Remedial Investigation Report for J-Field, Aberdeen Proving Ground, Maryland

Volume 3: Ecological Risk Assessment

Part A: Summary

by I. Hlohowskyj, J. Hayse, R. Kuperman,* and R. Van Lonkhuyzen

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

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* Kuperman is currently affiliated with the U.S. Army Chemical and Biological Defense Command; Edgewood Research, Development and Engineering Center; Aberdeen Proving Ground, Maryland

FOREWORD

This document presents the results of an ecological risk assessment (ERA) conducted at J-Field in the Edgewood Area of Aberdeen Proving Ground (APG), a U.S. Army installation located in Harford County, Maryland. The ERA was carried out for the U.S. Army under the direction of the Environmental Conservation and Restoration Division, Directorate of Safety, Health, and Environment at APG, pursuant to the requirements outlined under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended. This report comprises Volume 3 of a three-part series of documents that were prepared to describe the comprehensive evaluation of the site conditions, nature and extent of contamination, and risks to human health and the environment. Volume 1 of this series, prepared by Argonne National Laboratory, provides the results of the remedial investigation. Volume 2, prepared by ICF Kaiser Engineers, provides the results of the human health risk assessment. More information on the APG, including J-Field, may be obtained by visiting the APG Web site at www.apg.army.mil.

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REMEDIAL INVESTIGATION REPORT FOR J-FIELD, ABERDEEN PROVING GROUND, MARYLAND

VOLUME 3: ECOLOGICAL RISK ASSESSMENT

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SUMMARY

S.1 INTRODUCTION

The J-Field site is located within the Edgewood Area of the U.S. Army Aberdeen Proving Ground (APG) in Harford County, Maryland (Figure S.1). Activities at J-Field since World War II have included the testing and destruction of chemical agents and munitions. The testing of lethal chemical agents ceased in 1969. Chemicals disposed of at the J-Field site have included nerve agents (such as methyl phosphonothioc acid [VX]), blister agents, riot control agents, white phosphorus, chlorinated solvents, and drummed chemical wastes generated by research laboratories, process laboratories, pilot plants, and machine and maintenance shops.

This ecological risk assessment (ERA) for J-Field was conducted as part of a remedial investigation (RI) initiated by APG. This RI is composed of two distinct, but highly integrated, components: (1) a characterization investigation that identified the nature and the extent of contamination at the site and (2) a baseline risk assessment (BRA) that evaluated risks from site contamination to human health and the environment. The BRA consisted of two separate risk assessments — a human health risk assessment, which evaluated potential risks of site contamination to human health, and the present ERA, which evaluated potential risks to ecological resources at the site. The RI report consists of three volumes. Volume 1 presents the results of the J-Field characterization investigation, Volume 2 presents the results of the human health risk assessment, and Volume 3 presents the results of the ERA.

S.2 DESCRIPTION OF J-FIELD AREAS OF CONCERN

For the RI, the J-Field site was divided on the basis of known APG activities into eight geographic areas or features designated as areas of concern (AOCs): the Toxic Burning Pits (TBP), the White Phosphorus Burning Pits (WPP), the Riot Control Burning Pit (RCP), the Robins Point Demolition Ground (RPDG), the Robins Point Tower Site (RPTS), the South Beach Demolition Ground (SBDG), the South Beach Trench (SBT), and the Prototype Building (PB) (Figure S.2). In

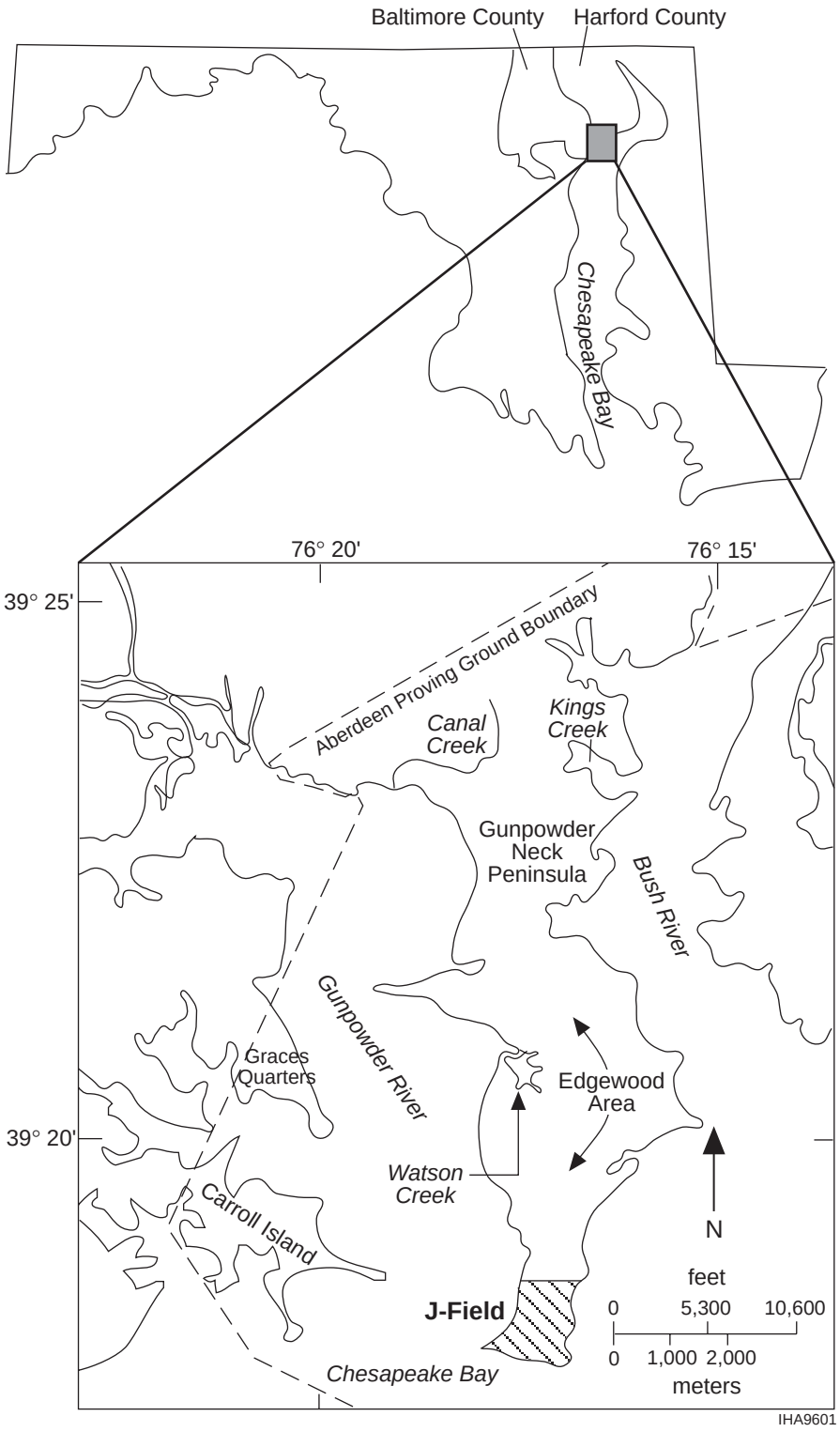

FIGURE S.1 Location of J-Field in the Edgewood Area at Aberdeen Proving Ground (Source: Adapted from Hughes 1993)

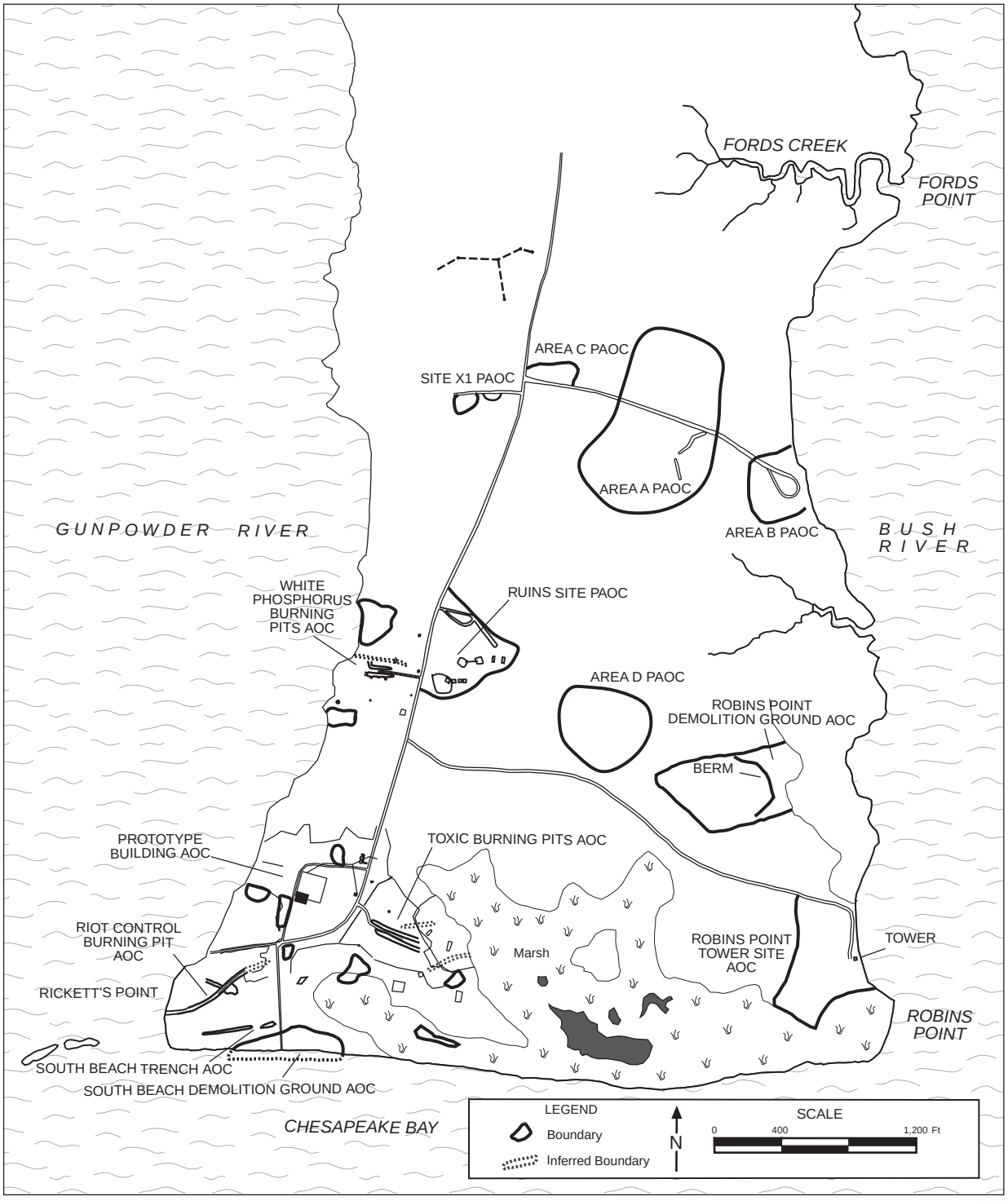

FIGURE S.2 Locations of Areas of Concern (AOCs), Potential Areas of Concern (PAOCs), and Principal Site Features at J-Field (Source: Adapted from Hughes 1993)

addition to the eight AOCs, a number of other areas at J-Field were identified as potential areas of concern (PAOCs). These PAOCs included suspected storage areas, burning areas, and trenches, as well as crater areas and ruins associated with some of the AOCs or located elsewhere within the J-Field site. The following sections summarize the environmental setting and historical use at each AOC.

S.2.1 Toxic Burning Pits Area of Concern

The 3.6-ha TBP AOC is located in the southern portion of J-Field (Figure S.2). The TBP AOC is bounded to the northeast by marsh and to the south and southeast by woods and marsh. Five disposal pits were used at the TBP AOC. The two existing (or main) burning pits were most actively used for disposal of various chemical agents and explosives. The other pits, now covered, were used to dispose of VX, mustard, and liquid smoke components. The main disposal pits were maintained by periodically pushing burned soil and ash toward the marsh area, creating what is referred to as the "Pushout Area." This area extends more than 30 m into the adjacent marsh.

S.2.2 White Phosphorus Burning Pits Area of Concern

The 3.2-ha WPP AOC is located in a grassland area near the Gunpowder River in the western part of J-Field (Figure S.2). This area contains two pits used for open burning and detonation of white phosphorus, munitions containing white phosphorus, and other materials contaminated with white phosphorus. The WPP AOC is now an active emergency disposal facility. (The existing pits and areas potentially affected by emergency disposal operations have been excluded from the remedial investigation/feasibility study [RI/FS], and their investigation has been deferred pending relocation of the emergency disposal operations.)

S.2.3 Riot Control Pit Area of Concern

The 2.6-ha RCP AOC is located in a heavily wooded area in the southwestern part of J-Field (Figure S.2). Except for a small area in the northeastern part of the site, the area is overgrown with vegetation. Disposal at this site occurred from the late 1940s until the early 1970s. From 1960 until the early 1970s, a trench excavated at the site was used for burning riot control agents, munitions filled with such agents, and material contaminated with these agents.

S.2.4 Prototype Building Area of Concern

The 3.6-ha PB AOC is located in a grassland area in the southwestern part of J-Field (Figure S.2). The building is an open-sided, three-level reinforced concrete structure that was originally used to test the effectiveness of bombs during WWII. Since the war, the building and areas to the west and north of it have been used intermittently for temporary storage of solid waste. Two suspect burning areas are also associated with the site, one located northeast and the other west of the PB AOC.

S.2.5 South Beach Demolition Ground Area of Concern

The 1.0-ha SBDG AOC was located along the southern beach of J-Field (Figure S.2). The area was used as a demolition site for high explosive (HE) munitions during the 1960s and 1970s. Because of progressive beach erosion, at high tide most of the former demolition ground is now 0.3–0.6 m below water. Remnants of detonated munitions are visible about 30 m offshore during low tide. A few demolition craters, which are assumed to be remnants of SBDG operations, are visible just inland from the shoreline and east of the end of Rickett's Point Road (Figure S.2).

S.2.6 South Beach Trench Area of Concern

The 0.4-ha SBT AOC is located in a wooded area near the southern beach of J-Field, southeast of the RCP AOC (Figure S.2). A trench approximately 23 m by 4 m was excavated between 1957 and 1960 and may have been a borrow pit for nearby demolition activities. No information has been found regarding any past chemical or hazardous material disposal in this area.

S.2.7 Robins Point Demolition Ground Area of Concern

The 2.8-ha RPDG AOC is located in the eastern part of J-Field, close to the Bush River (Figure S.2). The site was first used in the late 1970s for destroying HE and HE-filled munitions. It was also used during the 1980s for destroying small amounts of sensitive and unstable chemicals by detonation with explosives. The site was originally a small clearing near the edge of a marsh. In 1985, the clearing was enlarged, and a berm was built on the eastern edge of the enlarged clearing. The area west of the berm continues to be used for disposal activities. The berm prevents surface runoff from the disposal activities from entering the marsh.

S.2.8 Robins Point Tower Site Area of Concern

The 2.9-ha RPTS AOC is a grassland area located near Robins Point at the southeastern tip of the Gunpowder Peninsula (Figure S.2). The area was first used in the 1950s for launching and observing rockets. The wooden observation tower at the site was built between 1957 and 1960. Around 1958, the Robins Point area may have been used for at least one test burn of wood contaminated with radioactive material.

S.2.9 Potential Areas of Concern

In addition to the eight AOCs at J-Field, 17 other areas have been identified as PAOCs. These PAOCs include Site X1, Areas A through D, two suspected storage areas associated with the TBP AOC and the WPP AOC, four suspected burning areas (two near the WPP AOC and two near the PB AOC), one suspected filled trench near the SBT AOC, one clearing near the southwestern corner of the Prototype Building, one suspected disposal area southwest of the TBP AOC, the craters at J-Field, one ruins site east of the WPP AOC, and one demolition area southeast of the TBP AOC area. Several of these PAOCs are shown on Figure S.2. Detailed descriptions of these PAOCs are provided in Volume 1 of the RI report (Yuen et al. 1999) and in the field sampling plan (FSP) (Benioff et al. 1995). These sites occur among the woods, open fields, and marshes of J-Field. Few permanent aquatic habitats are associated with the PAOCs; most aquatic habitats are ephemeral surface waters (e.g., rain-filled trenches, craters, or other depressions) that support limited fauna. Permanent aquatic habitats are present at Area A and the Ruins Site; they consist of some ponds and trenches.

S.3 ECOLOGICAL RISK ASSESSMENT APPROACH

The ERA was designed to (1) determine whether past site activities and current levels of contamination have adversely affected the ecological resources at the site, (2) determine whether conditions at the site pose potential adverse risks to ecological resources, and (3) identify areas of J-Field where remediation may be warranted from an ecological standpoint. The ERA used both the site-specific data collected as part of the RI contaminant characterization investigation and data collected for ERA-specific studies.

The approach used in this ERA meets the requirements for a quantitative-level risk assessment and is fully consistent with the 1997 U.S. Environmental Protection Agency (EPA) guidance for designing and conducting environmental evaluations and ERAs under the Comprehensive Environmental, Response, Compensation, and Liability Act (CERCLA). The ERA targeted multiple ecosystem components, including aquatic and terrestrial vegetation, soil and

aquatic invertebrates, fish, and terrestrial wildlife. The assessment also evaluated multiple levels of ecosystem organization, including individuals, populations, and communities.

The ERA consisted of three steps. Step 1 included a screening assessment that identified assessment endpoints, complete exposure pathways, and potential contaminants of ecological concern (PCOECs) for further evaluation in the ERA. Step 2 included exposure and effects assessments for the PCOECs and assessment endpoints. Exposure assessment included dose modeling and tissue residue analysis, while the effects assessment included toxicity tests and field and laboratory studies. This step involved the development of contaminant uptake models for selected ecological receptors, such as birds of prey, waterfowl, and large mammals. In Step 3, the results of Step 2 were integrated in a weight-of-evidence risk evaluation to characterize the risk to ecological resources from the current levels of contamination at J-Field. Potential risks to ecological receptors were characterized for each AOC and for wide-ranging species that may visit multiple AOCs and PAOCs.

S.4 CONTAMINANTS OF ECOLOGICAL CONCERN

A final list of PCOECs was developed for each AOC by comparing media concentrations with chemical-specific regulatory standards and ecological screening values. The detection frequency, capacity to bioconcentrate, importance as a micro- or macronutrient, and known toxicity were also considered in this screening process.

The first step in the process involved comparing maximum reported concentrations of contaminants, by medium and AOC, to ecological screening values. The ecological screening values represent medium-specific contaminant concentrations considered protective of biota. The screening values were obtained from many sources, including regulatory values, EPA Region 3, and the open scientific literature. The regulatory values were EPA ambient water quality criteria (AWQC) for the protection of aquatic biota. At each AOC, contaminants present at concentrations exceeding screening concentrations were retained as the final PCOECs for that AOC. Contaminants present at concentrations for which no screening values are available were also retained for further evaluation. Next, each of these chemicals was evaluated with regard to known toxicity, importance as a micro- or macronutrient, capacity to bioaccumulate, and detection frequency. Contaminants that are known nutrients and those with detection frequencies of less than 1% were not considered further. The final PCOECs included 18 metals and 42 volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs). Metals were the most commonly encountered PCOECs, occurring at all the AOCs and in all media. The greatest number of PCOECs were identified for the TBP AOC.

S.5 ECOLOGICAL RECEPTORS AND EXPOSURE SCENARIOS

The evaluation of ecological risks required the identification of exposure pathways to ecological resources and the selection of representative ecological receptors to be evaluated at each AOC. During the initial phases of the ERA, a series of ecological conceptual models that incorporated known or expected contaminant fate and transport pathways was developed for each AOC to determine the potential exposure routes to ecological resources. Characterization data from Volume 1 of the RI, aerial photographs, U.S. Geological Survey topographic maps, previous investigations at J-Field, and preliminary field surveys of ecological habitats at the site were used to develop these models. The models were then used to identify ecosystem components that could be exposed at each AOC.

Uptake modeling was used to quantitatively evaluate the selected exposure pathways and ecological receptors. Exposure pathways included the incidental ingestion of contaminated soil or sediment, ingestion of contaminated drinking water, food-chain transfer and uptake of contaminants, root uptake for vegetation, and dermal absorption for terrestrial invertebrates and aquatic biota. Contaminant uptake through the food chain was the principal exposure route for most terrestrial wildlife. These exposure routes were then modeled to predict applied daily doses (ADDs) of contaminants for individual receptors.

S.6 ASSESSMENT METHODS

Table S.1 summarizes the measurement endpoints evaluated for each assessment endpoint. The assessment endpoints identified for J-Field targeted ecological resources that, because of their ecological characteristics, represent important components of the local ecosystem and that are in direct contact with potentially contaminated media. For terrestrial resources, three general assessment endpoints were identified. The first was the protection of plant communities from ecological changes related to contaminant exposure. The testable hypotheses associated with this assessment endpoint are: (1) Is plant species diversity reduced as a result of exposure to PCOECs in site soil? (2) Are PCOEC concentrations in site soils at levels that may adversely affect plant reproductive success and survival? and (3) Is plant biomass reduced as a result of exposure to PCOECs present in site soils?

The second terrestrial assessment endpoint was the protection of terrestrial vertebrate communities from ecological changes related to contaminant exposure. The associated testable hypothesis associated with this assessment endpoint is: Could terrestrial wildlife utilizing the site be exposed to site PCOECs at levels that could result in contaminant doses that might adversely impact reproduction, survival, and/or growth?

TABLE S.1 General Assessment Endpoints, Ecological Receptors, Assessment Levels, and Measurement Endpoints for the J-Field Ecological Risk Assessment

Assessment Endpoint	Ecological Receptor	Assessment Level	Measurement Endpoint
Protection of the plant community from ecological changes related to contaminant exposure	Vegetation	Individual	Seed germination, growth, survival, tissue concentrations
		Population and community	Species diversity, total biomass
Protection of the soil invertebrate community and soil nutrient processes from ecological changes related to contaminant exposure	Soil invertebrates	Individual	Earthworm survival, tissue concentrations
		Population and community	Species diversity, trophic dominance, biomass, abundance
		Biological processes	Soil respiration, microbial enzyme activities
Protection of the terrestrial vertebrate community from ecological changes related to contaminant exposure	Terrestrial vertebrates	Individual	Modeling dose estimates, tissue concentrations
		Population and community	Species diversity, reproductive success, abundance
Protection of the aquatic community from ecological changes related to contaminant exposure	Aquatic biota	Individual	Acute and chronic toxicity, tissue concentrations
		Population and community	Species diversity

The third terrestrial assessment endpoint was the protection of the soil biota communities and associated soil nutrient processes from ecological changes related to contaminant exposure. The associated testable hypotheses associated with this assessment endpoint are: (1) Are soil biota survival, abundance, diversity, and/or community structure reduced as a result of exposure to PCOECs in site soils? and (2) Are soil processes associated with decomposition and nutrient cycling being adversely affected as a result of PCOEC levels in site soils?

For aquatic resources, the general assessment endpoint was the protection of aquatic communities from ecological changes related to contaminant exposure, including maintenance of aquatic invertebrate species diversity and plankton and fish survival at levels similar to those at areas not exposed to site PCOECs. The associated testable hypotheses associated with this assessment

endpoint are: (1) Is macroinvertebrate species diversity reduced as a result of exposure to PCOECs in site surface water and sediment? (2) Could semiaquatic wildlife utilizing aquatic habitats at the site be exposed to PCOECs at levels that may result in adverse impacts to reproduction, survival, and/or growth? and (3) Are the growth and/or survival of plankton, fish, and amphibians being adversely impacted by PCOECs in surface water and sediment?

A variety of measurement endpoints were identified for evaluating potential or actual ecological changes that may occur or have occurred as a result of exposure to site PCOECs. The EPA (1997) defines a measurement endpoint as "A measurable ecological characteristic that is related to the valued characteristic chosen as the assessment endpoint. As used in this guidance ... measurement endpoints can include measures of effect and measures of exposure..." The measurement endpoints identified for this ERA included measures of survival, growth, reproductive success, abundance and biomass production, enzyme activity, tissue concentration, diversity, and community structure (summarized in Table S.1). Exposure assessments characterized the co-occurrence of the ecological receptors with the distribution of contaminants by using one of two approaches: direct measurements of contaminant concentrations in biological tissues or modeling of contaminant uptake. Effects assessment, which involved field studies and laboratory toxicity testing of site media, identified and quantified actual adverse effects occurring at the AOCs under existing environmental conditions.

The exposure assessment included both direct measurements (e.g., PCOECs in tissues of biota collected from the J-Field site) and dose modeling for selected wildlife at the site. For tissue analysis, terrestrial vegetation (common reed), terrestrial invertebrates (grasshoppers and crickets), fish (golden shiners and banded killifish), amphibians (frogs), and small mammals (white-footed mice) were collected from different AOCs and habitats at J-Field and analyzed for metals, SVOCs, pesticides, and polychlorinated biphenyls (PCBs). The measured tissue concentrations provided insight into contaminant uptake by biota at the site and were used in uptake models.

Because collecting many wildlife species for tissue analysis was not practical or feasible, contaminant uptake was modeled for various avian and mammalian species. A contaminant dose, expressed as ADDs, were estimated by AOC for each PCOEC and selected ecological receptor. Mathematical equations were developed to model contaminant uptake along all appropriate exposure pathways, including food web pathways, to selected receptors. The greatest number of exposure routes modeled for any particular receptor was eight (for the red fox). The ADDs were modeled by using exposure point concentrations of contaminants in each medium and species-specific exposure factors, such as body weight, home range, and diet composition. Exposure point concentrations were determined from the characterization data presented in Volume 1 of the RI. Exposure factors were obtained from the EPA *Wildlife Exposure Factors Handbook* or the scientific literature, or were estimated by using empirically derived allometric equations.

Uptake modeling was conducted to estimate either tissue concentrations or ADDs for various receptors. Measured or modeled tissue concentrations for vegetation and insects were used in modeling contaminant uptake to higher-trophic-level receptors. Although measured tissue concentrations were available for vegetation and insects, not all the PCOECs were included in the tissue analyses. Thus, tissue concentrations of most contaminants were estimated by modeling. Higher-trophic-level receptors for which ADDs were estimated included the mallard, great blue heron, American robin, tree swallow, American kestrel, red-tailed hawk, muskrat, white-footed mouse, eastern cottontail, white-tailed deer, and red fox. At each AOC, contaminant uptake was modeled for those receptors known or considered likely to occur at the AOC. For wide-ranging wildlife, a total ADD was estimated for each contaminant by summing the PCOEC-specific ADD from each AOC that the wildlife receptor utilizes.

S.7 ASSESSMENT RESULTS AND RISK ESTIMATES

S.7.1 Toxic Burning Pits Area of Concern

S.7.1.1 Risk Characterization Summary

The assessments conducted at the TBP AOC included quantitative and qualitative surveys of terrestrial and aquatic invertebrate and vertebrate biota and wetland and upland vegetation; quantitative evaluations of soil invertebrate physiological parameters such as enzyme activity and respiration rates; and quantitative evaluations of biologically mediated soil processes, such as litter decomposition and nitrogen mineralization. Toxicity tests of site soils, sediments, and surface waters were also conducted with a variety of invertebrate, vertebrate, and plant test organisms. The specific measurement endpoints for each assessment endpoint at the TBP AOC are presented in Tables S.2 through S.6.

On the basis of media-based hazard quotient (HQ) risk estimates, growth of herbaceous vegetation is at risk from antimony, arsenic, barium, cadmium, chromium, copper, lead, manganese, and selenium (Table S.2). Growth and reproduction of woody and herbaceous understory vegetation in forested areas are at risk from metals in soils at the pushout area along the forest/marsh boundary (Table S.3). Microbial abundance and community structure, as well as nutrient cycling processes, are at risk from metals in soils at the pushout area. Macroinvertebrate abundance, diversity, survival, and growth are at risk from metals in soils at the pushout area and pits (Table S.4). The survival, growth, and/or reproduction of primary and secondary consumers are at risk from trichloroethene (TRCLE) and metals (antimony, arsenic, barium, cadmium, chromium, copper, lead, and zinc) in soils from the pushout area, pits, and the southwestern suspect burning area (Table S.5). On the basis

TABLE S.2 Hazard Quotient (HQ) Risk Characterization Summary for Herbaceous Vegetation at J-Field

J-Field AOC	Rationale for AE Selection	Measurement Endpoint	Results	Risk Characterization
Toxic Burning Pits	Growth of herbaceous vegetation	Hazard quotient based on comparison of maximum concentration or 95% UCL of the mean measured soil concentrations to a benchmark value; Sb, As, Ba, Cd, Cr, Cu, Pb, Mn, Se, and Aroclor 1248	HQs $\geq$ 1.0 for 9 metals	Growth at risk from metals in soil
	Survival of herbaceous vegetation	As above; Co, Hg, Ag, and fluorene only	HQs $\geq$ 1.0 for 3 metals	Survival at risk from metals in soil
	Reproduction of herbaceous vegetation	As above; Zn only	HQ $\geq$ 1.0	Reproduction at risk from Zn in site soil
White Phosphorus Pits	Growth of herbaceous vegetation	As above; Sb, Cd, Cr, Cu, Pb, and Ni only	HQs $\geq$ 1.0 for Cr and Pb	Growth at risk from Cr and Pb
	Survival of herbaceous vegetation	As above; Hg only	HQ < 1.0	Survival not at risk from soil
	Reproduction of herbaceous vegetation	As above; Zn only	HQ $\geq$ 1.0	Reproduction at risk from Zn in site soil
Riot Control Pit	Growth of herbaceous vegetation	As above; Sb, Cd, Cr, Cu, Pb, and Ni only	HQs $\geq$ 1.0 for Cr, Cu, Pb, and Ni	Growth at risk from Cr, Cu, Pb, and Ni in site soil
	Survival of herbaceous vegetation	As above; Hg and Ag only	HQ $\geq$ 1.0 for Ag	Survival at risk from Ag in site soil
	Reproduction of herbaceous vegetation	As above; Zn only	HQ $\geq$ 1.0 for Zn	Reproduction at risk from Zn in site soil
South Beach Trench	Growth of herbaceous vegetation	As above; Cd, Cu, Pb, and Ni only	All HQs < 1.0	Growth not at risk from site soil
	Survival of herbaceous vegetation	As above; no PCOEC	All HQs < 1.0	Survival not at risk from site soil

TABLE S.2 (Cont.)

J-Field AOC	Rationale for AE Selection	Measurement Endpoint	Results	Risk Characterization
	Reproduction of herbaceous vegetation	As above; Zn only	HQ $\geq$ 1.0 for Zn	Reproduction at risk from Zn in site soil
Robins Point Demolition Ground	Growth of herbaceous vegetation	As above; Sb, Cr, Cu, Pb, Mn, and Ni only	HQ $\geq$ 1.0 for Cr	Growth at risk from Cr in soil
	Survival of herbaceous vegetation	As above; Hg and Ag only	HQ $\geq$ 1.0 for Ag	Survival at risk from Ag in site soil
	Reproduction of herbaceous vegetation	As above; Zn only	HQ $\geq$ 1.0 for Zn	Reproduction at risk from Zn in site soil
Robins Point Tower Site	Growth of herbaceous vegetation	As above; Pb, Mn, and Ni only	HQ $\geq$ 1.0 for Pb and Ni.	Growth at risk from Pb and Ni in soil
	Survival of herbaceous vegetation	As above; Hg only	HQ < 1.0	Survival not at risk from site soil
	Reproduction of herbaceous vegetation	As above; Zn only	HQ $\geq$ 1.0 for Zn	Reproduction at risk from Zn in site soil
Prototype Building	Growth of herbaceous vegetation	As above; Sb, Cd, Cu, Pb, Mn, and Ni only	HQ $\geq$ 1.0 for Mn	Growth at risk from Mn in site soil
	Survival of herbaceous vegetation	As above; Hg only	HQ < 1.0	Survival not at risk from site soil
	Reproduction of herbaceous vegetation	As above; Zn only	HQ $\geq$ 1.0 for Zn	Reproduction at risk from Zn in site soil
Ruins Site[a]	Growth of herbaceous vegetation	As above; Pb and Ni only	HQ $\geq$ 1.0 for Ni	Growth at risk from Ni in site soil
	Survival of herbaceous vegetation	As above; Hg only	HQ < 1.0	Survival not at risk from site soil
	Reproduction of herbaceous vegetation	As above; Zn only	HQ $\geq$ 1.0 for Zn	Reproduction at risk from Zn in site soil

[a] The Ruins site is a potential area of concern.

TABLE S.3 Risk Characterization Summary for Plant Community Assessment Endpoints at the TBP 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. Field biomass measurements using quadrats and reference sites. Biomass considered to directly reflect overall growth.	Reduced mean seedling height and weight from 2 TBP pushout area locations. Biomass was significantly lower in areas (pushout area) with significantly higher total heavy metal concentrations (compared to reference locations).	Growth of old-field herbaceous vegetation is at risk from heavy metals in soils at the TBP, especially at the pushout area and the pits.
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.	Low (0 - <75%) seedling emergence rates for soils from pits and pushout area.	Reproduction of old-field herbaceous vegetation is at risk from heavy metals in soils at the TBP, especially from the pushout area and the pits.
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.	0% survival in soils from VX and southern main pits; only 50% survival in pushout area soil.	Survival of old-field herbaceous vegetation is at risk from heavy metals in soils from the pushout area and the pits.
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 reduced at pits and pushout area soils that had higher total heavy metal concentrations than reference location soils.	Diversity of old-field herbaceous vegetation is at risk from heavy metals in soils from the pushout area and the pits.

TABLE S.3 (Cont.)

Assessment Endpoint (AE)	Rationale for AE Selection	Measurement Endpoint	Results	Risk Characterization
Growth of marsh 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. Evaluated from one location only in the pushout area.	Mean seedling weight and height < 50% that of control soil.	Growth of marsh herbaceous vegetation is at risk in the pushout area from heavy metals.
		Field biomass measurements using quadrats at 5 plots and reference sites. Biomass considered to directly reflect overall growth.	Biomass at marsh pushout area <30% of biomass measured at reference site.	
Reproduction of marsh 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.	Seed germination reduced 25 – 100% in soils from marsh pushout area.	Reproduction of marsh herbaceous vegetation is at risk in pushout area from heavy metals in soils.
Survival of marsh herbaceous vegetation	Survival directly affects population size, community structure, productivity, and biomass.	Toxicity testing with site soils and an endpoint of seedling survival.	50% survival in test seedlings exposed to marsh pushout area soil.	Survival of marsh herbaceous vegetation at risk in pushout area from heavy metals.
Diversity of marsh 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.	No reduction in diversity observed.	Diversity of marsh vegetation is not at risk from heavy metals in the site soils.

TABLE S.3 (Cont.)

Assessment Endpoint (AE)	Rationale for AE Selection	Measurement Endpoint	Results	Risk Characterization
Growth of forest woody plants and herbaceous understory 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. Forest habitat not expected to have been exposed by past site activities. One location sampled near forest/marsh boundary immediately below the pushout area.	Mean seedling height and weight reduced by approximately 50% compared to negative control.	Growth of forest woody plants and herbaceous understory vegetation may be at risk along forest/marsh boundary areas that border pushout area.
Reproduction of forest woody plants and herbaceous understory 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. Forest habitat not expected to have been exposed by past site activities. One location sampled near forest/marsh boundary.	Seed germination reduced relative to negative control (10% vs 65%).	Reproduction of forest woody plants and herbaceous understory vegetation at risk at the forest/marsh boundary at the TBP AOC.
Survival of forest woody plants and herbaceous understory vegetation	Survival directly affects population size, community structure, productivity, and biomass.	Toxicity testing with site soils and an endpoint of seedling survival. Forest habitat not expected to have been exposed by past site activities. One location sampled near forest/marsh boundary.	14-day survival of all germinated seedlings.	Survival of forest woody plants and herbaceous understory vegetation not at risk at the TBP AOC.
Diversity of herbaceous understory 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 herbaceous understory diversity at the site and reference areas.	Diversity of the herbaceous understory vegetation was greater than diversity at the reference location.	Diversity of the herbaceous understory vegetation is not at risk at the TBP AOC.

TABLE S.4 Risk Characterization Summary for Soil Microbiota and Macroinvertebrate Assessment Endpoints at the TBP 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.	Direct measurement of fungal and bacterial biomass; considered representative of overall fungal and bacterial abundance and productivity.	Fungal and bacterial biomass significantly lower at pushout area than at reference site.	Microbial abundance and community structure at risk from metals in soils from the pushout area.
		Nematode abundance and community structure; reflects disruption of microinvertebrate community structure.	Within specific trophic groups, nematode abundance significantly lower at pushout area locations than at reference site.	
		Biomass nitrogen production; considered representative of soil microbial biomass, which in turn reflects overall microbial abundance.	Biomass nitrogen at the pushout area significantly lower than at the reference site.	
		Basal and substrate-induced soil respiration measured as CO_2 evolution; considered as representative of microbial decomposition and nutrient cycling activity.	Basal and substrate-induced respiration significantly lower at pushout area than at reference site.	Nutrient cycling processes at risk from heavy metals in soils at the pushout area.
		Activity of nutrient-acquiring enzymes; direct measure of microbial activity related to organic matter degradation and nutrient cycling.	Nutrient-acquiring enzyme activities significantly lower than at reference site; activity significantly and negatively correlated with total heavy metal concentration.	
		Soil nitrogen mineralization rate; representative of nitrogen cycling by soil microbiota.	Nitrogen mineralization rates significantly lower at pushout area than at reference site.	
		Litter decomposition; direct measure of microbial degradation of organic matter and subsequent nutrient release.	Litter decomposition differed temporally between the pushout area and the reference site.	

TABLE S.4 (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. Soil macroinvertebrates also important as prey for higher trophic level biota, including wildlife. 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 abundance of epifauna considered direct indicator of surface activity.	Abundance and diversity of macroinvertebrate infauna lower at the pushout area than at reference area. Activity of epigeic invertebrates greater at pushout area than at reference site.	Macroinvertebrate abundance and diversity at risk from metals at the pushout area and the southern main pit.
		Survival of macroinvertebrate infauna; evaluated using earthworm toxicity testing with an endpoint of survival rate.	Survival significantly lower in soils from the southern main pit than other locations or control.	Macroinvertebrate survival and growth at risk from metals in soils at the pits and the pushout area.
		Growth of macroinvertebrate infauna; evaluated using earthworm toxicity testing with an endpoint of change in mean body weight.	Reduced growth observed for soils from the southern main pit, soils immediately adjacent to both pits, and the pushout area.	
		Exposure of macroinvertebrate epifauna evaluated via tissue analysis; considered to be representative of contaminant bioconcentration and availability to higher trophic levels.	Seven metals and dieldrin (1 of 2 samples) detected in insects collected from the AOC.	Exposure and subsequent uptake of some metals and dieldrin.

TABLE S.5 Hazard Quotient (HQ) Risk Characterization Summary for Terrestrial Vertebrates at the TBP 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 PCOECs for the eastern cottontail, muskrat, and the white-tailed deer to dose-based benchmark values.	Eastern cottontail: HQs ≥1 for Sb, As, Ba, Cr, Cu, Pb, TRCLE, & Zn. White-tailed deer: HQs ≥1 for Sb, As, & PB. Muskrat: HQs≥1 for Sb, As, Ba, Cd, Pb, & TRCLE.	Primary consumers are at risk from metals and TRCLE in the TBP main pits, pushout area, and southwestern suspect burning area.
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 PCOECs for the mallard, American robin, American swallow, and white-footed mouse to dose-based benchmark values.	Mallard: HQs ≥1 for Pb, & Zn. American robin: HQs ≥1 for Sb, As, Ba, Cd, Cr, Pb, & Zn. American swallow: all HQs <1. White-footed mouse: HQs ≥1 for Sb, As, Ba, Cr, Cu, Pb, & TRCLE.	Secondary consumers are at risk from metals and TRCLE in the TBP main pits, pushout area, and southwestern suspect burning area. Avian insectivores are not at risk from TBP contaminants.
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 PCOECs (including bioaccumulative compounds detected at the TBP such as DDT and metabolites, dieldrin, and PAHs) for the great blue heron, American kestrel, red-tailed hawk, and red fox to dose-based benchmark values.	HQs for all tertiary consumers were <1.	There are no unacceptable risks to tertiary consumers from contaminants at the TBP AOC.

TABLE S.6 Risk Characterization Summary for Aquatic Biota Assessment Endpoints at the TBP 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 and thus indirectly affect the food availability for upper trophic level predators; growth also considered to directly reflect overall plant productivity and condition.	Growth of *Selenastrum* (planktonic alga) and *Lemna* (vascular aquatic plant) exposed to surface water from the AOC in 96-h toxicity tests.	Reduced growth of *Selenastrum* and *Lemna*.	Risks to growth of phytoplankton and vascular plants from surface water along margins of pushout area of the AOC.
Zooplankton	Zooplankton serve an important role as a food source for higher trophic level predators. Primary exposure route is concentrations of PCOECs in surface water.	Toxicity tests to evaluate survival, growth, and reproduction of zooplankton exposed to surface water from the AOC. Survival: 48-h toxicity to *Daphnia* and 7-day toxicity to *Ceriodaphnia*. Growth: 7-day toxicity testing with *Ceriodaphnia*. Reproduction: 7-day toxicity testing with *Ceriodaphnia*.	No effects on survival, growth, or reproduction compared to laboratory controls.	Zooplankton not at risk from PCOECs in surface water at the AOC.
Benthic invertebrates	Benthic invertebrates serve an important role as a food source for higher trophic level predators. Primary exposure route is concentrations of PCOECs 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. Measured abundance and diversity of benthic invertebrates in samples from the AOC.	Reduced survival and growth of *Hyalella.* No effect on the abundance and diversity of benthic invertebrates in the marsh pond.	Contaminants in sediments may pose a risk to benthic invertebrates along the margins of the pushout area, although abundance and diversity of benthic invertebrates in the marsh pond appear unaffected.

TABLE S.6 (Cont.)

Assessment Endpoint (AE)	Rationale for AE Selection	Measurement Endpoint	Results	Risk Characterization
Fish	Fish represent a link from zooplankton and benthic invertebrates to piscivorous birds.	Toxicity tests to evaluate effects of surface water from the AOC on survival (48-h) and growth (7-day) of *Pimephales*. Presence/absence of various life stages (larvae and adults) in pond at AOC used as indication of reproductive success and survival. Health and condition of fish from marsh pond compared to health and condition of fish from reference area using necropsy evaluation methods for *Fundulus*.	Reduced survival and growth of *Pimephales* in toxicity tests with water from locations along boundary of pushout area. No toxicity detected for water from marsh pond. Adults and larvae of several fish species present in marsh pond, indicating successful reproduction and recruitment. No significant effect on health and condition of fish in marsh pond.	Risks to survival and growth of young fish from PCOECs in surface water along the boundary of the pushout area.
Amphibians	Amphibians represent a trophic link from marsh insects to birds and other predators.	48- and 96-h 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.

of toxicity tests, the growth of phytoplankton and vascular plants is at risk from metals in surface water from along the pushout area/marsh boundary. The growth and survival of benthic invertebrates are at risk from metals in sediment from along the pushout area/marsh boundary; while the survival and growth of young fish are at risk from metals in surface water from this area (Table S.6).

S.7.1.2 Overall Conclusion

The concentrations of metals present in soils in the main pits and the pushout area and in sediments along the boundary between the marsh and the pushout area pose a risk to a variety of ecological attributes at multiple trophic levels. On the basis of this risk characterization, remediation to reduce exposure concentrations of metals in surface soils at the main pits and the pushout area and in sediments at the boundary between the marsh and the pushout area may be appropriate. The greatest impacts appeared to be associated with the pushout area and the main pits. The HQ risk estimates identified several contaminants as posing potentially high to extreme risks to wildlife. These risks were associated primarily with soil levels of antimony, arsenic, lead, mercury, and zinc. On the basis of these results, the TBP AOC poses a risk to ecological resources that are largely restricted to the AOC proper, but little or no risk to wide-ranging receptors that may visit the site for short periods.

S.7.2 White Phosphorus Pits Area of Concern

S.7.2.1 Risk Characterization Summary

The assessments conducted at the WPP AOC included quantitative and qualitative surveys of terrestrial invertebrate and vertebrate biota and wetland and upland vegetation; quantitative evaluations of soil microbial respiration rates and soil invertebrate-mediated processes, such as litter decomposition and nitrogen mineralization; and toxicity tests of site soils, sediments, and surface waters with a variety of invertebrate, vertebrate, and plant test organisms. The specific measurement endpoints for each assessment endpoint at the WPP AOC are presented in Tables S.2 and S.7 through S.9.

Media-derived HQ risk estimates indicate that the growth of herbaceous vegetation is at risk from chromium and lead, and that reproduction of herbaceous vegetation is at risk from zinc in the soils from the suspect pushout area and main pits (Table S.2). On the basis of toxicity tests, the growth and reproduction of old-field herbaceous vegetation are at risk from metals in soils at the suspect pushout area and the northern main pit (Table S.7). On the basis of toxicity tests, growth of soil-dwelling macroinvertebrates is at risk from metals in soils at the suspect pushout area (Table S.8). Dose modeling demonstrates that the growth, survival, and/or reproduction of

TABLE S.7 Risk Characterization Summary for Plant Community Assessment Endpoints at the WPP 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 main pit and suspected pushout area; 65% seedling emergence rate from negative control, and > 90% from southern main pit and suspect filled trench areas.	Reproduction of old-field herbaceous vegetation at risk at the northern main 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 S.8 Risk Characterization Summary for Soil Microbiota and Macroinvertebrate Assessment Endpoints at the WPP 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 as 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 S.8 (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 growth of macroinvertebrate at risk from metals in soils from the suspect pushout area. Macroinvertebrate survival not at risk.
		Growth of macroinvertebrate infauna; evaluated using earthworm toxicity testing.	Slightly reduced growth in soil from the south trench and the suspect trench areas.	

TABLE S.9 Hazard Quotient (HQ) Risk Characterization Summary for Terrestrial Vertebrates at the WPP 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 PCOECs 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 PCOECs 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 a 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 PCOECs 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.

mammalian primary consumers are at risk from antimony, lead, and mercury in the soils from the northwest and southwest suspect burning areas and the suspect storage area. The growth, survival, and/or reproduction of avian secondary consumers are at risk from chromium, lead, and zinc in the soils from the same areas at this AOC (Table S.9). On the basis of toxicity tests, phytoplankton growth is at risk from surface water of the small pond that receives runoff from the northern main pit at the WPP AOC (Table S.10). However, qualitative observations indicate an apparently healthy aquatic community in the pond, suggesting that the toxicity tests for phytoplankton (*Selenastrum*) production may have been overly sensitive.

S.7.2.2 Overall Conclusion

Terrestrial organisms may be at risk from some of the metals in the soils at the WPP AOC. There does not appear to be an unacceptable risk to ecological resources in the aquatic habitats at this AOC. On the basis of these results, the contaminated media at the WPP AOC pose an overall low risk to ecological receptors at the site, and any risks would be limited to biota that would use the pits and presumed pushout area.

S.7.3 Riot Control Pit Area of Concern

S.7.3.1 Risk Characterization Summary

The assessments conducted at the RCP AOC included quantitative evaluations of the abundance of soil invertebrates and community composition; qualitative surveys of wetland and upland vegetation; qualitative surveys of aquatic and terrestrial invertebrates and vertebrates; quantitative evaluations of soil invertebrate physiological parameters, such as enzyme activity and respiration rates, and soil invertebrate-mediated processes, such as litter decomposition and nitrogen mineralization; and toxicity tests for site soils, sediments, and surface waters. A variety of invertebrate, vertebrate, and plant test organisms were used in the testing. The specific measurement endpoints for each assessment endpoint at the RCP AOC are presented in Tables S.2 and S.11 through S.14.

Media-derived HQ risk estimates indicate that the growth of herbaceous understory vegetation is at risk from chromium, copper, lead, and nickel; while survival is at risk from silver; and reproduction is at risk from zinc in the soils from the trench (Table S.2). On the basis of toxicity tests, reproduction of forest woody and herbaceous understory vegetation are at risk from metals in the soils from directly within the trench and suspect trench areas (Table S.11). Microbial abundance and community structure and nutrient cycling processes may be at risk from metals in soil from the trench (Table S.12). However, observed effects may be due to physical disturbance of the soil

TABLE S.10 Risk Characterization Summary for Aquatic Biota Assessment Endpoints at the WPP 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 and thus indirectly affect the food availability of upper trophic level predators; growth also considered to directly reflect overall plant productivity and condition.	Growth of *Selenastrum* (planktonic alga) and *Lemna* (vascular aquatic plant) exposed to surface water from the AOC in 96-h toxicity tests.	Reduced growth of *Selenastrum.* 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 serve an important role as a food source for higher trophic level predators. Primary exposure route is concentrations of PCOECs in surface water.	48-h toxicity tests to evaluate survival of *Daphnia* exposed to surface water from the AOC.	No effects on survival, compared to laboratory controls.	Zooplankton not at risk from PCOECs in surface water at the AOC.
Benthic invertebrates	Benthic invertebrates serve an important role as a food source for higher trophic level predators. Primary exposure route is concentrations of PCOECs 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 PCOECs in sediments at the AOC.
Fish	Fish represent a link from zooplankton and benthic invertebrates to piscivorous birds.	Toxicity tests to evaluate effects of surface water from the AOC on survival (48-h) 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.	48- and 96-h 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 S.11 Risk Characterization Summary for Plant Community Assessment Endpoints at the RCP AOC

Assessment Endpoint (AE)	Rationale for AE Selection	Measurement Endpoint	Results	Risk Characterization
Growth of forest woody plants and herbaceous understory vegetation	Reductions in growth directly affect food availability for primary consumers and thus indirectly affect the food availability of 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.	Two locations evaluated. Height and weight unavailable for soils from suspect trench because no seedling germination. Mean seedling height and weight for trench soil did not differ from control.	Growth of forest woody and herbaceous understory vegetation not at risk at RCP AOC; risk from suspect trench unknown.
		Field biomass measurements using quadrats and reference sites. Biomass considered to directly reflect overall growth.	No above ground vegetation at two sample locations directly within pit, and very low biomass (<0.6 g/0.1m^2) at third adjacent location. Biomass at remainder of sample locations higher than reference site.	Growth of forest woody and herbaceous understory vegetation not at risk at the RCP AOC. Potential risks at three pit locations may be due to soil disturbance rather than contamination.
Reproduction of forest woody plants and herbaceous understory 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.	Seedling germination less than 75% at 3 of 12 locations. Germination rate was 91% for standard control and 65% for negative control.	Reproduction of forest woody and herbaceous understory vegetation not at risk at RCP AOC with exception localized area at trench and suspect trench.
Survival of forest woody plant and herbaceous understory vegetation	Survival directly affects population size, community structure, productivity and biomass.	Toxicity testing with site soils and an endpoint of seedling survival.	0% survival recorded for suspect trench area; 80% survival for the known trench soil location; 80 – 100% survival of test plants from both locations in definitive tests.	Survival of forest woody and herbaceous understory vegetation not at risk from soils at RCP AOC. Potential risk at suspect trench area, though no risks indicated for this location from definitive tests.

TABLE S.11 (Cont.)

Assessment Endpoint (AE)	Rationale for AE Selection	Measurement Endpoint	Results	Risk Characterization
Diversity of forest woody and herbaceous understory 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 species diversity and richness.	No observed difference between RCP locations and reference site in species diversity or richness.	Diversity of forest woody and herbaceous understory vegetation not at risk from soils at the RCP AOC.

TABLE S.12 Risk Characterization Summary for Soil Microbiota and Macroinvertebrate Assessment Endpoints at the RCP 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 affect primary production. Disruption/ alteration of soil biota populations may lead to localized disruption of ecosystem structure and function.	Direct measurement of fungal and bacterial biomass; considered representative of overall fungal and bacterial abundance and productivity.	Fungal biomass reduced in pit area soils compared to background soils. Bacterial biomass was higher in pit soils than in background soils.	Microbial abundance and community structure may be at risk from metals in soils from the pit area. However, observed affects may be due to physical disturbance in soil horizons at the pit area and not due to potential contaminants in the soil.
		Protozoan abundance.	No significant difference in protozoan abundance between pit area and reference site soils.	
		Nematode abundance and community structure; reflects disruption of microinvertebrate community structure.	Total abundance reduced and trophic level-specific abundance different between pit area and background locations.	
		Biomass nitrogen production; considered representative of soil microbial biomass, which in turn reflects overall microbial abundance.	Microbial biomass nitrogen reduced by 50% at the pit area over background. Difference may be due to physical differences in soil horizons.	
		Basal and substrate-induced soil respiration measured as CO_2 evolution; considered as representative of microbial decomposition and nutrient cycling activity.	No significant differences in substrate-induced respiration observed.	Nutrient cycling processes may be at risk from heavy metals in pit soil. However, the observed adverse effects may be due to physical disturbance to the soil horizons in the pit rather than to contaminant effects.

TABLE S.12 (Cont.)

Assessment Endpoint (AE)	Rationale for AE Selection	Measurement Endpoint	Results	Risk Characterization
		Activity of nutrient-acquiring enzymes; direct measure of microbial activity related to organic matter degradation and nutrient cycling.	No significant differences in enzyme activity observed.	
		Soil nitrogen mineralization rate; representative of nitrogen cycling by soil microbiota.	Nitrogen mineralization reduced in pit compared to background site	
		Litter decomposition; direct measure of microbial degradation of organic matter, subsequent nutrient release and cycling.	Litter decomposition reduced in pits compared to background site.	
Maintenance of soil macroinvertebrate community structure and function	Soil macroinvertebrates important in decomposition and nutrient cycling, which in turn affect primary production. Soil macroinvertebrates also important as prey for higher trophic level biota, including wildlife. Disruption/alteration of soil biota populations may lead to localized disruption of ecosystem structure and function.	Abundance of macroinvertebrate epifauna; reflects overall community structure. Total number of epifauna captured considered a direct measure of surface activity.	No significant difference in abundance of epigeic invertebrates between the pit area and the background site. No significant difference in abundance/activity of epigeic invertebrates between AOC and background site.	Abundance of soil macroinvertebrates not at risk at the AOC.
		Survival of macroinvertebrate infauna; evaluated using earthworm toxicity testing.	100% survival in all sampled soils (suspected previous trench and main pit)	Growth and survival of soil macroinvertebrates not at risk at the AOC.
		Growth of macroinvertebrate infauna; evaluated using earthworm toxicity testing.	Mean growth rates did not significantly differ from controls.	

TABLE S.13 Hazard Quotient (HQ) Risk Characterization Summary for Terrestrial Vertebrates at the RCP 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 PCOECs for the eastern cottontail and the white-tailed deer to dose-based benchmark values.	Eastern cottontail: HQs for Cr, Cu, and Pb ≥ 1. White-tailed deer: all HQs <1	Risks to primary consumers from three metals in soils from localized areas of the main pit.
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 PCOECs for the American robin and white-footed mouse to dose-based benchmark values.	American robin: HQs ≥ 1 for Cr, Cu, Pb, and Zn. White-footed Mouse: all HQs <1.	Risks to secondary consumers, especially omnivorous birds, from metals in soils from localized areas of the main pit.
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 PCOECs for the red fox to dose-based benchmark values.	Red fox: all HQs <1.	No risks to tertiary consumers from the contaminants at the AOC.

TABLE S.14 Risk Characterization Summary for Aquatic Biota Assessment Endpoints at the RCP 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 and thus indirectly affect the food availability of upper trophic level predators; growth also considered to directly reflect overall plant productivity and condition.	Growth of *Selenastrum* (planktonic alga) and *Lemna* (vascular aquatic plant) exposed to surface water from the AOC in 96-h toxicity tests.	Reduced growth of *Selenastrum.* 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 serve an important role as a food source for higher trophic level predators. Primary exposure route is concentrations of PCOECs in surface water.	Toxicity tests to evaluate survival, growth, and reproduction of zooplankton exposed to surface water from the AOC. Survival: 48-h toxicity to *Daphnia* and 7-day toxicity to *Ceriodaphnia*. Growth: 7-day toxicity testing with *Ceriodaphnia*. Reproduction: 7-day toxicity testing with *Ceriodaphnia*.	No effects on survival, growth, or reproduction compared to laboratory controls.	Zooplankton not at risk from PCOECs in surface water at the AOC.
Benthic invertebrates	Benthic invertebrates serve an important role as a food source for higher trophic level predators. Primary exposure route is concentrations of PCOECs 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 PCOECs in sediments at the AOC.
Amphibians	Amphibians represent a trophic link from marsh insects to birds and other predators.	48- and 96-h toxicity tests with *Rana* larvae to evaluate survival when exposed to surface water from the AOC.	No toxicity to *Rana* larvae.	Survival of amphibians not at risk from exposure to surface water at the AOC.

horizons and not from soil contaminants. On the basis of media-derived HQ risk estimates, growth, survival, and/or reproduction of mammalian primary consumers may be at risk from chromium, copper, and lead in the soils from the trench. Similarly, avian secondary consumers may be at risk from chromium, copper, lead, and zinc (Table S.13). On the basis of toxicity tests, the growth of phytoplankton may be at risk from metals in surface waters at the RCP AOC. However, no risks are indicated for vascular plants, zooplankton, benthic invertebrates, or amphibians (Table S.14).

S.7.3.2 Overall Conclusion

The concentrations of some metals in localized areas of the main trench may pose a risk to ecological components. Observed effects were associated with soils from a small area within the trench proper. The media-based and dose-based HQ values ≥ 1 were largely driven by soil metal concentrations at single sample locations within the trench. Therefore, the ecological significance of the risks posed by the AOC is believed to be small. Little evidence exists to indicate that surface waters at the site pose a risk to aquatic biota, particularly given the very limited nature of the aquatic biota at the site. The principal risks at the site are related to soil contamination. Although a strong potential for adverse risks from soil contamination was suggested by the number of measured adverse effects and the modeled risks, the magnitude of some of the impacts (slight reduction in earthworm weight) was relatively minor, while the observed reduction in plant biomass may have been due more to factors unrelated to contamination (loss of topsoil during initial excavations). In addition, the adverse effects identified at the site were limited to the immediate vicinity of the pit and were not widespread across the AOC. Thus, the overall level of ecological risk posed at the site is low.

S.7.4 South Beach Trench Area of Concern

S.7.4.1 Risk Characterization Summary

The assessments conducted at the SBT AOC were less intensive than those conducted at some of the other AOCs because of the small size of and limited wildlife habitat at the SBT AOC. The effects assessment included quantitative surveys of soil-dwelling and epigeic invertebrates; qualitative surveys of amphibians; quantitative evaluations of nutrient-acquiring enzyme activity and soil respiration rates; and toxicity tests of site soils, sediments, and surface waters. Several types of invertebrate, vertebrate, and plant toxicity tests were used. The specific measurement endpoints for each assessment endpoint at the SBT AOC are presented in Tables S.2 and S.15 through S.18.

On the basis of media-derived HQ risk estimates, reproduction of herbaceous vegetation is at risk from zinc in soils from the trench (Table S.2). On the basis of field studies, growth of forest

TABLE S.15 Risk Characterization Summary for Plant Community Assessment Endpoints at the SBT AOC

Assessment Endpoint (AE)	Rationale for AE Selection	Measurement Endpoint	Results	Risk Characterization
Growth of forest woody plants and herbaceous understory vegetation	Reductions in growth directly affect food availability for primary consumers and thus indirectly affect the food availability of upper trophic level predators; growth also considered to directly reflect overall plant productivity and condition.	Field biomass measurements of understory herbaceous vegetation using quadrats and reference sites. Biomass considered to directly reflect overall growth.	Little or no biomass (0 – 0.1 g/ 0.1 m^2) measured for two locations immediately within the trench proper. Biomass from outside the trench much higher (2.6 – 4.9 g/m^2).	Growth of forest herbaceous understory vegetation at risk from soils within the trench proper at the SBT AOC.
Reproduction of forest woody plants and herbaceous understory 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.	Seed germination significantly different from control (61 vs. 91%) at only one sample location, directly from the center of the trench. Seed germination at all other sample locations, including two within the trench, not different from control, ranging from 73 to 89%.	Reproduction of forest woody plants and herbaceous understory vegetation at risk from soils at the SBT AOC immediately within the center of the trench.

TABLE S.16 Risk Characterization Summary for Soil Microbiota and Macroinvertebrate Assessment Endpoints at the SBT 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.	Direct measurement of fungal and bacterial biomass; considered representative of overall fungal and bacterial abundance and productivity.	Fungal and bacterial biomass higher at AOC than at reference area.	Microbial abundance and community structure not at risk at the AOC.
		Protozoan abundance.	No significant difference in flagellate or ciliate abundance; amoebae abundance significantly lower from the trench than the reference site.	
		Nematode abundance.	No significant difference in nematode abundance between AOC and reference site.	
		Substrate-induced soil respiration measured as CO_2 evolution; considered as representative of microbial decomposition and nutrient cycling activity.	No significant difference in substrate-induced respiration between the AOC and reference site.	Nutrient cycling processes not at risk at the AOC.
		Activity of nutrient-acquiring enzymes; direct measure of microbial activity related to organic matter degradation and nutrient cycling.	No significant difference in enzyme activities between the AOC and reference site.	

TABLE S.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 affect primary production. Soil macroinvertebrates also important as prey for higher trophic level biota, including wildlife. 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 significant difference in total abundance of soil macroinvertebrates between AOC and reference site; number of taxa at AOC almost twice that of reference site. No significant difference in abundance/ activity of epigeic invertebrates between AOC and reference site.	Abundance and diversity of macroinvertebrate infauna not at risk at the AOC.

TABLE S.17 Hazard Quotient (HQ) Risk Characterization Summary for Terrestrial Vertebrates at the SBT 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 PCOECs for the eastern cottontail and white-tailed deer to dose-based benchmark values.	HQs for all primary consumers were <1.	No risks to primary consumers 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 PCOECs for the American robin and white-footed mouse to dose-based benchmark values.	American robin: HQs ≥1 for Pb and Zn. White-footed mouse: all HQs <1.	Risks to secondary consumers from Pb and Zn in soils 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 PCOECs for the red fox to dose-based benchmark values.	All HQs <1.	No risks to tertiary consumers from the contaminants at the AOC.

TABLE S.18 Risk Characterization Summary for Aquatic Biota Assessment Endpoints at the SBT 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 and thus indirectly affect the food availability of upper trophic level predators; growth also considered to directly reflect overall plant productivity and condition.	Growth of *Selenastrum* (planktonic alga) and *Lemna* (vascular aquatic plant) exposed to surface water from the AOC in 96-h toxicity tests.	Reduced growth of *Selenastrum.* 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 serve an important role as a food source for higher trophic level predators. Primary exposure route is concentrations of PCOECs in surface water.	48-h toxicity tests to evaluate survival of *Daphnia* exposed to surface water from the AOC. 7-day toxicity tests to evaluate survival and growth of *Ceriodaphnia* exposed to surface waters from the AOC.	No effects on survival or growth compared to laboratory controls.	Zooplankton not at risk from PCOECs in surface water at the AOC.
Benthic invertebrates	Benthic invertebrates serve an important role as a food source for higher trophic level predators. Primary exposure route is concentrations of PCOECs 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 PCOECs in sediments at the AOC.
Fish	Fish represent a link from zooplankton and benthic invertebrates to piscivorus birds.	Toxicity tests to evaluate effects of surface water from the AOC on survival (48-h) 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 insects to marsh birds and other terrestrial predators.	48- and 96-h 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.

herbaceous understory vegetation is at risk from metals in soils from the trench; while toxicity tests indicate that reproduction of forest herbaceous understory vegetation is at risk (Table S.15). No risks are indicated for microbial abundance and community structure, nutrient cycling processes, or abundance and diversity of soil macroinvertebrates (Table S.16). Growth, survival, and/or reproduction of avian secondary consumers are at risk from lead and zinc in soils from the trench (Table S.17). On the basis of toxicity tests, growth of phytoplankton may be at risk in seasonally present surface waters from the trench (Table S.18).

S.7.4.2 Overall Conclusion

The concentrations of zinc and lead at the SBT AOC may pose a risk to vegetation and secondary avian consumers. Observed effects and calculated HQs ≥ 1 were associated with soils from the small area within the trench. The ecological significance of the risks posed by the AOC is believed to be small. On the basis of the weight of evidence, the SBT AOC poses little risk to ecological resources at the site. No adverse effects to ecological parameters were identified for surface water and sediment from the site.

S.7.5 South Beach Demolition Ground Area of Concern

S.7.5.1 Risk Characterization Summary

The assessments conducted at the SBDG AOC was very limited because the site is now located offshore in Chesapeake Bay. The assessment focused primarily on the large detonation crater located onshore north of the RPDG AOC. The assessment included surveys for fish and amphibians and acute and chronic toxicity testing of surface water and sediment from the crater. The specific measurement endpoints for each assessment endpoint at the SBDG AOC are presented in Table S.19.

On the basis of toxicity tests, survival and growth of benthic invertebrates are at risk from sediments in an onshore crater at the SBDG (Table S.19). However, qualitative observations of invertebrates and amphibians in the crater pond indicate an apparently healthy aquatic community. On the basis of dose-modeling and HQ risk estimates, mammalian and avian receptors are not at risk from PCOECs in surface waters in the SBDG on-shore crater (i.e., all HQs are below 1.0).

S.7.5.2 Overall Conclusion

Most of the SBDG site is located offshore. Thus, the ERA was limited to a single large onshore crater that ponds from precipitation during portions of the year. On the basis of toxicity tests,

TABLE S.19 Risk Characterization Summary for Aquatic Biota Assessment Endpoints at the SBDG 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 and thus indirectly affect the food availability of upper trophic level predators; growth also considered to directly reflect overall plant productivity and condition.	Growth of *Lemna* (vascular aquatic plant) exposed to surface water from the AOC in 96-h toxicity tests.	No effect on growth of *Lemna.*	Vascular aquatic vegetation not at risk from surface water at AOC.
Zooplankton	Zooplankton serve an important role as a food source for higher trophic level predators. Primary exposure route is concentrations of PCOECs in surface water.	48-h toxicity tests to evaluate survival of *Daphnia* exposed to surface water from the AOC.	No effects on survival of *Daphnia*.	Zooplankton not at risk from acute exposure to PCOECs in surface water at the AOC.
Benthic invertebrates	Benthic invertebrates serve an important role as a food source for higher trophic level predators. Primary exposure route is concentrations of PCOECs 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.	Reduced survival and growth of *Hyalella*.	Benthic invertebrates at risk from sediments at the AOC.
Amphibians	Amphibians represent a link from marsh insects to birds and other predators.	48- and 96-h toxicity tests with *Rana* larvae to evaluate survival when exposed to surface water from the AOC.	No toxicity to *Rana* larvae.	Survival of amphibians not at risk from exposure to surface water at the AOC.

amphibian surveys, and dose modeling, the SBDG AOC poses very little risk to aquatic biota of the onshore crater, and no significant risks to other ecological resources at J-Field. Risk estimation indicated only a low risk from a single contaminant (iron) to aquatic biota, and no risks for terrestrial wildlife were identified from uptake modeling. On the basis of these results, contamination at the onshore crater at the SBDG AOC does not pose a significant risk to ecological resources at J-Field.

S.7.6 Robins Point Demolition Ground Area of Concern

S.7.6.1 Risk Characterization Summary

The assessments conducted at the RPDG AOC included quantitative surveys of the abundance of soil invertebrates and bacterial and fungal biomasses; qualitative surveys of amphibians and birds; quantitative evaluations of nutrient-acquiring enzyme activity and soil respiration rates; evaluations of bird nesting success using nest boxes; and soil, surface water, and sediment toxicity testing with a variety of plant and animal test species. The specific measurement endpoints for each assessment endpoint at the RPDG AOC are presented in Tables S.2 and S.20 through S.23.

HQ risk estimates indicate herbaceous vegetation growth is at risk from chromium in soils from the berm area; while survival is at risk from Ag and reproduction is at risk from zinc (Table S.2). On the basis of toxicity tests, reproduction of old-field herbaceous vegetation is at risk from metals in soil from the berm area (Table S.20). On the basis of field studies, nutrient cycling processes are at risk from metals in soil at the berm area (Table S.21). The growth, reproduction, and survival of avian secondary consumers are at risk from lead and zinc in soil from the berm area (Table S.22). Toxicity tests indicate that growth of phytoplankton and survival of zooplankton are at risk from metals in surface waters that collect during ponding in the berm area (Table S.23).

S.7.6.2 Overall Conclusion

Overall, risks to ecological attributes are associated with soils in the berm area that separate the active and inactive portions of the RPDG AOC, and with ephemeral surface water that collects in this berm area. However, because of the nature and magnitude of the observed adverse effects and the limited availability of quality habitat in the clear area of the AOC, the ecological significance of the predicted risks is expected to be minor. Thus, the small size of the berm area and the limited nature of the effects do not warrant remediation of the RPDG AOC.

TABLE S.20 Risk Characterization Summary for Plant Community Assessment Endpoints at the RPDG AOC

Assessment Endpoint (AE)	Rationale for AE Selection	Measurement Endpoint	Results	Risk Characterization
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.	Two of four sample locations in clear area east of the berm exhibited seed germination rates (30-50%) significantly lower than control (91%).	Reproduction of old-field herbaceous vegetation is at risk from contaminants in the clear area east of the berm.
Growth of old-field herbaceous vegetation	Reductions in growth directly affect food availability for primary consumers and thus indirectly affect the food availability of upper trophic level predators; growth also considered to directly reflect overall plant productivity and condition.	Field biomass measurements using quadrants and reference sites. Biomass considered to directly reflect overall growth.	No significant difference in biomass between the clear area and the control site.	Growth of old-field herbaceous vegetation not at risk at the RPDG 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 and species richness at the site and reference areas.	Species diversity was higher at the clear area than the reference site.	Diversity of old-field herbaceous vegetation is not at risk at the RPDG AOC.
Diversity of forest woody and herbaceous understory 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 at RPDG AOC comparable to that at reference location.	Diversity of forest woody and herbaceous understory vegetation not at risk at the RPDG AOC.

TABLE S.21 Risk Characterization Summary for Soil Microbiota and Macroinvertebrate Assessment Endpoints at the RPDG 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.	Direct measurement of fungal and bacterial biomass; considered representative of overall fungal and bacterial abundance and productivity.	Total fungal biomass significantly higher at the berm area than reference site; no significant difference in total bacterial biomass.	Microbial abundance not at risk at the AOC, however, abundance within the berm area may be at risk.
		Protozoan abundance.	Abundance of flagellates and ciliates significantly lower at the berm area then reference site; no significant difference in amoebae abundance.	
		Nematode abundance.	No significant difference in abundance between the berm area and reference site.	
		Substrate-induced soil respiration measured as CO_2 evolution; considered as representative of microbial decomposition and nutrient cycling activity.	Respiration rates were significantly lower in the berm area than at reference site.	Nutrient cycling processes at risk from heavy metals in soils at the berm area.
		Activity of nutrient-acquiring enzymes; direct measure of microbial activity related to organic matter degradation and nutrient cycling.	Three enzymes evaluated; no significant difference in activity in two enzymes, activity of third enzyme significantly reduced for soils from berm area compared to reference site	
Maintenance of soil macroinvertebrate community structure and function	Soil macroinvertebrates important in decomposition and nutrient cycling, which in turn affects primary production. Soil macroinvertebrates also important as prey for higher trophic level biota, including wildlife. 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 abundance of epifauna considered direct indicator of surface activity.	No significant difference in total macroinvertebrate abundance between the AOC and reference site; number of taxa greater at AOC than reference site. Abundance/activity of epifauna greater at AOC than reference site.	Macroinvertebrate abundance and diversity not at risk at the AOC.

TABLE S.22 Hazard Quotient (HQ) Risk Characterization Summary for Terrestrial Vertebrates at the RPDG 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 PCOECs for the eastern cottontail and white-tailed deer to dose-based benchmark values.	HQs for all primary consumers were <1.	No risks to primary consumers 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 PCOECs for the American robin, tree swallow, and white-footed mouse to dose-based benchmark values.	American robin: HQs ≥1 for Pb and Zn. Tree swallow: all HQs <1. White-footed mouse: all HQs <1.	Risks to secondary consumers from Pb and Zn in soils in the inactive portion of the AOC, between the berm and the marsh.
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 PCOECs for the American kestrel, red-tailed hawk, and red fox to dose-based benchmark values.	All HQs <1.	No risks to tertiary consumers from the contaminants at the AOC.

TABLE S.23 Risk Characterization Summary for Aquatic Biota Assessment Endpoints at the RPDG 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 and thus indirectly affect the food availability of upper trophic level predators; growth also considered to directly reflect overall plant productivity and condition.	Growth of *Selenastrum* (planktonic alga) and *Lemna* (vascular aquatic plant) exposed to surface water from the AOC in 96-h toxicity tests.	Reduced growth of *Selenastrum.* No effect on growth of *Lemna.*	Phytoplankton production may be at risk, but vascular aquatic vegetation not at risk from surface water at the AOC.
Zooplankton	Zooplankton serve an important role as a food source for higher trophic level predators. Primary exposure route is concentrations of PCOECs in surface water.	Toxicity tests to evaluate survival, growth, and reproduction of zooplankton exposed to surface water from the AOC. Survival: 48-h toxicity to *Dphnia* and 7-day toxicity to *Ceriodaphnia*. Reproduction: 7-day toxicity testing with *Ceriodaphnia*.	No effects on survival of *Daphnia* or reproduction of *Ceriodaphnia*. Reduced survival of *Ceriodaphnia*.	Zooplankton survival may be at risk from surface water at the AOC.
Amphibians	Amphibians represent a trophic link from marsh insects to birds and other predators.	48- and 96-h 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.

S.7.7 Robins Point Tower Site Area of Concern

S.7.7.1 Risk Characterization Summary

Because of the absence of aquatic habitats at the RPTS AOC, no surveys of aquatic biota or toxicity testing of surface water and sediment were performed. The assessments conducted at the RPTS AOC included quantitative surveys of soil invertebrates and bacterial and fungal biomasses, quantitative evaluations of microbial enzyme activity and soil respiration rates, qualitative surveys of birds, evaluations of bird nesting success in nest boxes, and soil toxicity testing to evaluate seed emergence rates (SERs). The specific measurement endpoints for each assessment endpoint at the RPTS AOC are presented in Tables S.2 and S.24 through S.26.

Media-derived HQ risk estimates for herbaceous vegetation indicate that growth is at risk from lead and nickel, and reproduction is at risk from zinc in soils at the site (Table S.2). Both field studies and toxicity tests indicate that growth of forest woody and herbaceous understory vegetation and old-field herbaceous vegetation is at risk from metals in the soils at the site (Table S.24). Soil nematode abundance was reduced at the RPTS AOC (Table S.25). Dose modeling and HQ risk estimates indicate that growth, survival, and/or reproduction of avian secondary consumers are at risk from lead and zinc in soils at the site (Table S.26). Potential adverse effects to aquatic organisms are indicated by HQ risk estimates $\geq$1.0 for iron, lead, and zinc in offshore surface waters based on comparisons of contaminant concentrations and ambient water quality criteria.

S.7.7.2 Overall Conclusion

Risks to ecological resources are associated with offshore surface waters and soils at the RPTS AOC. Overall, contaminants at the RPTS AOC pose a risk to ecological resources, but these risks are limited to select areas within the AOC. Potential risks would not be expected to extend to other areas of J-Field. On the basis of the nature and magnitude of the measured effects and the predicted risks to aquatic and terrestrial biota, the RPTS AOC does not pose an ecologically significant risk to resources at J-Field or other APG areas.

S.7.8 Prototype Building Area of Concern

S.7.8.1 Risk Characterization Summary

Because aquatic habitats are not present at the PB AOC, the assessments focused on soil biota and soil toxicity. Soil macroinvertebrate abundance and activity, soil nematode abundance, and

TABLE S.24 Risk Characterization Summary for Plant Community Assessment Endpoints at the RPTS AOC

Assessment Endpoint (AE)	Rationale for AE Selection	Measurement Endpoint	Results	Risk Characterization
Growth of forest woody plants and herbaceous understory vegetation	Reductions in growth directly affect food availability for primary consumers and thus indirectly affect the food availability of upper trophic level predators; growth also considered to directly reflect overall plant productivity and condition.	Field biomass measurements using quadrats and reference sites. Biomass considered to directly reflect overall growth.	Biomass from one forest plot much lower than other forest plots.	Growth of forest woody and herbaceous understory vegetation at risk from soil contaminants at one location in the RPTS AOC.
Growth of old-field herbaceous vegetation	Reductions in growth directly affect food availability for primary consumers and thus indirectly affect the food availability of upper trophic level predators; growth also considered to directly reflect overall plant productivity and condition.	Field biomass measurements using quadrats and reference sites. Biomass considered to directly reflect overall growth.	Biomass from three old-field plots was significantly lower than reference location.	Growth of old-field herbaceous vegetation at risk from soil contaminants at the RPTS AOC.
Reproduction of forest woody plants and herbaceous understory 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.	Seed emergence rate significantly lower than control (91%) at four of seven forest locations (53-77%).	Reproduction of forest woody and herbaceous understory vegetation at risk from soil contaminants at the RPTS AOC.
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.	Seed emergence rates significantly lower than control (91%) at two of three sample locations (65 and 76%).	Reproduction of old-field herbaceous vegetation at risk from soil contaminants at the RPTS AOC.

TABLE S.24 (Cont.)

Assessment Endpoint (AE)	Rationale for AE Selection	Measurement Endpoint	Results	Risk Characterization
Diversity of forest woody and herbaceous understory 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 from 18 plots comparable to diversity and richness from reference locations.	Diversity of forest woody and herbaceous understory vegetation not at risk at the RPTS AOC.

TABLE S.25 Risk Characterization Summary for Soil Microbiota and Macroinvertebrate Assessment Endpoints at the RPTS 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 affect primary production. Disruption/ alteration of soil biota popula-tions may lead to localized disruption of ecosystem structure and function.	Direct measurement of fungal and bacterial biomass; considered representative of overall fungal and bacterial abundance and productivity.	Fungal and bacterial biomass significantly higher at AOC than reference site.	Microbial abundance not at risk at the AOC.
		Protozoan abundance.	No difference in abundance between AOC and reference site.	
		Nematode abundance.	Total abundance significantly lower at AOC than reference site.	
		Substrate-induced soil respiration measured as CO_2 evolution; considered as representative of microbial decomposition and nutrient cycling activity.	No significant difference in respiration rate between AOC and reference site.	Nutrient cycling processes not at risk at the AOC.
		Activity of nutrient-acquiring enzymes; direct measure of microbial activity related to organic matter degradation and nutrient cycling.	Enzyme activities at AOC greater than or similar to levels at reference site.	
Maintenance of soil macroinvertebrate community structure and function	Soil macroinvertebrate important in decomposition and nutrient cycling, which in turn affects primary production. Soil macroinvertebrates also important as prey for higher trophic level biota, including wildlife. Disruption/alteration of soil biota populations may lead to localized disruption of ecosystem structure and function.	Abundance of macroinvertebrate epifauna; total abundance of epifauna considered direct indicator of surface activity.	No significant difference in abundance or activity of macroinvertebrate epifauna.	Macroinvertebrate abundance and activity not at risk at the AOC.

TABLE S.26 Hazard Quotient (HQ) Risk Characterization Summary for Terrestrial Vertebrates at the RPTS 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 PCOECs for the eastern cottontail and white-tailed deer to dose-based benchmark values.	HQs for all primary consumers were <1.	No risks to primary consumers 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 PCOECs for the American robin and white-footed mouse to dose-based benchmark values.	American robin: HQs ≥1 for Pb and Zn. White-footed mouse: all HQs <1.	Risks to secondary consumers from Pb and Zn in soils 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 PCOECs for the red fox to dose-based benchmark values.	All HQs <1.	No risks to tertiary consumers from the contaminants at the AOC.

total fungal and bacterial biomasses were greater at the AOC than at the reference site. In contrast, active fungal and bacterial biomasses were less at the AOC. Protozoan ciliates and flagellates were less abundant at the AOC, while the abundance of amoebae did not differ between the AOC and the reference site. The specific measurement endpoints for each assessment endpoint at the PB AOC are presented in Tables S.2 and S.27 through S.29.

HQ risk estimates indicate that old-field vegetation growth is at risk from manganese and reproduction is at risk from zinc (Table S.2). Field studies and toxicity tests indicate that growth and reproduction of herbaceous old-field vegetation are at risk from metals in the soils at the PB AOC (Table S.27). Nutrient cycling may be at risk from metals in soils at the AOC (Table S.28). According to dose modeling and HQ risk estimates, avian secondary consumers are at risk from lead and zinc in soils at the AOC (Table S.29).

S.7.8.2 Overall Conclusion

The magnitude of observed effects was low, and potential impacts would likely be limited to the immediate vicinity of the AOC. Furthermore, because the site is actively mowed, little quality habitat is present at the PB AOC. Thus, the risks identified for the site are not considered ecologically significant and do not warrant active remediation.

S.7.9 Potential Areas of Concern

S.7.9.1 Risk Characterization Summary

The limited assessments performed at the PAOCs consisted principally of toxicity testing of surface waters and sediments from craters, pits, and other depressions, and qualitative surveys of amphibian and bird populations. Soil biota and soil processes were not investigated at the PAOCs. The specific measurement endpoints for each assessment endpoint at the PAOCs are presented in Tables S.2.

HQ risk estimates for the Ruins Site PAOC indicate that the growth of herbaceous vegetation is at risk from nickel, and reproduction is at risk from zinc (Table S.2). Toxicity tests indicate that growth of phytoplankton and vascular plants is at risk from contaminants in surface waters in one or possibly two craters at the Ruins Site PAOC. Elevated concentrations of several contaminants were detected in several frogs collected from some craters. However, the fact that frogs are present within the craters indicates that risks are low.

TABLE S.27 Risk Characterization Summary for Plant Community Assessment Endpoints at the PB 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 of upper trophic level predators; growth also considered to directly reflect overall plant productivity and condition.	Field biomass measurements using quadrats and reference sites. Biomass considered to directly reflect overall growth.	Biomass at on-site plots was significantly lower than at reference location; likely due to mowing activities at the AOC.	Growth of old-field herbaceous vegetation may be at risk from contaminants in site soils, but observed impacts may be related to mowing effects rather than contamination.
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.	Seed emergence rates significantly lower at PB AOC sample locations (55 – 85%) than at reference site (91%).	Reproduction of old-field herbaceous vegetation is at risk from contaminants in soils.

TABLE S.28 Risk Characterization Summary for Soil Microbiota and Macroinvertebrate Assessment Endpoints at the PB 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 affect primary production. Disruption/alteration of soil biota populations may lead to localized disruption of ecosystem structure and function.	Direct measurement of fungal and bacterial biomass; considered representative of overall fungal and bacterial abundance and productivity.	Total bacterial biomass significantly greater at AOC than reference site; no significant difference in fungal biomass.	Microbial abundance not at risk at the AOC.
		Protozoan abundance.	Abundance of flagellates and ciliates significantly lower at AOC than reference site; no significant difference between AOC and reference site in amoebae abundance.	
		Nematode abundance.	Nematode abundance significantly greater at AOC than reference site.	
		Substrate-induced soil respiration measured as CO_2 evolution; considered as representative of microbial decomposition and nutrient cycling activity.	Respiration significantly lower at the AOC than at reference site.	
		Activity of nutrient-acquiring enzymes; direct measure of microbial activity related to organic matter degradation and nutrient cycling.	Activity of one enzyme significantly lower at AOC than reference site; no significant difference observed in activity of two other enzymes.	Nutrient cycling processes may be at risk from soil at the AOC.
Maintenance of soil macroinvertebrate community structure and function	Soil macroinvertebrate important in decomposition and nutrient cycling, which in turn affect primary production. Soil macroinvertebrates also important as prey for higher trophic level biota, including wildlife. 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 abundance of epifauna considered direct indicator of surface activity.	No significant difference in macroinvertebrate abundance between the AOC and reference site. Number of taxa at AOC twice that at reference site. Activity of epifauna significantly greater at the AOC than the reference site.	Macroinvertebrate abundance and diversity not at risk at the AOC.

TABLE S.29 Hazard Quotient (HQ) Risk Characterization Summary for Terrestrial Vertebrates at the PB 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 PCOECs for the eastern cottontail and white-tailed deer to dose-based benchmark values.	HQs for all primary consumers were <1.	No risks to primary consumers 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 PCOECs for the American robin, tree swallow, and white-footed mouse to dose-based benchmark values.	American robin: HQs ≥1 for Pb and Zn. Tree swallow: HQ ≥1 for Zn. White-footed mouse: all HQs <1.	Risks to secondary consumers from Pb and Zn in soils 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 PCOECs for the American kestrel, red-tailed hawk, and red fox to dose-based benchmark values.	All HQs <1.	No risks to tertiary consumers from the contaminants at the AOC.

S.7.9.2 Overall Conclusion

Potential risks to aquatic biota were indicated for surface waters in one or two craters at the Ruins Site, but media toxicity was not evident at the other craters evaluated. The contaminants present in surface waters of some of the craters at the PAOCs pose a potential risk to phytoplankton and vascular plants. For any particular crater, potential adverse impacts will largely be restricted to biota that directly use the crater (particularly invertebrates and amphibians) and are not expected to extend to other areas of J-Field or APG. It is not possible to make inferences regarding effects, impacts, and risks for other craters at the J-Field site at this time.

S.7.10 Sitewide Ecological Receptors

S.7.10.1 Risk Characterization Summary

Potential risks to wide-ranging ecological receptors (tree swallow, American kestrel, red-tailed hawk, white-tailed deer, and red fox) were estimated by calculating a total ADD from the sum of the ADDs calculated for each relevant AOC at J-Field. These total doses were then used to calculate an HQ risk estimate for each receptor and PCOEC. A low risk was identified to the white-tailed deer from antimony and lead and to the tree swallow from zinc. Most of the estimated risks, particularly to the white-tailed deer, were the result of contaminant uptake from the TBP AOC. When the TBP AOC is excluded from the sitewide risk estimation, a low risk is only indicated for the tree swallow from zinc.

S.7.10.1 Overall Conclusion

Only two sitewide receptors (tree swallow and white-tailed deer) are at risk from contaminant exposure at J-Field, and that risk is low. The risk to deer is primarily related to contaminant concentrations at the TBP AOC. The deer population at J-Field and nearby areas farther north on the Edgewood peninsula appears to be large and is unlikely to be significantly affected by contaminants at J-Field. Consequently, the overall risk to the local deer population is considered minor. Because the tree swallow is only at a low risk from zinc at J-Field, the population of this species is not likely to be significantly affected.

S.8 CONCLUSIONS

The ERA for the J-Field site was designed to (1) determine whether past site activities and current levels of contamination have adversely affected the ecological resources at the site,

(2) determine whether current or future conditions at the site pose a potential adverse risk to ecological resources, and (3) identify areas of J-Field where remediation may be warranted from an ecological standpoint. The ERA addressed the following ecological questions about the contamination at the site:

- Are current levels of contaminants in environmental media producing demonstrable ecological effects on the population, community, or ecosystem; and, if so, what are the extent and magnitude of the effects?

- Are contaminated environmental media directly toxic to biota?

- What is the potential risk to biota of receiving contaminant doses through direct and indirect uptake from contaminated environmental media, and what are the extent and magnitude of any such risks?

The following conclusions address these questions:

- Some adverse ecological effects on the individual, population, and community levels are evident at all AOCs at J-Field. These effects are limited primarily to soil biota and vegetation in direct contact with contaminated soils. The effects vary in magnitude among the AOCs. They are relatively minor at the PB, RPTS, SBT, and SBDG AOCs. The adverse effects in these AOCs are also limited to small areas within the AOC boundaries and typically within specific features, such as pits and trenches.

- More extensive adverse ecological effects are evident at the TBP, WPP, RCP, and RPDG AOCs. These effects occur to soil biota, terrestrial vegetation, and aquatic components. Effects at the WPP, RCP, and RPDG AOCs are restricted to specific portions of each AOC and do not appear to be widespread.

- Adverse ecological effects are evident throughout the TBP AOC, particularly at the Pushout Area and main pits. The effects are generally limited to terrestrial biota, with adverse effects on aquatic biota limited to the boundary between the Pushout Area and the marsh.

- Soil toxicity is evident at all AOCs but is generally limited to small areas (pits or trenches) within the AOCs. Soil toxicity is widespread and high at the TBP AOC. Soil toxicity is also indicated for multiple locations in the RPTS and PB AOCs, but the magnitude of the toxic effects is low.

- Limited surface water toxicity is evident at the WPP, RCP, and SBT AOCs.

In testing, these surface waters were toxic only to the green alga *Selenastrum*. Surface water toxicity is also indicated at the TBP AOC, but it is limited to waters collected along the marsh-Pushout Area boundary.

- No sediment toxicity is evident at the WPP, RCP, and SBT AOCs. Sediment toxicity was found at the TBP, SBDG, and RPDG AOCs and the Ruins Site PAOC. At the TBP, toxicity was detected only for sediments collected along the marsh-Pushout Area boundary; sediments from the pond and other portions of the marsh exhibited no toxicity. Sediment toxicity at the other AOCs and the Ruins Site is not widespread and is generally of limited magnitude.

- Risk estimates based on modeling identify the potential for high risks from exposure to contaminated media (i.e., soils, sediments, and surface water) at several of the AOCs. Heavy metals (particularly lead and zinc) may pose the greatest risk to biota. Among the organic PCOECs modeled, risks from exposure to contaminants in soil were inferred only for trichloroethene. The inferred risks are low and are identified only for the TBP AOC. No organic PCOECs are predicted to pose risks at the other AOCs.

- At most AOCs, the ecological significance of the observed effects and predicted risks is low, and the potential risks are limited to small areas within the AOC boundaries. In contrast, the extent and magnitude of contamination at the TBP AOC may produce adverse effects that are ecologically significant on a local scale (J-Field) and that may pose adverse risks to wide-ranging biota, including migratory waterfowl and top-level avian predators.

- High risks to terrestrial receptors were indicated for some metals. It is important to note that these risk estimates are based on dose estimates derived by using an assumption of 100% bioavailability of the metals from the environmental media of interest. Actual bioavailability is not known, but it is very likely to be much less than 100%. Consequently, actual doses and risks are likely to be less than those estimated in this assessment.