,780
33220106	Staff Engineer	3,788	11,437
33220110	QA/QC Officer	143	431
33220112	Field Technician	76	231
33220114	Word Processing/Clerical	623	1,882
33220115	Draftsman/CADD	407	1,230
33220119	Health and Safety Officer	79	238
33240101	Other Direct Costs	176	226
Modification/Termination			
33220102	Project Manager	2,442	7,373
33220105	Project Engineer	4,023	12,145
33220106	Staff Engineer	4,023	12,145
33220110	QA/QC Officer	678	2,047

Note: This report shows first year costs.

Folder Cost Summary Report

		Direct Cost	Marked Up Cost
33220114	Word Processing/Clerical	869	2,624
33220115	Draftsman/CADD	815	2,460
33240101	Other Direct Costs	321	414
	Total ADMINISTRATIVE LAND USE CONTROLS (#1)	**318,109**	**823,598**

Technology: Five-Year Review (#1)

Comments: For the 5-year review we defined the system to involve document review, site inspection and report writing. We assumed the site would have low complexity. Document review would consist of a review of 5 year review checklist, the Decision Document and previous 5 year review reports. Site inspections tasks would include a general site inspection and site visit documentation. The report included ARAR review, summary of site visit and a statement of protectiveness.

Assembly		**Direct Cost**	**Marked Up Cost**
Document Review			
33220105	Project Engineer	189	570
33220108	Project Scientist	145	437
33220109	Staff Scientist	198	599
Site Inspection			
33220102	Project Manager	160	482
33220105	Project Engineer	142	427
33220108	Project Scientist	145	437
33220109	Staff Scientist	99	300
Report			
33220102	Project Manager	160	482
33220105	Project Engineer	425	1,282
33220108	Project Scientist	290	875
33220109	Staff Scientist	463	1,398
	Total Five-Year Review (#1)	**2,414**	**7,288**
	Total Phase:	**320,523**	**830,886**
Total Alternative:		**2,950,993**	**4,418,874**
Total Project:		**2,950,993**	**4,418,874**

Folder Cost Summary Report

Project:

Project ID:	WPP FS
Project Name:	WPP Feasibility Study Alternative 4
Project Category:	None

Location

State / Country:	MARYLAND
City:	ABERDEEN PROVING GROUND

Location Modifiers	**Default**	**User**
Material:	*1.04*	1.04
Labor:	*0.984*	0.984
Equipment:	*0.993*	0.993

Options

Database:	System Costs
Cost Database Date:	2007
Report Option:	Fiscal

Description

This project involves cost estimation for alternative 4 associated with a focused feasibility study for the White Phosphorus Burning Pits located at J-Field, APG. This alternative involves implementing LUCs, the installation of a multi-layered RCRA-type cap and the performance of 5 year reviews for 30 years.

Note: This report shows first year costs.

Folder Cost Summary Report

Alternative:

Alternative ID: Alternative 4
Alternative Name: Alternative 4 Capping with a RCRA-type Cap
Alternative Type: None

Phase Names

- **SI:** ☐
- **RI/FS:** ☐
- **RD:** ☑
- **IRA:** ☐
- **RA(C):** ☑
- **RA(O):** ☑
- **LTM:** ☑
- **Site Closeout:** ☐

Documentation

Description: Alternative 4 involves filling the burn pits to grade and capping with a RCRA-type cap. Alternative 4 also involves LUCs and 5 Year Reviews occurring for 30 years.

Support Team: Louis Martino and Williams Davies
Lisa Myers from Myers Engineering
John Wrobel and Amy Burgess from APG DSHE

References: Argonne National Laboratory, 2006 J-Field, White Phosphorus Burning Pits, Remedial Investigation Report, Volume I Contamination Assessment and Ecological Risk Report Final, December.

Argonne National Laboratory, 2007 White Phosphorus Pits Focused Feasibility Study Draft January.

Argonne National Laboratory White Phosphorus Pits Focused Feasibility Study Draft Final March 2007.

EA (EA Engineering, Science and Technology, Inc.), 2006. J-Field White Phosphorus Pits, Remedial Investigation Report Volume II: Baseline Human Health Risk Assessment, Aberdeen Proving Ground, Maryland, March.

Estimator Information

Estimator Name: Louis Martino
Estimator Title: Environmental Systems Engineer
Agency/Org./Office: Argonne
Business Address: Suite 6000 955 L'Enfant Plaza
SW Washington DC 200244
Telephone Number: 202-488-2422
Email Address: martinol@anl.gov
Estimate Prepared Date: 01/05/2007

Estimator Signature: ______________________ **Date:** ____________

Note: This report shows first year costs.

Folder Cost Summary Report

Reviewer Information

Reviewer Name:
Reviewer Title:
Agency/Org./Office:
Business Address:
Telephone Number:
Email Address:
Date Reviewed:

Reviewer Signature: ______________________ **Date:** ____________

Phase:

Phase Type: Design Percent Method
Phase Name: RD
Description: Cap design

Total Capital Costs are the marked up costs for the Phase, excluding the Professional Labor Management, Administrative Land Use Controls, and Operations and Maintenance technologies. Only the first year costs are included for cost-over-time technologies.

Phase Name	Phase Date	Design Approach	Total Capital Cost	Design %	Design Costs	Design Cost Year
Capping	January, 2008	Ex Situ Removal - Performance-Based On-site Treatment or Disposal	$307,338	5.00	$15,367	2008

Total Design Cost: $15,367

Folder Cost Summary Report

Phase:

Phase Type: Remedial Action
Phase Name: Capping
Description: MEC removal in specific areas followed by filling to grade and capping.

Media/Waste Type
Primary: Soil
Secondary: Groundwater

Contaminant
Primary: Metals
Secondary: Volatile Organic Compounds (VOCs)

Approach: Ex Situ
Start Date: January, 2008

Rate Groups
Labor: System Labor Rate
Analysis: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
Capping	Yes	100	0
Load and Haul	Yes	100	0
MEC Removal Action	Yes	100	0
Professional Labor Management	Yes	100	0

Technologies:

Technology: Capping (#1)

Comments: The cover would involve two separate areas: the Northern Burn Pit and the Pushout Area west of the Southern Burn Pit. There would be two separate covers because these two areas are separated by approximately 100 feet. We have used the costs associated with a geotextile/compacted clay construction. Assumedly geotextile layer would likely be used to both separate the contaminated soil from the cleanfill and/or to create an barrier to burrowing animals.

Assembly		Direct Cost	Marked Up Cost
17030423	Unclassified Fill, 6" Lifts, Off-Site, Includes De	10,526	13,890
18050301	Loam or topsoil, imported topsoil, 6" deep, furnis	6,911	9,220
18050402	Seeding, Vegetative Cover	309	423
33080503	Polymeric Liner Anchor Trench, 3' x 1.5'	918	1,417

Note: This report shows first year costs.

Folder Cost Summary Report

33080513	Drainage Netting, Geotextile Fabric Heat-bonded 2	7,141	9,426
33080520	Bentonite, rolls, with geotextile fabric both side	13,149	17,864
33080571	40 Mil Polymeric Liner, High-density Polyethylene	6,322	8,724
	Total Capping (#1)	**45,276**	**60,964**

Technology: Load and Haul (#1)

Comments: Load and Haul technology used to account for costs associated with bringing clean fill to the site in order to level the Northern and Southern Burn Pits (not to haul soil to an off-site disposal site).
North Pit 4,044 square feet-5 feet of clean fill = 20, 224 cubic feet
Northern Pit drainage feature 500 square feet-5 feet of clean fill = 2,500 cubic feet
South Pit 5,796.1 square feet-5 feet of clean fill = 28,983.5 cubic feet
About 1,915 cubic yards of clean fill would be required to bring the burn pits and the drainage feature up to grade.

Assembly		Direct Cost	Marked Up Cost
17030222	926, 2.0 CY, Wheel Loader	2,121	3,080
17030287	20 CY, Semi Dump	21,575	31,341
	Total Load and Haul (#1)	**23,696**	**34,420**

Folder Cost Summary Report

Technology: MEC Removal Action (#1)

Comments: Under the System Definition Tab we assume that UXO would not be surveyed in with a surveying instrument.

Under the Site Management Tab we assume that a Project Manager only would be required to manage the UXO team.

Under the Reporting and Stakeholder Involvement Tab and Vegetation Removal Tab we assumed moderate involvement and complexity and moderate to light removal respectively.

Under the Removal Area Tab we used the smallest removal area provided (1 acre) and we assumed the following:
UXO removal would occur to a depth of 4 feet. The WPP is an OB/OD area and is located on an Artillery Range. All types of ordnance could be present. The maximum number of anomalies (500) was assumed and 100% of the anomalies would be scrap. We assume that the activity will not involve the identification and removal of metallic items from the burn pits or the sidewalls and pushout area of the WPP because said areas will be covered with soil and the cap. Rather, the MEC Removal Action is meant to address staging areas for equipment and ordnance clearance as needed to key the toe of the cap into native soil.

For the UXO Mapping Tab we assume the following:
No geophysics will be performed. A 1 acre area (the smallest area allowed by the model) would be surveyed via "mag and flag" methods, requiring 1 day of work. Surface clearance would then occur requiring 15 days.

Under the UXO removal Tab we assumed that 100% of the UXO discovered would be consolidated (referred to as "grid consolidation") in order to represent a likely scenario involving grid consolidation by civilizn EOD teams followed by ordnance destruction by US Army EOD teams.

Assembly		Direct Cost	Marked Up Cost
Site Visit			
33010108	Sedan, Automobile, Rental	151	195
33010202	Per Diem (per person)	1,080	1,080
33040921	Senior UXO Supervisor (SUXOS)	2,519	2,519
33040923	UXO Project Manager	3,738	3,738
33040925	UXO Staff Engineer	2,815	2,815
33041101	Airfare	2,250	2,250
33240101	Other Direct Costs	500	644
Vegetation Removal			
17010401	Chipping brush, light brush	1,080	1,627
17010402	Chipping brush, medium brush	1,389	2,092
33010202	Per Diem (per person)	120	120
33040935	UXO Technician III (UXO Supervisor)	534	534
UXO Mapping			
33010202	Per Diem (per person)	1,560	1,560
33021530	Differential GPS Unit Rental	1,238	1,594
33040210	Geonics EM-61 Metal Locator, Towed (Weekly Rental)	419	539
33040223	Ordnance Locator, Schoenstedt, Model GA-72CD, week	459	590

Note: This report shows first year costs.

Folder Cost Summary Report

33040230	Geonics EM-61 Metal Locator, Hand Held (Weekly Ren	347	447
33040651	4 X 4 Truck- Rental/Lease	378	500
33040653	All Terrain Vehicle (ATV) - Rental/Lease	90	118
33040934	UXO Technician II	2,682	2,682
33040935	UXO Technician III (UXO Supervisor)	1,068	1,068
33040936	Geophysicist (UXO)	1,890	1,890
33041101	Airfare	7,500	7,500
33240101	Other Direct Costs	804	1,034
UXO Removal			
33010202	Per Diem (per person)	12,000	12,000
33040223	Ordnance Locator, Schoenstedt, Model GA-72CD, week	524	675
33040230	Geonics EM-61 Metal Locator, Hand Held (Weekly Ren	347	447
33040646	Backhoe - Rental/Lease	2,427	3,207
33040651	4 X 4 Truck- Rental/Lease	1,892	2,500
33040934	UXO Technician II	18,775	18,775
33040935	UXO Technician III (UXO Supervisor)	5,338	5,338
33040936	Geophysicist (UXO)	5,670	5,670
33041001	16oz Standard TNT Booster	440	567
33041002	50 gr/ft Det -Cord (1000 ft roll)	3,631	4,674
33041004	12 ft Lead Primadet Non- Electric Detonators	165	212
33240101	Other Direct Costs	1,960	2,524
Site Management			
33010202	Per Diem (per person)	10,080	10,080
33040651	4 X 4 Truck- Rental/Lease	5,297	7,000
33040921	Senior UXO Supervisor (SUXOS)	7,557	7,557
33040923	UXO Project Manager	11,214	11,214
33040930	UXO QC Specialist	7,130	7,130
33040931	UXO Safety Officer	7,124	7,124
33041101	Airfare	3,000	3,000
Stakeholder Involvement			
33040923	UXO Project Manager	1,121	1,121
33040935	UXO Technician III (UXO Supervisor)	641	641
33041302	Site Specific Workplan (Moderate Complexity)	23,288	23,288
33041305	Explosive Safety Submission (Moderate Complexity)	11,612	11,612
33041314	UXO Removal Report (Moderate Complexity)	28,462	28,462
	Total MEC Removal Action (#1)	**204,305**	**211,954**

Technology: Professional Labor Management (#1)

Assembly		**Direct Cost**	**Marked Up Cost**
Professional Labor Percentage			
33220138	Project Management Labor Cost	20,496	61,877
33220139	Planning Documents Labor Cost	19,129	57,752
33220140	Construction Oversight Labor Cost	16,397	49,502
33220141	Reporting Labor Cost	2,733	8,250
33220142	As-Built Drawings Labor Cost	2,733	8,250

Note: This report shows first year costs.

Folder Cost Summary Report

33220143	Public Notice Labor Cost	820	2,475
33220144	Site Closure Activities Labor Cost	0	0
33220145	Permitting Labor Cost	27,328	82,503
33220146	Responsible Party Labor Cost	0	0
33220147	Reimbursement Claims Preparation Labor Cost	0	0
33220148	Other Labor Cost	0	0
	Total Professional Labor Management (#1)	**89,635**	**270,608**
	Total Phase:	**362,911**	**577,947**

Note: This report shows first year costs.

Folder Cost Summary Report

Phase:

Phase Type: Operations & Maintenance
Phase Name: RA(O)
Description: Cap maintenance

Media/Waste Type
Primary: Soil
Secondary: Groundwater

Contaminant
Primary: Metals
Secondary: Volatile Organic Compounds (VOCs)

Start Date: January, 2008

Rate Groups
Labor: System Labor Rate
Analysis: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
Operations and Maintenance	Yes	100	0

Technologies:

Technology: Operations and Maintenance (#1)

Assembly		Direct Cost	Marked Up Cost
33010423	Disposable Gloves (Latex)	1	1
33010425	Disposable Coveralls (Tyvek)	14	20
33190340	Non Haz Drummed Site Waste - Load, Transp, & Landf	229	326
33199921	DOT steel drums, 55 gal., open, 17C	99	141
99020110	Annual Maintenance Materials and Labor	218	352
Capping			
18050402	Seeding, Vegetative Cover	1,342	2,073
18050409	Fertilize, 800 Lbs/Acre, Push Rotary	97	156
18050415	Mowing	431	761

Note: This report shows first year costs.

Folder Cost Summary Report

33220106	Staff Engineer	82	265
33220112	Field Technician	229	745
	Total Operations and Maintenance (#1)	**2,742**	**4,841**
	Total Phase:	**2,742**	**4,841**

Note: This report shows first year costs.

Folder Cost Summary Report

Phase:

Phase Type: Long Term Monitoring
Phase Name: LTM
Description: 5 year reviews and LUCs associated with the remedy.

Media/Waste Type
Primary: Soil
Secondary: Groundwater

Contaminant
Primary: Metals
Secondary: Volatile Organic Compounds (VOCs)

Start Date: January, 2008

Rate Groups
Labor: System Labor Rate
Analysis: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
ADMINISTRATIVE LAND USE CONTROLS	Yes	100	0
Five-Year Review	Yes	100	0

Technologies:

Technology: ADMINISTRATIVE LAND USE CONTROLS (#1)

Note: This report shows first year costs.

Folder Cost Summary Report

Comments: We designated the site as an active government installation. Default system definition options were used; only "Modification Termination" was not activated. Using the default system, costs would result from creating planning documents, participating in planning meetings, implementing agreed-upon plans and minimal monitoring and enforcement. For the planning document tab, we assumed that a LUC Implementation Plan (LUCIP), Installation Master Plan (IMP) and Geographic Information System (GIS) Overlay Maps would create costs to the project. These plans would have low complexity. Planning document related costs would result from limited to minimal adjustments to the LUCIP, IMP and the existing GIS. We assume that 1 planning meeting would be required to obtain EPA and MDE input for the needed modifications to the IMP and GIS and to assist in the development of the LUCIP. We assumed implementation efforts would be limited to efforts to modify the IMP and the GIS (efforts with a low level of complexity) and erection of signage. We assumed that Monitoring and Enforcement would be limited to the periodic notification of APG organizations via notice letters.

Assembly		Direct Cost	Marked Up Cost
Planning Docs			
33220102	Project Manager	2,268	6,911
33220105	Project Engineer	5,802	17,682
33220106	Staff Engineer	11,566	35,248
33220110	QA/QC Officer	1,998	6,089
33220114	Word Processing/Clerical	3,967	12,091
33220115	Draftsman/CADD	7,469	22,760
33220503	Attorney, Partner, Real Estate	4,400	4,400
33240101	Other Direct Costs	827	1,093
Planning Meetings			
33010202	Per Diem (per person)	240	240
33220102	Project Manager	1,744	5,316
33220114	Word Processing/Clerical	605	1,842
33220115	Draftsman/CADD	362	1,104
33240101	Other Direct Costs	68	90
Implementation			
33022037	Overnight Delivery, 8 oz Letter	106	140
33220102	Project Manager	1,962	5,981
33220105	Project Engineer	4,062	12,377
33220106	Staff Engineer	4,023	12,260
33220110	QA/QC Officer	1,106	3,371
33220114	Word Processing/Clerical	1,700	5,182
33220115	Draftsman/CADD	5,432	16,553
33220120	Computer Data Entry	2,537	7,732
33240101	Other Direct Costs	521	688
99040401	Construction Signs	1,198	1,583
99041201	Surveying - 2-man Crew	2,440	3,859
99041205	Portable GPS Set with Mapping, 5 cm Accuracy	728	962
Monitoring & Enforcement			
33220102	Project Manager	131	399
33220106	Staff Engineer	1,106	3,372
33220110	QA/QC Officer	71	217
33220114	Word Processing/Clerical	57	173

Note: This report shows first year costs.

Folder Cost Summary Report

		Direct Cost	Marked Up Cost
33240101	Other Direct Costs	34	45
	Total ADMINISTRATIVE LAND USE CONTROLS (#1)	**68,530**	**189,759**

Technology: Five-Year Review (#1)

Comments: For the 5-year review we defined the system to involve document review, site inspection and report writing. We assumed the site would have low complexity. Document review would consist of a review of 5 year review checklist, the Decision Document and previous 5 year review reports. Site inspections tasks would include a general site inspection and site visit documentation. The report included ARAR review, summary of site visit and a statement of protectiveness.

Assembly		Direct Cost	Marked Up Cost
Document Review			
33220105	Project Engineer	189	575
33220108	Project Scientist	145	442
33220109	Staff Scientist	198	605
Site Inspection			
33220102	Project Manager	160	486
33220105	Project Engineer	142	431
33220108	Project Scientist	145	442
33220109	Staff Scientist	99	302
Report			
33220102	Project Manager	160	486
33220105	Project Engineer	425	1,294
33220108	Project Scientist	290	883
33220109	Staff Scientist	463	1,411
	Total Five-Year Review (#1)	**2,414**	**7,357**
	Total Phase:	**70,944**	**197,116**
	Total Alternative:	**451,964**	**795,271**
	Total Project:	**451,964**	**795,271**

Note: This report shows first year costs.

Folder Cost Summary Report

Project:

Project ID:	WPP FS
Project Name:	WPP Feasibility Study Alternative 3
Project Category:	None

Location

State / Country:	MARYLAND
City:	ABERDEEN PROVING GROUND

Location Modifiers	**Default**	**User**
Material:	*1.04*	1.04
Labor:	*0.984*	0.984
Equipment:	*0.993*	0.993

Options

Database:	System Costs
Cost Database Date:	2007
Report Option:	Fiscal

Description

This project involves cost estimation for alternative 3 associated with a focused feasibility study for the White Phosphorus Burning Pits located at J-Field, APG. This alternative involves the installation of a soil blanket as a cap, the implementation of LUCs and the performance of 5 year reviews for 30 years.

Note: This report shows first year costs.

Folder Cost Summary Report

Alternative:

Alternative ID: Alternative 3
Alternative Name: Alternative 3 Capping with a Soil Blanket
Alternative Type: None

Phase Names

SI: ☐
RI/FS: ☐
RD: ☑
IRA: ☐
RA(C): ☑
RA(O): ☑
LTM: ☑
Site Closeout: ☐

Documentation

Description: Alternative 3 involves filling the burn pits to grade and capping with a soil blanket. Alternative 3 also involves LUCs and 5 Year Reviews occurring for 30 years.

Support Team: Louis Martino and Williams Davies from Argonne
Lisa Myers from Meyers Engineering
John Wrobel and Amy Burgess from APG DSHE

References: Argonne National Laboratory, 2006. J-Field, White Phosphorus Burning Pits, Remedial Investigation Report, Volume I Contamination Assessment and Ecological Risk Report Final, December.

Argonne National Laboratory 2007 White Phosphorus Pits Focused Feasibility Study Draft, January

Argonne National Laboratory White Phosphorus Pits Focused Feasibility Study Draft Final March 2007.

EA (EA Engineering, Science and Technology, Inc.), 2006. J-Field White Phosphorus Pits, Remedial Investigation Report Volume II: Baseline Human Health Risk Assessment, Aberdeen Proving Ground, Maryland, March.

Estimator Information

Estimator Name: Louis Martino
Estimator Title: Environmental Systems Engineer
Agency/Org./Office: Argonne
Business Address: Suite 6000 955 L'Enfant Plaza
SW Washington DC 200244
Telephone Number: 202-488-2422
Email Address: martinol@anl.gov
Estimate Prepared Date: 01/05/2007

Estimator Signature: ______________________ **Date:** ____________

Note: This report shows first year costs.

Folder Cost Summary Report

Reviewer Information

Reviewer Name:
Reviewer Title:
Agency/Org./Office:
Business Address:
Telephone Number:
Email Address:
Date Reviewed:

Reviewer Signature: ______________________ **Date:** ____________

Phase:

Phase Type: Design Percent Method
Phase Name: RD
Description: Cap design

Total Capital Costs are the marked up costs for the Phase, excluding the Professional Labor Management, Administrative Land Use Controls, and Operations and Maintenance technologies. Only the first year costs are included for cost-over-time technologies.

Phase Name	Phase Date	Design Approach	Total Capital Cost	Design %	Design Costs	Design Cost Year
Capping	January, 2008	Ex Situ Removal - Performance-Based On-site Treatment or Disposal	$284,499	5.00	$14,225	2008

Total Design Cost: $14,225

Folder Cost Summary Report

Phase:

Phase Type: Remedial Action
Phase Name: Capping
Description: MEC removal in specific areas followed by filling to grade and capping.

Media/Waste Type
Primary: Soil
Secondary: Groundwater

Contaminant
Primary: Metals
Secondary: Volatile Organic Compounds (VOCs)

Approach: Ex Situ
Start Date: January, 2008

Rate Groups
Labor: System Labor Rate
Analysis: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
Capping	Yes	100	0
Load and Haul	Yes	100	0
MEC Removal Action	Yes	100	0
Professional Labor Management	Yes	100	0

Technologies:

Technology: Capping (#1)

Comments: The cover would involve two separate areas: the Northern Burn Pit and the Pushout Area west of the Southern Burn Pit. There would be two separate covers because these two areas are separated by approximately 100 feet. We have used the costs associated with a geotextile/compacted clay construction. Assumedly geotextile layer would likely be used to both separate the contaminated soil from the cleanfill and/or to create an barrier to burrowing animals.

Assembly		Direct Cost	Marked Up Cost
17030423	Unclassified Fill, 6" Lifts, Off-Site, Includes De	13,367	17,638
18050301	Loam or topsoil, imported topsoil, 6" deep, furnis	6,911	9,220
18050402	Seeding, Vegetative Cover	309	423
33080503	Polymeric Liner Anchor Trench, 3' x 1.5'	918	1,417

Note: This report shows first year costs.

Folder Cost Summary Report

33080513	Drainage Netting, Geotextile Fabric Heat-bonded 2	7,141	9,426
	Total Capping (#1)	**28,646**	**38,125**

Technology: Load and Haul (#1)

Comments: Load and Haul technology used to account for costs associated with bringing clean fill to the site in order to level the Northern and Southern Burn Pits (not to haul soil to an off-site disposal site).
North Pit 4,044 square feet-5 feet of clean fill = 20, 224 cubic feet
Northern Pit drainage feature 500 square feet-5 feet of clean fill = 2,500 cubic feet
South Pit 5,796.1 square feet-5 feet of clean fill = 28,983.5 cubic feet
About 1,915 cubic yards of clean fill would be required to bring the burn pits and the drainage feature up to grade.

Assembly		**Direct Cost**	**Marked Up Cost**
17030222	926, 2.0 CY, Wheel Loader	2,121	3,080
17030287	20 CY, Semi Dump	21,575	31,341
	Total Load and Haul (#1)	**23,696**	**34,420**

Technology: MEC Removal Action (#1)

Comments: Under the System Definition Tab we assumed that UXO would not be surveyed in with a surveying instrument.

Under the Site Management Tab we assumed that a Project Manager only would be required to manage the UXO team.

Under the Reporting and Stakeholder Involvement Tab and Vegetation Removal Tab we assumed moderate involvement and complexity and moderate to light removal respectively.

Under the Removal Area Tab we used the smallest removal area provided (1 acre) and we assumed the following:
UXO removal would occur to a depth of 4 feet. The WPP is an OB/OD area and is located on an Artillery Range. All types of ordnance could be present. The maximum number of anomalies (500) was assumed and 100% of the anomalies would be scrap. We assume that the activity will not involve the identification and removal of metallic items from the burn pits or the sidewalls and pushout area of the WPP because said areas will be covered with soil and the cap. Rather, the MEC Removal Action is meant to address staging areas for equipment and ordnance clearance as needed to key the toe of the cap into native soil.

For the UXO Mapping Tab we assume the following:
No geophysics will be performed. A 1 acre area (the smallest area allowed by the model) would be surveyed via "mag and flag" methods, requiring 1 day of work. Surface clearance would then occur requiring 15 days.

Under the UXO removal Tab we assumed that 100% of the UXO discovered would be consolidated (referred to as "grid consolidation") in order to represent a likely scenario involving grid consolidation by civilizn EOD teams followed by ordnance destruction by US Army EOD teams.

Assembly	**Direct Cost**	**Marked Up Cost**

Site Visit

Folder Cost Summary Report

33010108	Sedan, Automobile, Rental	151	195
33010202	Per Diem (per person)	1,080	1,080
33040921	Senior UXO Supervisor (SUXOS)	2,519	2,519
33040923	UXO Project Manager	3,738	3,738
33040925	UXO Staff Engineer	2,815	2,815
33041101	Airfare	2,250	2,250
33240101	Other Direct Costs	500	644
Vegetation Removal			
17010401	Chipping brush, light brush	1,080	1,627
17010402	Chipping brush, medium brush	1,389	2,092
33010202	Per Diem (per person)	120	120
33040935	UXO Technician III (UXO Supervisor)	534	534
UXO Mapping			
33010202	Per Diem (per person)	1,560	1,560
33021530	Differential GPS Unit Rental	1,238	1,594
33040210	Geonics EM-61 Metal Locator, Towed (Weekly Rental)	419	539
33040223	Ordnance Locator, Schoenstedt, Model GA-72CD, week	459	590
33040230	Geonics EM-61 Metal Locator, Hand Held (Weekly Ren	347	447
33040651	4 X 4 Truck- Rental/Lease	378	500
33040653	All Terrain Vehicle (ATV) - Rental/Lease	90	118
33040934	UXO Technician II	2,682	2,682
33040935	UXO Technician III (UXO Supervisor)	1,068	1,068
33040936	Geophysicist (UXO)	1,890	1,890
33041101	Airfare	7,500	7,500
33240101	Other Direct Costs	804	1,034
UXO Removal			
33010202	Per Diem (per person)	12,000	12,000
33040223	Ordnance Locator, Schoenstedt, Model GA-72CD, week	524	675
33040230	Geonics EM-61 Metal Locator, Hand Held (Weekly Ren	347	447
33040646	Backhoe - Rental/Lease	2,427	3,207
33040651	4 X 4 Truck- Rental/Lease	1,892	2,500
33040934	UXO Technician II	18,775	18,775
33040935	UXO Technician III (UXO Supervisor)	5,338	5,338
33040936	Geophysicist (UXO)	5,670	5,670
33041001	16oz Standard TNT Booster	440	567
33041002	50 gr/ft Det -Cord (1000 ft roll)	3,631	4,674
33041004	12 ft Lead Primadet Non- Electric Detonators	165	212
33240101	Other Direct Costs	1,960	2,524
Site Management			
33010202	Per Diem (per person)	10,080	10,080
33040651	4 X 4 Truck- Rental/Lease	5,297	7,000
33040921	Senior UXO Supervisor (SUXOS)	7,557	7,557
33040923	UXO Project Manager	11,214	11,214
33040930	UXO QC Specialist	7,130	7,130
33040931	UXO Safety Officer	7,124	7,124
33041101	Airfare	3,000	3,000

Note: This report shows first year costs.

Folder Cost Summary Report

Stakeholder Involvement			
33040923	UXO Project Manager	1,121	1,121
33040935	UXO Technician III (UXO Supervisor)	641	641
33041302	Site Specific Workplan (Moderate Complexity)	23,288	23,288
33041305	Explosive Safety Submission (Moderate Complexity)	11,612	11,612
33041314	UXO Removal Report (Moderate Complexity)	28,462	28,462
	Total MEC Removal Action (#1)	**204,305**	**211,954**

Technology: Professional Labor Management (#1)

Assembly		**Direct Cost**	**Marked Up Cost**
Professional Labor Percentage			
33220138	Project Management Labor Cost	19,248	58,111
33220139	Planning Documents Labor Cost	17,965	54,237
33220140	Construction Oversight Labor Cost	15,399	46,489
33220141	Reporting Labor Cost	2,566	7,748
33220142	As-Built Drawings Labor Cost	2,566	7,748
33220143	Public Notice Labor Cost	770	2,324
33220144	Site Closure Activities Labor Cost	0	0
33220145	Permitting Labor Cost	25,665	77,482
33220146	Responsible Party Labor Cost	0	0
33220147	Reimbursement Claims Preparation Labor Cost	0	0
33220148	Other Labor Cost	0	0
	Total Professional Labor Management (#1)	**84,180**	**254,140**
	Total Phase:	**340,826**	**538,639**

Note: This report shows first year costs.

Folder Cost Summary Report

Phase:

Phase Type: Operations & Maintenance
Phase Name: RA(O)
Description: Cap maintenance

Media/Waste Type
Primary: Soil
Secondary: Groundwater

Contaminant
Primary: Metals
Secondary: Volatile Organic Compounds (VOCs)

Start Date: January, 2008

Rate Groups
Labor: System Labor Rate
Analysis: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
Operations and Maintenance	Yes	100	0

Technologies:

Technology: Operations and Maintenance (#1)

Assembly		Direct Cost	Marked Up Cost
33010423	Disposable Gloves (Latex)	1	1
33010425	Disposable Coveralls (Tyvek)	14	20
33190340	Non Haz Drummed Site Waste - Load, Transp, & Landf	229	326
33199921	DOT steel drums, 55 gal., open, 17C	99	141
99020110	Annual Maintenance Materials and Labor	218	352
Capping			
18050402	Seeding, Vegetative Cover	1,342	2,073
18050409	Fertilize, 800 Lbs/Acre, Push Rotary	97	156
18050415	Mowing	431	761

Note: This report shows first year costs.

Folder Cost Summary Report

33220106	Staff Engineer	82	265
33220112	Field Technician	229	745
	Total Operations and Maintenance (#1)	**2,742**	**4,841**
	Total Phase:	**2,742**	**4,841**

Folder Cost Summary Report

Phase:

Phase Type: Long Term Monitoring
Phase Name: LTM
Description: 5 year reviews and LUCs associated with the remedy.

Media/Waste Type
Primary: Soil
Secondary: Groundwater

Contaminant
Primary: Metals
Secondary: Volatile Organic Compounds (VOCs)

Start Date: January, 2008

Rate Groups
Labor: System Labor Rate
Analysis: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
ADMINISTRATIVE LAND USE CONTROLS	Yes	100	0
Five-Year Review	Yes	100	0

Technologies:

Technology: ADMINISTRATIVE LAND USE CONTROLS (#1)

Note: This report shows first year costs.

Folder Cost Summary Report

Comments: We designated the site as an active government installation. Default system definition options were used; only "Modification Termination" was not activated. Using the default system, costs would result from creating planning documents, participating in planning meetings, implementing agreed-upon plans and minimal monitoring and enforcement. For the planning document tab, we assumed that a LUC Implementation Plan (LUCIP), Installation Master Plan (IMP) and Geographic Information System (GIS) Overlay Maps would create costs to the project. These plans would have low complexity. Planning document related costs would result from limited to minimal adjustments to the LUCIP, IMP and the existing GIS. We assume that 1 planning meeting would be required to obtain EPA and MDE input for the needed modifications to the IMP and GIS and to assist in the development of the LUCIP. We assumed implementation efforts would be limited to efforts to modify the IMP and the GIS (efforts with a low level of complexity) and erection of signage. We assumed that Monitoring and Enforcement would be limited to the periodic notification of APG organizations via notice letters.

Assembly		Direct Cost	Marked Up Cost
Planning Docs			
33220102	Project Manager	2,268	6,911
33220105	Project Engineer	5,802	17,682
33220106	Staff Engineer	11,566	35,248
33220110	QA/QC Officer	1,998	6,089
33220114	Word Processing/Clerical	3,967	12,091
33220115	Draftsman/CADD	7,469	22,760
33220503	Attorney, Partner, Real Estate	4,400	4,400
33240101	Other Direct Costs	827	1,093
Planning Meetings			
33010202	Per Diem (per person)	240	240
33220102	Project Manager	1,744	5,316
33220114	Word Processing/Clerical	605	1,842
33220115	Draftsman/CADD	362	1,104
33240101	Other Direct Costs	68	90
Implementation			
33022037	Overnight Delivery, 8 oz Letter	106	140
33220102	Project Manager	1,962	5,981
33220105	Project Engineer	4,062	12,377
33220106	Staff Engineer	4,023	12,260
33220110	QA/QC Officer	1,106	3,371
33220114	Word Processing/Clerical	1,700	5,182
33220115	Draftsman/CADD	5,432	16,553
33220120	Computer Data Entry	2,537	7,732
33240101	Other Direct Costs	521	688
99040401	Construction Signs	1,198	1,583
99041201	Surveying - 2-man Crew	2,440	3,859
99041205	Portable GPS Set with Mapping, 5 cm Accuracy	728	962
Monitoring & Enforcement			
33220102	Project Manager	131	399
33220106	Staff Engineer	1,106	3,372
33220110	QA/QC Officer	71	217
33220114	Word Processing/Clerical	57	173

Note: This report shows first year costs.

Folder Cost Summary Report

33240101	Other Direct Costs	34	45
	Total ADMINISTRATIVE LAND USE CONTROLS (#1)	**68,530**	**189,759**

Technology: Five-Year Review (#1)

Comments: For the 5-year review we defined the system to involve document review, site inspection and report writing. We assumed the site would have low complexity. Document review would consist of a review of 5 year review checklist, the Decision Document and previous 5 year review reports. Site inspections tasks would include a general site inspection and site visit documentation. The report included ARAR review, summary of site visit and a statement of protectiveness.

Assembly		Direct Cost	Marked Up Cost
Document Review			
33220105	Project Engineer	189	575
33220108	Project Scientist	145	442
33220109	Staff Scientist	198	605
Site Inspection			
33220102	Project Manager	160	486
33220105	Project Engineer	142	431
33220108	Project Scientist	145	442
33220109	Staff Scientist	99	302
Report			
33220102	Project Manager	160	486
33220105	Project Engineer	425	1,294
33220108	Project Scientist	290	883
33220109	Staff Scientist	463	1,411
	Total Five-Year Review (#1)	**2,414**	**7,357**
	Total Phase:	**70,944**	**197,116**
	Total Alternative:	**428,737**	**754,821**
	Total Project:	**428,737**	**754,821**

Note: This report shows first year costs.

Folder Cost Summary Report

Project:

Project ID: WPP FS
Project Name: WPP Feasibility Study Alternative 2
Project Category: None

Location

State / Country: MARYLAND
City: ABERDEEN PROVING GROUND

Location Modifiers	Default	User
Material:	*1.04*	1.04
Labor:	*0.984*	0.984
Equipment:	*0.993*	0.993

Options

Database: System Costs

Cost Database Date: 2007

Report Option: Fiscal

Description

This project involves cost estimation for alternative 2 associated with a focused feasibility study for the White Phosphorus Burning Pits located at J-Field, APG. Alternative 2 involves the LUCs and the performance of 5 year reviews for 30 years.

Note: This report shows first year costs.

Folder Cost Summary Report

Alternative:

Alternative ID: Alternative 2
Alternative Name: Alternative 2 Land Use Controls
Alternative Type: None

Phase Names

- **SI:** ☐
- **RI/FS:** ☐
- **RD:** ☑
- **IRA:** ☐
- **RA(C):** ☑
- **RA(O):** ☐
- **LTM:** ☑
- **Site Closeout:** ☐

Documentation

Description: Alternative 2 involves LUCs and 5 Year Reviews occurring for 30 years.

Support Team: Louis Martino and Williams Davies from Argonne
Lisa Myers from Myers Engineering
Amy Burgess and John Wrobel from APG DSHE

References: Argonne National Laboratory J-Field, White Phosphorus Burning Pits, Remedial Investigation Report, Volume I Contamination Assessment and Ecological Risk Report Final, December 2006.

Argonne National Laboratory J-Field, White Phosphorus Pits Focused Feasibility Study Draft, January 2007

Argonne National Laboratory White Phosphorus Pits Focused Feasibility Study Draft Final March 2007.

EA (EA Engineering, Science and Technology, Inc.), 2006. J-Field White Phosphorus Pits, Remedial Investigation Report Volume II: Baseline Human Health Risk Assessment, Aberdeen Proving Ground, Maryland, March.

Estimator Information

Estimator Name: Louis Martino
Estimator Title: Environmental Systems Engineer
Agency/Org./Office: Argonne
Business Address: Suite 6000 955 L'Enfant Plaza
SW Washington DC 200244
Telephone Number: 202-488-2422
Email Address: martinol@anl.gov
Estimate Prepared Date: 01/05/2007

Estimator Signature: ______________________ **Date:** ____________

Note: This report shows first year costs.

Folder Cost Summary Report

Reviewer Information

Reviewer Name:
Reviewer Title:
Agency/Org./Office:
Business Address:
Telephone Number:
Email Address:
Date Reviewed:

Reviewer Signature: ______________________________ **Date:** ______________

Note: This report shows first year costs.

Folder Cost Summary Report

Phase:

Phase Type: Long Term Monitoring
Phase Name: LTM
Description: Alternative 2, LUCs, 5 Yr Reviews

Media/Waste Type
Primary: Soil
Secondary: Groundwater

Contaminant
Primary: Metals
Secondary: Volatile Organic Compounds (VOCs)

Start Date: January, 2008

Rate Groups
Labor: System Labor Rate
Analysis: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
ADMINISTRATIVE LAND USE CONTROLS	Yes	100	0
Five-Year Review	Yes	100	0

Technologies:

Technology: ADMINISTRATIVE LAND USE CONTROLS (#1)

Note: This report shows first year costs.

Folder Cost Summary Report

Comments: We designated the site as an active government installation. Default system definition options were used; only "Modification Termination" was not activated. Using the default system, costs would result from creating planning documents, participating in planning meetings, implementing agreed-upon plans and minimal monitoring and enforcement. For the planning document tab, we assumed that a LUC Implementation Plan (LUCIP), Installation Master Plan (IMP) and Geographic Information System (GIS) Overlay Maps would create costs to the project. These plans would have low complexity. Planning document related costs would result from limited to minimal adjustments to the LUCIP, IMP and the existing GIS. We assume that 1 planning meeting would be required to obtain EPA and MDE input for the needed modifications to the IMP and GIS and to assist in the development of the LUCIP. We assumed implementation efforts would be limited to efforts to modify the IMP and the GIS (efforts with a low level of complexity) and erection of signage. We assumed that Monitoring and Enforcement would be limited to the periodic notification of APG organizations via notice letters.

Assembly		Direct Cost	Marked Up Cost
Planning Docs			
33220102	Project Manager	2,268	6,911
33220105	Project Engineer	5,802	17,682
33220106	Staff Engineer	11,566	35,248
33220110	QA/QC Officer	1,998	6,089
33220114	Word Processing/Clerical	3,967	12,091
33220115	Draftsman/CADD	7,469	22,760
33220503	Attorney, Partner, Real Estate	4,400	4,400
33240101	Other Direct Costs	827	1,093
Planning Meetings			
33010202	Per Diem (per person)	240	240
33220102	Project Manager	1,744	5,316
33220114	Word Processing/Clerical	605	1,842
33220115	Draftsman/CADD	362	1,104
33240101	Other Direct Costs	68	90
Implementation			
33022037	Overnight Delivery, 8 oz Letter	106	140
33220102	Project Manager	1,962	5,981
33220105	Project Engineer	4,062	12,377
33220106	Staff Engineer	4,023	12,260
33220110	QA/QC Officer	1,106	3,371
33220114	Word Processing/Clerical	1,700	5,182
33220115	Draftsman/CADD	5,432	16,553
33220120	Computer Data Entry	2,537	7,732
33240101	Other Direct Costs	521	688
99040401	Construction Signs	1,198	1,583
99041201	Surveying - 2-man Crew	2,440	3,859
99041205	Portable GPS Set with Mapping, 5 cm Accuracy	728	962
Monitoring & Enforcement			
33220102	Project Manager	131	399
33220106	Staff Engineer	1,106	3,372
33220110	QA/QC Officer	71	217
33220114	Word Processing/Clerical	57	173

Note: This report shows first year costs.

Folder Cost Summary Report

33240101	Other Direct Costs	34	45
	Total ADMINISTRATIVE LAND USE CONTROLS (#1)	**68,530**	**189,759**

Technology: Five-Year Review (#1)

Comments: For the 5-year review we defined the system to involve document review, site inspection and report writing. We assumed the site would have low complexity. Document review would consist of a review of 5 year review checklist, the Decision Document and previous 5 year review reports. Site inspections tasks would include a general site inspection and site visit documentation. The report included ARAR review, summary of site visit and a statement of protectiveness.

Assembly		Direct Cost	Marked Up Cost
Document Review			
33220105	Project Engineer	189	575
33220108	Project Scientist	145	442
33220109	Staff Scientist	198	605
Site Inspection			
33220102	Project Manager	160	486
33220105	Project Engineer	142	431
33220108	Project Scientist	145	442
33220109	Staff Scientist	99	302
Report			
33220102	Project Manager	160	486
33220105	Project Engineer	425	1,294
33220108	Project Scientist	290	883
33220109	Staff Scientist	463	1,411
	Total Five-Year Review (#1)	**2,414**	**7,357**
	Total Phase:	**70,944**	**197,116**
	Total Alternative:	**70,944**	**197,116**
Total Project:		**70,944**	**197,116**

Note: This report shows first year costs.

Folder Cost Summary Report

Project:

Project ID:	WPP FS	
Project Name:	WPP Feasibility Study Alternative 1	
Project Category:	None	

Location

State / Country:	MARYLAND
City:	ABERDEEN PROVING GROUND

Location Modifiers	**Default**	**User**
Material:	*1.04*	1.04
Labor:	*0.984*	0.984
Equipment:	*0.993*	0.993

Options

Database:	System Costs
Cost Database Date:	2007
Report Option:	Fiscal

Description

This project involves cost estimation for alternative 1, the No Action Alternative associated with a focused feasibility study for the White Phosphorus Burning Pits located at J-Field, APG. Other than existing baseline costs, this alternative involves the performance of 5 year reviews for 30 years.

Note: This report shows first year costs.

Folder Cost Summary Report

Alternative:

Alternative ID: Alternative 1
Alternative Name: Alternative 1 No Action, Five Year Reviews only
Alternative Type: None

Phase Names

SI: ☐
RI/FS: ☐
RD: ☐
IRA: ☐
RA(C): ☐
RA(O): ☐
LTM: ☑
Site Closeout: ☐

Documentation

Description: Alternative 1 involves No Action with 5 Year Reviews occurring for 30 years.

Support Team: Louis Martino and Williams Davies From Argonne
Lisa Myers From Myers Engineering
John Wrobel and Amy Burgess from DSHE APG.

References: Argonne National Laboratory, J-Field, White Phosphorus Burning Pits, Remedial Investigation Report, Volume I Contamination Assessment and Ecological Risk Report Final, December 2006.

Argonne National Laboratory White Phosphorus Pits Focused Feasibility Study Draft January 2007.

Argonne National Laboratory White Phosphorus Pits Focused Feasibility Study Draft Final March 2007.

EA (EA Engineering, Science and Technology, Inc.), 2006. J-Field White Phosphorus Pits, Remedial Investigation Report Volume II: Baseline Human Health Risk Assessment, Aberdeen Proving Ground, Maryland, March.

Estimator Information

Estimator Name: Louis Martino
Estimator Title: Environmental Systems Engineer
Agency/Org./Office: Argonne
Business Address: Suite 6000 955 L'Enfant Plaza
SW Washington DC 200244
Telephone Number: 202-488-2422
Email Address: martinol@anl.gov
Estimate Prepared Date: 01/05/2007

Estimator Signature: ____________________ **Date:** __________

Note: This report shows first year costs.

Folder Cost Summary Report

Reviewer Information

Reviewer Name:
Reviewer Title:
Agency/Org./Office:
Business Address:
Telephone Number:
Email Address:
Date Reviewed:

Reviewer Signature: ______________________ **Date:** ____________

Note: This report shows first year costs.

Folder Cost Summary Report

Phase:

Phase Type: Long Term Monitoring
Phase Name: LTM
Description: 5 year reviews associated with the "No Action" remedy.

Media/Waste Type
Primary: Soil
Secondary: Groundwater

Contaminant
Primary: Metals
Secondary: Volatile Organic Compounds (VOCs)

Start Date: January, 2008

Rate Groups
Labor: System Labor Rate
Analysis: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
Five-Year Review	Yes	100	0

Technologies:

Technology: Five-Year Review (#1)

Comments: For the 5-year review we defined the system to involve document review, site inspection and report writing. We assumed the site would have low complexity. Document review would consist of a review of 5 year review checklist, the Decision Document and previous 5 year review reports. Site inspections tasks would include a general site inspection and site visit documentation. The report included ARAR review, summary of site visit and a statement of protectiveness.

Assembly		Direct Cost	Marked Up Cost
Document Review			
33220105	Project Engineer	189	613
33220108	Project Scientist	145	470
33220109	Staff Scientist	198	644
Site Inspection			

Note: This report shows first year costs.

Folder Cost Summary Report

33220102	Project Manager	160	518
33220105	Project Engineer	142	459
33220108	Project Scientist	145	470
33220109	Staff Scientist	99	322
Report			
33220102	Project Manager	160	518
33220105	Project Engineer	425	1,378
33220108	Project Scientist	290	941
33220109	Staff Scientist	463	1,503
	Total Five-Year Review (#1)	**2,414**	**7,838**
	Total Phase:	**2,414**	**7,838**
Total Alternative:		**2,414**	**7,838**
Total Project:		**2,414**	**7,838**

Note: This report shows first year costs.

Folder Cost Summary Report

Total Folder:	**3,905,052**	**6,173,920**

Note: This report shows first year costs.