Revised Final Screening Level Ecological Risk Assessment

Reservoir No. 2 Burning Ground

Former Plum Brook Ordnance Works
Sandusky, Ohio

Prepared for:

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List of Acronyms and Abbreviations

%	percent
2BG	Reservoir No. 2 Burning Ground
amsl	above mean sea level
ARP	assessment receptor profile
BAF	bioaccumulation factor
BCF	bioconcentration factor
bgs	below ground surface
BSC	background screening concentration
BTAG	Biotechnical Assistance Group
CERLN	U.S. Army Corps of Engineers, Nashville District
COC	contaminant of concern
COPEC	chemicals of potential ecological concern
DNAP	(Ohio) Division of Natural Areas and Preserves
DERP	Defense Environmental Restoration Program
DNT	dinitrotoluene
EC_{20}	effective concentration for 20 percent
ECSM	ecological conceptual site model
EDQL	ecological data quality level
EPA	U.S. Environmental Protection Agency
EPC	exposure-point concentration
ERBSL	ecological risk-based screening levels
FCM	food chain multiplier
ft	foot or feet
ft^2	square feet
FUDS	Formerly Used Defense Site
H_o	null hypotheses
HQ	hazard quotient
IT	IT Corporation
Jacobs	Jacobs Engineering Group
kg	kilogram
KM	Kaplan-Meier
K_{oc}	soil adsorption coefficient
K_{ow}	octanol/water partition coefficient
LC_{50}	lethal concentration to 50 percent

LD_{50}	lethal dose to 50 percent
LOAEL	lowest observed adverse effect level
MDC	maximum detected concentration
mg/kg	milligrams per kilogram
mg/kg-day	milligram per kilogram per day
NASA	National Aeronautics and Space Administration
NOAEL	no observed adverse effect level
NWI	National Wetland Inventory
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
OME	Ontario Ministry of the Environment and Energy
PAH	polycyclic aromatic hydrocarbon
PBOW	Plum Brook Ordnance Works
PCB	polychlorinated biphenyl
RA	risk assessment
RBSC	risk-based screening criteria
RBSEV	risk-based screening ecotoxicity value
RI	Remedial Investigation
RTE	rare, threatened, or endangered
RTEC	Registry of Toxic Effects Concentrations
SLERA	screening level ecological risk assessment
SVOC	semivolatile organic compound
TCDD	tetrachlorodibenzo-p-dioxin
TEQ	toxicity equivalent
TRV	toxicity reference value
UCL	upper confidence limit
UCL_{95}	95 percent upper confidence limit
UTL	upper tolerance limit
U.S.C.	United States Code
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
VOC	volatile organic compound

EXECUTIVE SUMMARY

This screening level ecological risk assessment (SLERA) was prepared to evaluate the potential for adverse effects to ecological receptors from exposure to hazardous substance releases at Reservoir No. 2 Burning Ground (2BG), located at the former Plum Brook Ordnance Works (PBOW), Sandusky, Erie County, Ohio. This SLERA was prepared in accordance with the *Baseline Human Health Risk Assessment and Ecological Risk Assessment Work Plans* (Jacobs, 2008*),* and is consistent with U.S. Environmental Protection Agency (EPA) and Ohio EPA – Division of Emergency and Remedial Response (OEPA, 2003) guidance and with the procedures established in the Baseline Ecological Risk Assessment Work Plan for TNT Areas A & C soil (IT Corporation, 2001). The results of this assessment may be used to determine whether remediation or additional investigation is warranted at the site.

Reservoir No. 2 Burning Ground is located in the northwestern portion of PBOW. The burn area is approximately 125 feet (ft) wide by 175 ft long. This area covers much of the southeastern portion of the existing open field and extends approximately 20 to 30 ft into the wooded area south of the clearing. The burn layer is on average one ft below ground surface (bgs) and one ft in thickness.

The 2BG site physical features include a former burning ground located in an open field and a drainage ditch at the northern edge of the field. The remains of a baseball field are still evident at the site. A paved service road is adjacent to the east side of the site. The majority of the site is currently an open field; however, the southern portion of the site and areas to the west are now wooded. The only surface water feature within the 2BG site is a drainage ditch that runs east to west and forms the north edge of the site. A less pronounced drainage ditch runs south to north along the eastern side of the service road and discharges into the main drainage ditch north of the site. This drainage system is ephemeral and flows only during the wet season and following precipitation events, remaining essentially dry during the summer months (Jacobs 2006). The drainages were dry during completion of the spring and fall ecological surveys and at the time of environmental sampling during the remedial investigation (RI).

Ecological surveys were performed in the spring and fall of 2008. The predominant community types observed at 2BG were Upland Old Fields, Shrub Thickets, and Successional Woods. Wetlands were not identified at Site 2BG. During the ecological survey, 2BG was examined for vegetative stress, including plants displaying stunted growth, poor foliage growth, tissue discoloration, and a loss of leaf coverage. Vegetative stress attributable to chemicals was not observed. Based on site reconnaissance information, it does not appear that significant ecological threats exist at the site as there is no definitive absence of biota or animal life in areas expected to support these ecological components. No threatened or endangered species were found in 2BG.

The primary objective of this SLERA is to evaluate the potential for adverse effects posed to ecological receptors as a result of possible hazardous substance releases. This objective was met by characterizing the ecological communities in the vicinity of the site, determining the particular hazardous substances released, identifying pathways for receptor exposure, and estimating the magnitude of the potential for adverse effects to identified receptors. This SLERA addresses the potential for adverse effects to the vegetation, wildlife, aquatic life, threatened and endangered species, and wetlands and other sensitive habitats associated with the burn area and areas outside the burn associated with the site. There is no habitat for fish in

the area of concern as the small drainage ditches within and adjacent to the area are intermittent.

The chemicals of potential ecological concern (COPECs), the ecosystems and receptors at risk, the ecotoxicity of the contaminants known or suspected to be present, and observed or anticipated ecological effects were evaluated in two steps: (1) a screening assessment and (2) a predictive assessment. Ecological endpoints addressed in both steps were identified.

Assessment receptor species were selected based on the likelihood of finding the species at 2BG. Historical information, site reconnaissance, and the availability of toxicological data were used to select terrestrial and aquatic receptor species. The assessment receptors were selected for evaluation during the predictive SLERA. Seven representative assessment receptor species that are expected or possible in the vicinity of 2BG were selected as indicator species for the potential effects of COPECs. These indicator species represent two classes of vertebrate wildlife, mammals and birds, and a range of both body size and food habits, including herbivory, omnivory, and carnivory. Only terrestrial receptors were evaluated because aquatic habitat is absent at Site 2BG.

The assessment endpoints for the 2BG are stated as "the protection of long-term survival and reproductive capabilities for terrestrial invertebrates, herbivorous mammals, omnivorous mammals, insectivorous mammals and birds, carnivorous birds, and aquatic benthic invertebrates." The corresponding null hypothesis (H_o) for each of the assessment endpoints is stated as: "the presence of site contaminants within soil, sediment, vegetation, and prey will have no effect on the survival or reproductive capabilities of populations of terrestrial invertebrates, herbivorous mammals, omnivorous mammals, insectivorous mammals and birds, carnivorous birds, benthic invertebrates, and omnivorous aquatic mammals."

For assessments, measurable responses to stressors, collectively termed toxicity reference values (TRVs), were selected as measurement endpoints. The most appropriate measurement endpoints were chosen based on exposure pathways as well as ecotoxicity of the contaminant.

An exposure analysis combining the spatial and temporal distribution of the assessment receptors and the COPECs was performed to evaluate potential exposure. The focus of the analysis was dependent on the assessment receptors evaluated and the assessment and measurement endpoints.

The intake estimates were combined with the COPEC TRVs to derive estimates of potential adverse ecological effects. The uncertainties associated with the estimation of potential adverse ecological effects were identified, with the degree of uncertainty estimated qualitatively (low, medium, or high) or quantitatively, and the impact of the uncertainty estimated qualitatively (overestimate or underestimate, as appropriate).

Risk characterization integrates information on exposure, exposure-effects relationships, and defined or presumed target populations. The result is an estimate of the likelihood, severity, and characteristics of potential adverse effects from environmental stressors present at a site. Qualitative and semiquantitative approaches were taken to estimate the likelihood of adverse effects occurring as a result of potential exposure of the assessment receptors to COPECs. Potential adverse affects to terrestrial plants were qualitatively assessed by comparing plant toxicity benchmarks with COPEC concentrations. Potential adverse impacts to aquatic biota were qualitatively assessed by comparing and sediment quality criteria for the protection of

aquatic life to sediment COPEC concentrations. Surface water data were not used in the assessment because data were not available as the drainage ditches are intermittent and were dry at the time of sampling.

For the semiquantitative predictive assessment, TRVs and estimated exposure rates were used to generate hazard quotients (HQs) by dividing the receptor exposure rate for each contaminant by the TRV. HQs are a means of estimating the potential for adverse effects to organisms at a contaminated site and for assessing the potential for toxicological effects to occur.

For soils, ecological risk was evaluated separately between the burn area and areas outside the burn area. Hence two separate risk characterizations were completed for soils associated with 2BG. Soil data, from the 0 to 5-ft bgs, were used to characterize potential ecological risk in the burn area and outside the burn area. This was completed because the burn area itself is expected to contain greater chemical concentrations than areas outside the burn area, and therefore, greater risk to ecological receptors. The separate risk evaluation of the two areas (the burn area and outside the burn area) was completed to assist in future remedial decision-making for site if warranted. Ecological risk associated with drainage ditch sediments have been assessed across the entire 2 BG site.

Soil COPEC impacts to terrestrial plants are estimated to be generally insignificant as no vegetative stress was observed inside or outside the burn areas associated with 2BG.

Inside the burn area, terrestrial receptors are predicted to incur elevated hazards from exposure to 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD), explosives, and two polycyclic aromatic hydrocarbons (PAHs) (acenaphthene and naphthalene), based on no observed adverse effect level- (NOAEL-) based HQ approaches (Section 5.3). Several metals had elevated HQs but the metals concentrations are within the range of naturally occurring background. Estimated hazards are above 1,000 for some receptors using the NOAEL-based approach. However, the estimated HQs that are above 1,000 using the NOAEL-based approach are considered unrealistic and toxicologically impossible. The white-tailed deer and red-tailed hawk had no HQ exceedances greater than 10 within 2BG.

Outside the burn area, terrestrial receptors are predicted to incur elevated hazards from exposure to explosives only with 2,4,6-trinitrotoluene being the greatest risk driver. The white tailed deer and red-tailed hawk had no HQ exceedances greater than 10 outside 2BG.

Aquatic benthic organisms are predicted to have potentially elevated hazards from exposure to PAHs in sediments based on the data screening compared to ecological risk-based screening levels (ERBSLs). However, given the limited aquatic habitat at the site, the potential for adverse impacts to aquatic biota is considered negligible.

1.0 INTRODUCTION

This screening level ecological risk assessment (SLERA) was prepared to evaluate the potential for adverse effects to ecological receptors from exposure to hazardous substance releases at Reservoir No. 2 Burning Ground (2BG), located at the former Plum Brook Ordnance Works (PBOW), Sandusky, Erie County, Ohio (Figures 1-1 and 1-2). The results of this assessment may be used to determine whether remediation or additional investigation is warranted at the site.

This SLERA was prepared by Jacobs Engineering Group (Jacobs) under contract DACW62-03-D-0008, Delivery Order #8. This work is being conducted for the U.S. Army Corp of Engineers (USACE) under the Defense Environmental Restoration Program (DERP) – Formerly Used Defense Sites (FUDS). The Army is the executive agent for the FUDS program and the USACE manages and directs the program's administration. Investigations at PBOW under DERP-FUDS are being managed by the USACE Huntington District and technically overseen by the USACE Nashville District (CERLN).

This SLERA was prepared in accordance with the *Baseline Human Health Risk Assessment and* Ecological *Risk Assessment Work Plans* (Jacobs, 2008*), and* is consistent with U.S. Environmental Protection Agency (EPA) and Ohio EPA (OEPA) – Division of Emergency and Remedial Response (OEPA, 2003) guidance and with the procedures established in the Baseline Ecological Risk Assessment Work Plan for TNT Areas A & C soil (IT Corporation [IT], 2001).

The primary objective of this SLERA is to evaluate the potential for adverse effects posed to ecological receptors as a result of possible hazardous substance releases. This objective was met by characterizing the ecological communities in the vicinity of the site, determining the particular hazardous substances released, identifying pathways for receptor exposure, and estimating the magnitude of the potential for adverse effects to identified receptors. This SLERA addresses the potential for adverse effects to the vegetation, wildlife, aquatic life (aquatic sediment-dwelling organisms only), threatened and endangered species, and other sensitive habitats associated with the site. Wetlands were not evaluated as none are present at Site 2BG. There is no habitat for fish in the area of concern as the drainage ditches within and adjacent to the area are intermittent and were dry during the completion of the spring and fall ecological surveys and remedial investigation (RI) sampling events.

Concentrations of chemicals measured in relevant environmental media including soil and sediment were used to develop the SLERA, including problem formulation (Section 2.0); exposure characterization (Section 3.0); ecological effects characterization (Section 4.0); risk characterization (Section 5.0); and summary and conclusions (Section 6.0). These subtasks are described in greater detail in the following sections.

The chemicals of potential ecological concern (COPECs), the ecosystems and receptors at risk, the ecotoxicity of the contaminants known or suspected to be present, and observed or anticipated ecological effects were evaluated. This evaluation was conducted in two steps: (1) a screening assessment and (2) a predictive assessment. Ecological endpoints addressed in both steps have been identified. The results and conclusions of the screening assessment determined whether a predictive assessment was needed. The criteria by which the need for a predictive assessment was measured were formalized as null hypotheses (H_o) to be accepted, in which case a predictive assessment was not needed, or rejected, in which case a predictive assessment was needed.

2.0 PROBLEM FORMULATION

The screening assessment H_o is stated as follows:

- The potential for adverse ecological effects to ecological receptors at the site is minimal or nonexistent due to the lack of viable habitat for potential ecological receptors.
- The potential for adverse ecological effects to ecological receptors at the site is minimal or nonexistent due to the lack of potential ecological receptors.
- The potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of potential exposure pathways.
- The potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of potential chemical stressors.

If one or more of these H_o are accepted, a predictive assessment is not triggered. All four H_o must be rejected for a predictive assessment to be triggered. The first three H_o were tested with the results of the ecological site description (Section 2.1). The fourth H_o was tested with the results of COPEC selection (Sections 2.2 and 2.3).

Where a predictive assessment was triggered, terrestrial and aquatic ecological conceptual site models were developed, as appropriate, and additional problem formulation tasks were performed, as described in Sections 2.4 to 2.6.

2.1 Ecological Site Description

This ecological site description section includes a general discussion of site background, surface water resources, wetlands, vegetative communities, a species inventory, and a discussion of threatened and endangered species.

2.1.1 General Site Background

PBOW is located approximately 4 miles south of Sandusky, Ohio, and 59 miles west of Cleveland (Figure 1-1). Although located primarily in Perkins and Oxford Townships, the eastern edge of the facility extends into Huron and Milan Townships. PBOW is bounded on the north by Bogart Road, on the south by Mason Road, on the west by Patten Tract Road, and on the east by U.S. Highway 250. The area surrounding PBOW is mostly agricultural and residential (IT, 2001). The facility is currently surrounded by a chain-link fence, and the perimeter is regularly patrolled. Access by authorized personnel is limited to established checkpoints. Public access is restricted, except during the annual deer hunting season.

PBOW, approximately 6,453 acres, is located within the Eastern Lake Plains physiographic region of the Eastern Huron/Erie Lake Plain Ecoregion (Lafferty, 1979; Omernik, 1986). This region is generally characterized as containing flat plains as the predominant land surface form and as having a dominant natural vegetation of elm and ash in undisturbed areas. Approximately two-thirds of Erie County was once covered by a glacial lake that produced features such as beach ridges and wave-cut cliffs. Much of the region is poorly drained due to the flat topography and low stream gradients. Many of the wetlands adjacent to Lake Erie in this region have been preserved by various federal, state, and private organizations (Peterjohn and Rice, 1991), thereby providing important wetland habitat for wildlife.

Across PBOW, the land slopes gently to the north-northeast towards Lake Erie. Elevations range from 675 feet (ft) above mean sea level (amsl) at the southwest edge of the site to 625 ft amsl in the northern portion of the property at Bogart Road, resulting in an average slope of approximately 0.3 percent (%). The Lake Plains region is over 69% cropland, 2.7% pasture land, and 10.5% forest (Ohio Department of Natural Resources [ODNR], 1985). However, since the Trojan Powder Company operated the site in the early 1940s and agricultural production on the land ceased, undeveloped portions of the former PBOW have become second generation forest and open fields.

The 2BG site was used as a burning ground for production process wastes. It is not known when the site was first used for burning; however, a 1950 aerial photo clearly shows the site to be in existence and photographs dated as late as 1962 show ongoing operations at the site. Restoration of the site was performed in 1963 when the area was cleared of debris and the ground restored to proper grade. A review of aerial photographs taken in 1950, 1958, and 1968 indicated the presence of a disturbed area with a rectangular berm (1950), a pronounced burn ground (1958), and a large cleared area that shows the land to have been restored (1968). Based on these photos, the size of the burning ground was estimated to be 125 ft wide by 175 ft long (Jacobs 2006).

An RI (Jacobs, 2006) was performed May through July 2004 to define the extent of soil contamination and to evaluate impacts to the groundwater, surface water, and sediment in the vicinity of 2BG. RI sample collection and data evaluation are discussed in detail in the *Final Site Characterization Report Remedial Investigation Part 1, at Reservoir No. 2 Burning Ground* (Jacobs, 2006).

Based on the information obtained from these investigations, the burn layer at 2BG covers an area of approximately 21,000 square feet (ft^2), or approximately half an acre. This area covers much of the southeastern portion of the existing open field and extends approximately 20 to 30 ft into the wooded area south of the clearing. The burn layer is on average one ft below ground surface (bgs) and one ft in thickness.

Soil within the burn layer footprint represents the most contaminated area at the site. The highest concentrations of explosives and lead at the site were found in the burn layer material. The burn layer material sampled from trenches TR08 and TR09 is composed of 3.6% and 4.5% explosives, respectively. Surface soil contamination outside of the burn area is not as pervasive.

Subsurface soil contamination is minimal both inside and outside of the burn layer footprint. Explosives were detected in the subsurface soil beneath the burn layer at six of the seven locations. Based on these data, downward and lateral migration of contaminants is minimal.

Contaminants detected in the sediment include dioxins/furans and polycyclic aromatic hydrocarbons (PAHs). Organic concentrations are significantly higher at the location upstream of the site, adjacent to the service road, suggesting that contaminants are related to a source other than the burning ground. Polychlorinated biphenyls (PCBs) and explosives, which are the primary contaminants associated with the burning ground, were not detected in the sediments.

Ecological surveys were performed by Jacobs ecologists and their subcontractor in the spring and fall of 2008. Prior to arrival at the site, personnel obtained relevant information on the site including topographic, township, county, and other appropriate maps, and determined the

location of potential ecological units such as streams, creeks, ponds, grasslands, forest, and wetlands at or near the site. Additionally, the 1994 biological inventory of PBOW (National Aeronautics and Space Administration [NASA], 1995) that identified the locations of threatened and endangered species at PBOW was reviewed. The location of known or potential contaminant sources affecting the site and the probable gradient of the pathway by which contaminants may be released from the site to the surrounding environment were identified. Jacobs personnel also used the reconnaissance to evaluate the site for more subtle indications of potential effects from contaminant release.

2.1.2 Surface Water

The only surface water feature within the 2BG site is an intermittent drainage ditch that runs east to west and forms the north edge of the site. Wetlands were not observed at the site. The drainage ditch is located 200 to 300 ft north of the former burn area and drains to the west across the site, then northwest to Pipe Creek. This drainage feature is approximately four ft wide and six to seven ft deep. Elevations in the ditch range from 635 ft amsl upstream of the site to 633 ft amsl downstream. A less pronounced intermittent drainage ditch runs south to north along the eastern side of the service road and discharges into the main drainage ditch north of the site. This drainage system is intermittent and flows only during the wet season and following precipitation events, remaining essentially dry during the summer months (Jacobs 2006). The drainage ditch was dry at the time of the spring and fall ecological surveys. The drainage ditch is not considered significant aquatic habitat.

2.1.3 Wetlands

According to the National Wetland Inventory (NWI) Maps for the area (U.S. Fish and Wildlife Service [USFWS], 1977), there are no designated wetlands at the 2BG site. It should be noted that the accuracy of NWI maps are limited, especially in relatively flat landscapes such as PBOW because minor depressions often contain isolated wetlands not easily identified through air photo interpretation, the process used by the USFWS in preparing NWI maps. No wetlands or significant aquatic habitats were observed during conduct of the spring and fall ecological surveys.

2.1.4 Vegetative Communities

The predominant community types observed at 2BG are Upland Old Fields, Shrub Thickets, and Successional Woods.

Figure 2-1 is a general habitat map that presents the type and extent of biological communities within the site. The ecological survey is provided in Appendix A. A general description of each predominant vegetative community type is provided below.

Upland Old Fields. These areas are dominated by grasses and herbs and have been recently disturbed by mowing and/or brush hogging. Scattered shrubs, small trees, and groups of shrubs also occur in these areas.

Shrub Thickets. Dense areas of shrub thickets are present at 2BG. *Cornus racemosa* (gray dogwood) dominates most of these areas. *Eleagnus umbellata* (autumn olive) is also common. Small trees and saplings also are present within the shrub thickets.

Successional Woods. Successional woods are comprised of small and moderate sized trees, primarily *Fraxinus pennsylvanica* (green ash), *Acer negundo* (box elder), and *Populus deltoids* (cottonwood). These areas generally have moderate to dense shrubby understory. The herbaceous layer is dense in most areas. *Carex* spp. (sedges) dominate most of the understory.

2.1.5 Species Inventory

Based on information from ODNR (1995) and information collected during the site reconnaissance in May and October of 2008, species lists were prepared for plants, mammals, birds, reptiles, amphibians, and fish. Of the 365 plant species documented at the 6,453 acre former PBOW by the ODNR, 85 of the common plant species frequently observed at 2BG are listed in Table 2-1. The ecological survey is provided in Appendix A.

Of the 43 species of mammals that may be found in the region based on species range maps, white-tailed deer were observed onsite during the ecological surveys (Table 2-1). Numerous deer tracks were also observed during the site reconnaissance. Other mammals observed included the eastern fox squirrel and raccoon. It is likely that other species are present but were not observed due to the short duration of the field visits.

Of the 129 species of birds that may be found in the region based on species range maps, 105 species (81 percent) have been recorded at the former PBOW by the ODNR during their multiyear studies. Twenty one bird species were documented at 2BG during the ecological surveys performed by Jacobs. Of the species recorded by the ODNR, 49 were neotropical migrants and would not be expected to nest at the former PBOW. ODNR (1995) notes that, of the top 50 bird species recorded at the former PBOW, only 6 were ground nesters and 3 others occasionally nest on the ground, suggesting that ground nesting birds are being stressed at the facility.

The large deer population that feeds on much of the ground cover at the former PBOW limits the cover available for nesting birds and results in increased predation for these species (ODNR, 1995). Current burning practices used by NASA limit ground cover over the eastern portion of PBOW. Burning has not been conducted in the 2BG vicinity for at least 10 years (Long, 2008). Former burning practices are not expected to have an impact on the current presence of species at 2BG, as any ground cover affected by previous burning would have had ample time to recover. The 15 most abundant bird species recorded at the former PBOW by the ODNR included the American robin; red-winged blackbird; European starling; song sparrow; common grackle; field sparrow; American goldfinch; indigo bunting; blue jay; common yellowthroat; brown-headed cowbird; house wren; gray catbird; northern cardinal; and cedar waxwing. All of the bird species were observed during the ecological surveys with the exception of the red-winged blackbird and common yellowthroat (Table 2-1). However, due to the lack of wetland habitat at Site 2BG, observation of red-winged blackbird and common yellowthroat would not be expected.

Of the 14 species of reptile that may be found in the region based on species range maps, 10 species (71%) have been observed at the former PBOW, including turtles and snakes (ODNR, 1995). During the ecological surveys, no reptiles were observed at 2BG.

Of the 10 species of amphibians that may be found in the region based on species range maps, nine species (90%) have been observed at the former PBOW (ODNR, 1995), including

salamanders, toads, and frogs. No amphibians were observed at 2BG during the ecological surveys.

According to ODNR (1995), a combination of electro-shocking and seining was conducted during the field investigation that identified 14 species of fish at PBOW. Species observed included suckers, sunfish, minnows, sticklebacks, and bullheads. However, none are expected to be present at 2BG given the poor quality or lack of surface water habitat.

In addition to the wildlife discussed above, additional species observed during site reconnaissance visits included ants (active ant mounds), yellow jackets, honey bees, cicadae, monarch butterfly, Japanese beetles, and unidentified moth species.

Figures 2-2 and 2-3, respectively, provide simplified terrestrial and aquatic food webs for 2BG as ecological conceptual site models (ECSMs).

2.1.6 Threatened and Endangered Species Information

According to an Ohio Division of Natural Areas and Preserves (DNAP) review of their natural heritage maps and files (Woischke, 1998), there are records of legal status threatened or endangered species within a 2-mile radius of the site. These species include the following:

- Sedge wren (*Cistothorus platensis*) - endangered
- Dwarf bulrush (*Lipocarpha micrantha*) - threatened
- Twisted yellow-eye-grass (*Ayris torta*) - threatened
- Field sedge (*Carex conoidea*) - threatened
- Least St. John's-wort (*Hypericum gymnanthum*) - endangered
- Flat-leaved rush (*Juncus platyphyllus*) - endangered
- Bushy aster (*Aster dumosus*) - threatened

In addition, based on information contained in ODNR (1995), there are several species of threatened or endangered plants, potentially threatened plants, and threatened or endangered birds that have been recorded at PBOW, as follows:

- Grove sandwort (*Arenaria laterijlora*) - threatened
- Thin-leaved sedge (*C. cephaloidea*) - endangered
- Ashy sunflower (*Helianthus mollis*) - threatened
- Prairie false indigo (*Baptisia lactea*) - potentially threatened
- Broad-winged sedge (*C. alata*) - potentially threatened
- Round-fruited hedge-hyssop (*Gratiola virginiana*) - potentially threatened
- Tall St. John's wort (*H. majus*) - potentially threatened
- Virginia meadow beauty (*Rhexia virginica*) - potentially threatened

- Tall nut rush (*Scleria triglomerata*) - potentially threatened
- Lance-leaved violet (*Viola lanceolata*) - potentially threatened
- Winter wren (*Trogoldytes troglodytes*) - endangered
- Cattle egret (*Bublucus ibis*) - endangered
- Black-crowned night heron (*Aycticorax nycticorax*) - threatened
- Trumpeter swan (*Cygnus buccinator*) - endangered
- Upland sandpiper (plover) (*Bartramia longicauda*) - threatened
- Indiana bat (*Myotis sodalis*) - endangered

Also, wild white lettuce, a species considered extinct in Ohio but common in prairie states was recently found on site, although not in the vicinity of 2BG (Peecook, 1998).

Based on the ecological surveys conducted by Jacobs, no threatened or endangered species were found in 2BG.

2.2 Selection of Chemicals of Potential Ecological Concern

COPECs are the chemicals that were identified as site-related and potentially capable of contributing significantly to risk, and were carried forward to quantitative evaluation in the SLERA (Table 2-2). The following subsections describe the process for their identification. Prior to initiation of the SLERA, a list of chemicals present in site samples was compiled. This initial list included all chemicals detected in any site medium. COPECs were selected from this list as described in the following sections.

2.2.1 Data Organization

The data for each chemical were sorted by medium. For ecological impacts, soil from 0 to 5 ft bgs was considered from within the burn area and outside of the burn area. The 0 to 5 ft depth interval was selected for three primary reasons: (1) to maintain consistency with other PBOW ecological risk assessments that used this depth interval; (2) to include potential exposure to the shrew, a representative burrowing insectivorous mammal; and (3) to increase the size of the total soil data base by including samples collected from a depth interval of 4 to 5 ft; although the shrew may not actually burrow to a depth of 5 ft, there may be other burrowing mammals that do burrow this deep. Chemicals that were not detected at least once in a medium were not included in the risk assessment. Available background data were determined for each medium. Sources of background information include data from previous investigations.

Analytical data may have qualifiers from the analytical laboratory quality control or from the data validation process that reflect the level of confidence in the data. Some of the more common qualifiers and their meanings are as follows (EPA, 1989):

U Chemical was analyzed for but not detected; the associated value is the sample quantitation limit.

J Value is estimated, probably below the contract-required quantitation limit.

N The analysis indicates an analyte for which there is presumptive evidence to make a tentative identification.

NJ The analysis indicates a “tentatively identified analyte”, and the reported value represents its approximate concentration.

UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.

R Quality control indicates that the data are unusable (chemical may or may not be present).

B Inorganic chemicals: the concentration is less than the contract-required detection limit but greater than the instrument detection limit. Organic chemicals: the concentration in the sample is not sufficiently higher than the concentration in the blank, using the five-times, ten-times (5x, 10x) rule, whereby a chemical is considered a nondetect unless its concentration exceeds five or ten times the blank concentration. For common laboratory contaminants (acetone, 2-butanone [methyl ethyl ketone], methylene chloride, toluene, and the phthalate esters), the sample concentration must exceed 10 times the blank concentration to be considered a detection.

“J”, “N”, and “NJ” qualified data were used in the SLERA; “R” data and “B” qualified data were not used. The handling of “U” qualified data (nondetects) in the SLERA is described in Section 2.2.2. Where confidence was reasonably high that the chemical was present but the actual concentration was somewhat in question, the data generally were used.

Occasionally, chemicals were analyzed under two different analytical programs. For example, the dinitrotoluenes (DNTs) were analyzed by EPA Method 8330 for nitroaromatics as well as EPA Method 8270B for semivolatile organic compounds (SVOCs). EPA Method 8330 provides concentration values for total DNT, but does not provide isomer-specific data. EPA Method 8270B, on the other hand, provides concentrations for 2,4- and 2,6-DNT isomers, but does not provide a value for total DNT. For each medium evaluated it was necessary to choose the results provided by one analytical method rather than both to avoid double-counting and overestimating ecological hazard. The value for the method considered more sensitive to that specific analyte was used in lieu of the value from the less sensitive method when multiple analytical results were available for an analyte from more than one method. In most cases, the method with the lower detection limit and reporting limit was the more sensitive method.

2.2.2 Developing Exposure-Point Concentrations

The exposure-point concentration (EPC) is a conservative estimate of the average concentration of a COPC, statistically calculated from the analytical results of all samples for a particular environmental medium within an exposure unit.

Because of the uncertainty associated with characterizing contamination in environmental media, both the mean and the upper confidence limit (UCL) of the mean are usually estimated

for each COPC in each medium of interest. The UCL of the mean computed at a 95 percent confidence level is generally referred to as the 95 percent UCL of the arithmetic mean (UCL_{95}).

Concentrations of analytes in environmental samples are determined by using established analytical methods and accurately calibrated laboratory instrumentation. These methods and instruments have practical limits in their ability to accurately report very low and very high analyte concentrations. Each laboratory data value is typically reported with two associated limits; a detection limit and a quantitation limit. The detection limit is the minimum concentration of the analyte that can be differentiated from the normal, random noise of an analytical method or instrument. The quantitation limit, sometimes referred to as the reporting limit, is the minimum concentration of the analyte that can be reliably quantified. Laboratories sometimes report numerical values for analyte concentrations that are greater than the detection limit but less than the quantitation limit. These values are often referred to as "trace level concentrations" and are only rough approximations of the true analyte concentration.

Very high analyte concentrations can cause serious damage to some analytical instruments. Samples with known or suspected high analyte concentrations may be diluted before analysis to lower the analyte concentrations to levels that can be safely analyzed. The analyzed concentration values are then adjusted by the dilution factor to properly represent the analyte concentration in the original undiluted sample.

When a sample is diluted, the detection limits and quantitation limits for that sample must be adjusted by the dilution factor. For example, if a sample is diluted by a factor of 10 (the sample volume is increased to 10 times the original sample by dilution with a solvent before analysis), then the corresponding detection limit and quantitation limit must be multiplied by a factor of 10.

The detection limits and quantitation limits used in this project have been adjusted for dilutions and are referred to as sample detection limits and sample quantitation limits to indicate that the limits are specific to each individual sample and analytical method. These sample detection and quantitation limits may have also been adjusted by the laboratory for percent moisture in soil and sediment samples. Samples with higher moisture content will have higher sample detection and quantitation limits when the data are reported on a dry-weight basis.

For some analytical methods, the presence of even just one analyte with a very high concentration in a sample may necessitate the use of a large dilution that will result in elevated sample detection and quantitation limits for all analytes in that sample for that analytical method. This is especially true for organic analyses using gas-chromatography and mass-spectrometer methods such as for dioxins/furans, nitroaromatics, PCBs, PAHs, volatile organic compounds (VOCs), and SVOCs. For these methods a lower dilution for the non-detected analytes cannot be used without possible damage to the analytical instruments. Large dilutions of 1000 or even 5000 times may be required for some samples from heavily contaminated areas. These large dilutions result in two significant complications for statistical computations.

- Some analytes may be present in a sample at significant concentrations, but are reported as non-detects with elevated sample detection limits because of dilutions.

- Elevated sample detection limits, even for true non-detects, can cause a high-bias in computed UCL_{95} estimates. The magnitude of this high-bias can be significant and is unpredictable for most non-parametric UCL methods.

The proper handling of non-detect data points in statistical computations is critical for the generation of realistic UCL_{95} estimates. Analytical laboratory data sets used for UCL_{95} estimates can be classified as full, left-censored, or interval-censored data sets.

- A full data set is one in which every data point has a value that is assumed, for the purposes of statistical computations, to accurately represent the true analyte concentration in each sample. All data values in a full data set are considered to be positive detections because each reported concentration is greater than the associated sample quantitation limit.

- A left-censored data set is one in which some of the data points cannot be reported with an accurately known value. The non-detects in a laboratory data set are known as censored values. Laboratory data non-detects are called left-censored because the data are reported as "less-than" some value, usually the sample detection limit. These "less-than" data are said to be censored at the detection limit. The only information known about the numerical value of a censored data point is that the true concentration is less than the censoring value.

- Interval-censored data sets contain data points that are reported as being between two censoring values. Many laboratories report estimated data as "trace-level values" with concentrations between the sample detection limit and the sample quantitation limit. These trace-level values are intended to represent concentrations that are believed by the laboratory to be positive detections, above the sample detection limit, but have concentrations too small to be accurately quantified. These interval censored data can be evaluated by some statistical methods as being greater than a lower censoring level (the sample detection limit) and less than higher censoring level (the sample quantitation limit).

The interval-censored data values for this project were evaluated as though they were positive detections. Trace-level values reported as greater than the sample detection limit but less than the sample quantitation limit are assumed to be detected, uncensored values. For this project, all data sets were considered to be either full or left-censored.

The EPA statistical software package ProUCL Version 4.0 was used to compute estimated UCL_{95} concentrations for all data sets containing four or more distinct detected values. ProUCL uses numerous parametric and nonparametric statistical methods to compute UCLs. Parametric methods assume that the data set being evaluated fits closely to a known, predictable data distribution. Nonparametric methods do not rely on the data set fitting a specific distribution.

ProUCL computes parametric UCLs using normal, lognormal and gamma distributions. Nonparametric UCLs are computed using a variety of methods including maximum likelihood estimation, central limit theorem, jackknife, bootstrap, Kaplan-Meier (KM), and regression on order statistics. Maximum likelihood estimation and regression on order statistics methods are sometimes referred to as semi-parametric methods. These two methods use techniques to estimate or assume temporary surrogate values for censored data points before computing estimated UCLs.

Detailed descriptions of the statistical methods use in ProUCL are available in the following two documents:

- ProUCL Version 4.0 User Guide (EPA/600/R-07/038, April 2007, www.epa.gov)

- ProUCL Version 4.0 Technical Guide (EPA/600/R-07/041, April 2007, www.epa.gov)

The ProUCL User Guide acknowledges that at one time the EPA recommended using one-half the detection limit as replacement values for non-detects when only a small percentage of the data were non-detects. This has become the traditional approach for many projects and is known as the "DL/2" method. The EPA now advises against using DL/2 for any statistical calculations. Several studies have shown that DL/2 frequently results in unrealistic statistical results. Several nonparametric statistical methods are now recommended for data sets with non-detects (censored data sets). Since many work plans still reference the DL/2 method it has been included in ProUCL Version 4.0 but with the following comment "Note: DL/2 is not a recommended method."

ProUCL computes estimated UCLs using two slightly different approaches depending on whether the data set to be evaluated is a full data set or a censored data set.

Full Data Sets

- Raw statistics are computed (i.e., minimum, maximum, mean, median).

- Data set is tested for normal distribution, lognormal distribution, and gamma distribution.

- Parametric UCLs are computed as appropriate.

- Nonparametric UCLs are computed as appropriate.

- Recommended UCLs are listed based on logic programmed into ProUCL.

Censored Data Sets

- Raw statistics are computed based on the detected data points only.

- Data set is tested for normal, lognormal and gamma distributions using the detected data points only.

Note: For data sets with multiple detection limits for non-detects, all data less than the largest non-detect detection limit are considered non-detects. This includes positive detections with values less than the maximum non-detect detection limit. If non-detects exist for samples with very large dilutions, a large percentage of the detected data may be considered to be non-detect at an elevated detection limit. This approach is known as "censoring at the highest detection limit."

- Parametric UCLs are computed as appropriate, treating all values less than the largest non-detect detection limit as non-detects.

- Nonparametric UCLs are computed as appropriate, treating all values less than the largest non-detect detection limit as non-detects --- except for the KM, regression on order statistics, and DL/2 methods. KM and regression on order statistics are able to

handle multiple detection limits. The DL/2 method simply uses one-half the sample detection limit for each non-detect value.

- Recommended UCLs are listed based on logic programmed into ProUCL.

For data sets with multiple detection limits for non-detects, ProUCL recommends using the KM method UCLs. For this project, essentially all data sets with more than one non-detect have multiple detection limits for the non-detect samples. The KM UCLs are therefore recommended for data sets in this project that have more than one non-detect sample.

Analytical data from field duplicates were joined with parent sample results to yield one result for use in the statistical manipulations as follows:

- Use average of field duplicate and parent sample if both are positive detections.
- Use average of field duplicate and parent sample detection limits if both are non-detects.
- Use detected value if one sample is a positive detection and the other is a non-detect.

The UCL_{95} or maximum detected concentration (MDC), whichever is smaller, was selected as the EPC and is understood to represent a conservative estimate of average for use in the risk assessment (RA) or in various transport models used to estimate exposure.

2.2.3 Frequency of Detection

Chemicals that are detected infrequently may be artifacts in the data that do not reflect site related activity or disposal practices. Such chemicals were not included in the risk evaluation. Generally, chemicals that are detected only at low concentrations in less than 5% of the samples from a given medium are dropped from further consideration unless their presence is expected based on historical information for the site. For the current assessment, nitroaromatics were not eliminated as COPECs because this group of constituents is site related.

2.2.4 Essential Nutrients

Evaluating essential nutrients is a special form of risk-based screening applied to certain ubiquitous elements that are generally considered to be required nutrients. Essential nutrients such as calcium, iron, magnesium, potassium, and sodium are usually eliminated as COPECs because they are generally considered innocuous in environmental media. Other essential nutrients including chloride, iodine, and phosphorus may be eliminated as COPECs, provided that their presence in a particular medium is shown to be unlikely to cause adverse effects to biological health. No members of this latter group were selected as site-related chemicals; therefore, an exposure analysis for essential nutrients was not performed (Appendix C).

2.2.5 Background Screening

For background screening, the MDC was compared to the PBOW chemical-specific background screening concentration (BSC) for soil. BSCs for soil established as part of the acid areas investigation (IT, 1998) were used for this RA. BSCs for soil were reported as the 95 percent

upper tolerance limit (UTL) for lognormal data sets or the 95th percentile for datasets with a nonparametric distribution.

Background screening also applies to certain organic compounds that are part of normal background concentrations. Such chemicals may include VOCs and PAHs, a class of organic compounds that form from natural or anthropogenic combustion of organic matter including fossil fuels and are generally ubiquitous in the environment. Airborne PAHs associated with non-Department of Defense sources may be deposited on soil and leach to groundwater.

Background screening was applied to each inorganic constituent whose MDC exceeded the risk-based screening criteria (RBSC) and that could not be characterized as an infrequently detected analyte. Background screening consisted of comparing the MDC of the site data set to the BSC. Background screening was not used to eliminate COPECs. Comparison of COPEC concentrations to background levels is discussed in Section 5.4.

2.2.6 Comparison to Risk-Based Screening Ecotoxicity Values

A comparison was made between EPCs of chemicals in sampled media and the risk-based screening ecotoxicity value (RBSEV) for ecological endpoints following recommendations received from OEPA and as discussed in EPA Region 5 Biotechnical Assistance Group (BTAG) Bulletin No. 1 (EPA, 1996a). Chemicals that exceeded the RBSEVs, or for which no RBSEV is available, were retained as COPECs. The following RBSEVs or RBSEV hierarchy, as noted, were used for the ecological evaluation:

- **Soil.** Soil (surface and subsurface soil) screening values were selected using the following hierarchy: (1) Preliminary Remediation Goals for Ecological Endpoints (Efroymson et. al.1997a); (2); Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process (Efroymson, Suter, and Will, 1997b); (3) Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants (Efroymson et. al. 1997c); and (4) Ecological Data Quality Levels (EDQLs)(EPA,1999a). It should be noted that effects on heterotrophic processes may not be relevant to ecological receptors of concern at the site.

- **Sediment**. Sediment screening values were selected using the following hierarchy: (1) EDQLs (EPA, 1999a); (2) Preliminary Remediation Goals for Ecological Endpoints (Efroymson et. al.1997a); and (3) Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario (Ontario Ministry of the Environment and Energy [OME]; 1993).

The results of the screening and the selected COPECs with RBSEVs for ecological endpoints of concern are presented in Table 2-2. COPECs were selected for further consideration in the SLERA only if the MDC exceeded the available RBSEV. If no RBSEV was available, the constituent was carried forward for consideration in the SLERA unless it was within background or if it was detected in less than 5 percent of the samples for a given medium.

2.3 Results of the Data Evaluation

Previous investigations at 2BG confirmed the presence of soil contamination from former PBOW operations. The sampling locations for these investigations are provided in Figure 2-4. The objective of the soil investigation conducted under the RI (Jacobs, 2006) was to evaluate the

presence of soil contamination at additional former site facilities not previously sampled. Sediment samples were collected from the drainage ditch bounding 2BG; a total of 3 sediment samples were collected. No surface water samples were collected because the drainages were dry at the time sampling.

Table 2-2 provides the following information for each detected chemical for each medium at 2BG:

- Chemical name,
- Frequency of detection,
- Range of detected concentrations,
- Range of detection limits,
- Arithmetic mean (average) of site concentrations,
- 95th percent UCL on the arithmetic mean,
- Appropriate BSC (background),
- Appropriate RBSEV, and
- Selection/exclusion of chemical as a COPEC.

Soil Within Burn Area. A maximum of 29 soils samples were collected from within the burn area at 2BG, which includes six samples collected in October 1996 and 23 samples collected in May 2004. Depths for the samples were from surface to five ft bgs. Contaminants detected include dioxins/furans, nitroaromatics, metals, PAHs, PCBs, and VOCs. None of the 29 samples were tested for all detected compounds. Generally, 14 samples were tested for dioxins/furans, 19 samples were tested for nitroaromatics (except for 2-amino-4,6-dinitrotoluene and 4-nitrotoluene, which was tested for in 13 samples, and nitrobenzene, which was tested for in 25 samples), metals (except for tin, which was analyzed for in only three samples), PCBs, and PAHs. VOCs were tested for in 6 to 19 samples, depending on the analytes. Specific compounds exceeding soil RBSEVs are identified in Table 2-2.

Soil Outside Burn Area. A maximum of 55 soil samples were collected from outside the burn area at 2BG, which includes 10 samples collected in October 1996, 20 samples collected in May 2004, 10 samples collected in April 2005, and 15 samples collected in December 2005. Depths for the samples were from surface to five ft bgs. Contaminants detected include nitroaromatics, cyanide, metals, PCBs, PAHs, SVOCs, and VOCs. Not all compounds were tested for in every sample. Only 45 samples were tested for metals (except for lead which was tested for in all 55 samples and tin was tested for in only 4 samples). Cyanide was tested for in 25 samples. SVOCs were tested for in 10 samples (except for 2-methylnaphthalene which was tested for in 35 samples and four tri/di-chlorobenzene compounds which were tested for in 30 samples). VOCs were tested for in 13 to 30 samples, depending on the analyte. Specific compounds exceeding soil RBSEVs are identified in Table 2-2.

Sediment. Contaminants detected in three sediment samples from May 2004 at 2BG include dioxins/furans, metals, PAHs, and VOCs. Specific compounds exceeding sediment RBSEVs are identified in Table 2-2.

2.4 Selection of Assessment Receptors

Assessment receptors were selected to represent receptor groups (e.g., insectivorous mammals) known or likely to be present at the site. The assessment receptors were selected for evaluation during the predictive SLERA. The selection process focused on species, groups of species, or functional groups, rather than higher organization levels such as communities or ecosystems. This focuses the exposure characterization on species or components that are the most likely to be affected by the toxicological and mobility characteristics of the COPECs and also focuses on those COPECs that are most likely to produce greater effects in the on-site ecosystem. Site biota was organized into two major functional groups: terrestrial and aquatic. For terrestrial communities, the major groups are plants and wildlife, including terrestrial invertebrates, mammals, and birds. For aquatic and/or wetland communities, the major groups are flora and fauna and sediment-dwelling organisms. Species presence at the site was determined by a literature review and the ecology survey (Sections 2.1.5 and 2.1.6) prior to identification of target receptor species.

Primary criteria for selecting appropriate assessment receptors included, but were not limited to, the following:

- The assessment receptor has a relatively high likelihood of contacting chemicals via direct or indirect exposure.
- The assessment receptor exhibits marked sensitivity to the COPECs given their mode of toxicity, propensity to bioaccumulate, etc.
- The assessment receptor is a key component of ecosystem structure or function (e.g., importance in the food web, ecological relevance).

The assessment receptor may be listed as rare, threatened, or endangered (RTE) by a governmental organization or may represent a critical habitat for RTE species. Based on the availability of species-specific data, an RTE surrogate species may have been selected. Additional criteria for selection of assessment receptors were used to identify species that offer the most favorable combination of characteristics for determining the implications of on-site contaminants. These criteria included (1) limited home range; (2) role in local nonhuman food chains; (3) potential high abundance and wide distribution at the site; (4) sufficient toxicological information available in the literature for comparative and interpretive purposes; (5) sensitivity to COPECs; (6) relatively high likelihood of occurrence on site following remediation (if required); (7) suitability for long-term monitoring; (8) importance to the stability of the ecological food chain or biotic community of concern; and (9) relatively high likelihood that they will be present at the site or that habitats present at the site could support the species.

It is important that sufficient toxicological information be available in the literature for the receptor species or that a closely related species be selected. While the ecological communities at the site have species with many desirable characteristics for use as receptor species, not all of these species have been used extensively for toxicological testing.

2.4.1 Terrestrial Receptors

Seven representative assessment receptor species that are expected or possible in the vicinity of 2BG were selected as indicator species for the potential effects of COPECs. These indicator species represent two classes of vertebrate wildlife, mammals and birds, and a range of both

body size and food habits, including herbivory, omnivory, and carnivory. Potential impacts to terrestrial plants are considered in Section 5.1. The seven species selected include the deer mouse (*Peromyscus maniculatus*; small, omnivorous mammal), short-tailed shrew (*Blarina brevicauda*; small, insectivorous mammal), Eastern cottontail rabbit (*Sylvilagus floridanus*; medium-sized herbivorous mammal), marsh wren (*Cistothorus palustris*; small insectivorous bird), white-tailed deer (*Odocoileus virginianus*; large herbivorous mammal), raccoon (*Procyon lotor*; medium-sized omnivorous mammal), and red-tailed hawk (*Buteo jamaicensis*; large, carnivorous bird). The marsh wren was selected as a surrogate for the sedge wren, an Ohio endangered species that has been documented in the general area and a species that may be expected on site given the availability of some preferred nesting habitat.

The deer mouse, shrew, Eastern cottontail, and marsh wren represent the prey base for the larger predators of the area, represented by the red-tailed hawk. A terrestrial food web is presented in Figure 2-2. Many of these species have limited home ranges, particularly the deer mouse, cottontail, shrew, and marsh wren, which make them particularly vulnerable to exposure from site contaminants. All of the selected terrestrial receptor species have a potentially high abundance and wide distribution at the site; also, sufficient toxicological information, with the exception of some bird species, is available in the literature for comparative and interpretive purposes. In addition, all of the selected species are likely to occur after site remediation, if risk management decisions require it. All species are considered important to the stability of the local ecological food chain and biotic community. Finally, all the selected species have readily available exposure data, as summarized in the Wildlife Exposure Factors Handbook (EPA, 1993).

Larger mammal species were generally not selected as sensitive receptors due to their large home ranges; however, the far-ranging red-tailed hawk was retained due to its unique role as a top predator in the food chain and the white-tailed deer was retained due to its high abundance at the site. Smaller birds were generally not included because most are migratory. The potential risk to species with larger home ranges and migratory avian species was bounded by the predicted risks to the selected terrestrial indicator receptors. Area use factors were conservatively set to 100 percent for the mouse, shrew, rabbit, wren, and raccoon, due to their relatively small home ranges. For the deer and hawk, the area use factor was set at 0.02 (2%) and 0.01 (1%), respectively, based on these two species' relatively large home ranges (518 and 842 hectares, or 1,280 and 2,081 acres, respectively), compared with the size of the site (25 acres).

Results of the assessment receptor selection process are presented in detailed biological and ecological descriptions called assessment receptor profiles (ARPs). Additionally, the biologically relevant criteria used to select the 7 terrestrial assessment receptors are discussed and summarized in the ARPs (Appendix B).

2.4.2 Aquatic Receptors

The only aquatic habitat at the site is the intermittent surface water drainage on the northern side and eastern side of the site. The drainages are considered poor aquatic habitat as they are dry most of the year. Exposure of aquatic benthic dwelling organisms within the intermittent drainages was assumed to occur via direct contact with contaminants in sediment. Potential effects to sediment-dwelling organisms were assessed using sediment quality criteria for the protection of aquatic life (Section 5.2).

2.5 Ecological Endpoint (Assessment and Measurement) Identification

The protection of ecological resources such as habitats and species of plants and animals is a principal motivation for conducting the SLERA. Key aspects of ecological protection are presented as policy goals. These are general goals established by legislation or agency policy that are based on societal concern for the protection of certain environmental resources. For example, environmental protection is mandated by a variety of legislation and government agency policies such as the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (United States Code [U.S.C.] Title 42, Section 9601 [42 U.S.C. 9601] et seq.) and the National Environmental Policy Act (42 U.S.C. 4321 et seq.). Other legislation includes the Endangered Species Act 16 U.S.C. 1531-1544 and the Migratory Bird Treaty Act 16 U.S.C. 703-711. To determine whether these protection goals are met at the site, assessment and measurement endpoints were formulated to define the specific ecological values to be protected and to define the degree to which each may be protected.

Unlike the human health risk assessment process, which focuses on individual receptors, the SLERA focuses on populations or groups of interbreeding nonhuman, non-domesticated receptors. In the SLERA process, the risks to individuals are assessed only if they are protected under the Endangered Species Act, are species that are candidates for protection, or are species that are considered rare. The results of this SLERA may be used to determine whether remediation or additional investigation is warranted at the site to protect populations of ecological receptors.

Given the diversity of the biological world and the multiple values placed on it by society, there is no universally applicable list of assessment endpoints. Suggested criteria that may be considered in selecting assessment endpoints suitable for a specific ecological risk assessment are: (1) ecological relevance; (2) susceptibility to the contaminant(s); (3) accessibility to prediction and/or measurement; and (4) definable in clear, operational terms (Suter, 1993). Selected assessment endpoints should reflect environmental values that are protected by law, are critical resources, or have relevance to ecological functions that may be impaired. Both the entity and attribute are identified for each assessment endpoint.

Assessment endpoints are inferred from effects to one or more measurement endpoints. The measurement endpoint is a measurable response to a stressor that is related to the valued attribute of the chosen assessment endpoint. It serves as a surrogate attribute of the ecological entity of interest (or of a closely related ecological entity) that can be used to draw a predictive conclusion about the potential for effects to the assessment endpoint. Information gained during the site reconnaissance was used to assist in the selection of assessment and measurement endpoints. These endpoints, formal expressions of the environmental values to be protected (Suter, 1993), were used to focus the goals of the SLERA (Table 2-3).

Measurement endpoints for this SLERA are based on toxicity values from the available literature and not on statistical or arithmetic summaries of actual field or laboratory observations or measurements. Where possible, receptors and endpoints were concurrently selected by identifying those that are known to be adversely affected by chemicals at the site based on published literature. COPECs for those receptors and endpoints were identified by drawing on the scientific literature to obtain information regarding potential toxic effects of site chemicals to site species. This process ensures that a conservative approach is taken in selecting endpoints and evaluating receptors that are likely to be adversely affected by the potentially most toxic chemicals at the site.

2.5.1 Assessment Endpoints

The assessment endpoints for 2BG are stated as "the protection of long-term survival and reproductive capabilities for terrestrial invertebrates, herbivorous mammals, omnivorous mammals, insectivorous mammals and birds, carnivorous birds, and aquatic benthic invertebrates." The corresponding H_o for each of the assessment endpoints is stated as: "the presence of site contaminants within soil, sediment, vegetation, and prey will have no effect on the survival or reproductive capabilities of populations of terrestrial invertebrates, herbivorous mammals, omnivorous mammals, insectivorous mammals and birds, carnivorous birds, and benthic invertebrates." Aquatic mammals and birds were not evaluated because of the absence of aquatic habitat at Site 2BG.

Assessment receptor species were selected based on the likelihood of finding the species at 2BG. Historical information, site reconnaissance, and the availability of toxicological data were used to select terrestrial and aquatic receptor species. These receptor species are depicted in food web ECSMs in Figures 2-2 and 2-3. Food web models are simplified versions of the possible movement of contaminants through the food chain present or potentially present at the site. Due to lack of data for all possible species, key species have been selected to represent broad classes, or guilds.

The food web conceptual site models were developed to illustrate how the selected terrestrial and aquatic species are ecologically linked within food webs. One species was used to represent each of the major trophic levels and habitats at the site. The decision was made not to complicate the food web models with detailed species selection at the base of the food web (i.e., specific terrestrial/benthic invertebrates or aquatic vertebrates). Thus, generic terrestrial invertebrates, benthic invertebrates, and aquatic sediment-dwelling organisms were used to represent the bottom of the food chain. For terrestrial invertebrates and plants, partitioning coefficients and simple empirical uptake models were employed to estimate COPEC concentrations within tissues (Section 3.1). These tissue concentrations were then used as input values for exposure to higher trophic level receptors through the dietary ingestion route. Brief life-history descriptions for the selected area receptor species are provided in Appendix B.

All trophic levels may be exposed to COPECs, either by direct exposure to contaminated abiotic media or through ingestion of lower trophic level food items. Primary producers (plants) absorb COPECs as well as nutrients from soil and/or water. Through abiotic processes, COPECs can adsorb to the sediment and detritus particles. When these particles settle and become part of the benthic substrate, they may also become a source of COPECs to benthic communities.

In terrestrial species, bioconcentration may occur in plants and invertebrates, and higher food chain receptors may bioaccumulate COPECs through the ingestion of food items.

2.5.2 Measurement Endpoints

Measurement endpoints are numerical expressions of observations (e.g. toxicity test results or community diversity indices) that can be compared statistically to detect adverse responses to a site contaminant. Examples of typical measurement endpoints include mortality, growth or reproduction in toxicity tests; individual abundance; species diversity; and the presence or absence of indicator data in field surveys of existing impacts (EPA, 1997).

For assessments, measurable responses to stressors may include lowest observed adverse effect levels (LOAEL), no observed adverse effect levels (NOAEL), lethal concentration to 50 percent (LC_{50}) of the test population, lethal dose to 50 percent (LD_{50}) of the test population, or effective concentration for 20 percent (EC_{20}) of the test population, collectively termed toxicity reference values (TRVs) (see Section 4.2 for further explanation). In addition, critical effect values for sediment and soil were selected as measurement endpoints (Table 2-3). The most appropriate measurement endpoints were chosen based on exposure pathways as well as ecotoxicity of the contaminant.

2.6 Ecological Conceptual Site Models

Pictorial representations of potential exposure through the food web are presented in Figures 2-2 and 2-3. The ECSMs trace the contaminant pathways through both abiotic components and biotic food web components of the environment. The ECSMs present all potentially complete exposure pathways. The ECSMs were used as a tool for judging the appropriateness and usefulness of the selected measurement endpoints in evaluating the assessment endpoints, and for identifying sources of uncertainty in the exposure characterization.

3.0 EXPOSURE CHARACTERIZATION

Estimates of the nature, extent, and magnitude of potential exposure to COPECs present at 2BG were developed for both current and reasonably plausible future assessment receptors. Exposure characterization is critical in further evaluating the risk from potential exposure to contaminants identified as COPECs. The exposure assessment was conducted by linking the magnitude (concentration) and distribution (locations) of the contaminants detected in environmental media, evaluating pathways by which chemicals may be transported through the environment, and determining the points at which assessment receptors may contact contaminants. The concepts of bioaccumulation, bioconcentration, and biomagnification are used throughout this document. These terms are defined by EPA (1997) as follows:

- **Bioaccumulation.** General term describing a process by which chemicals are taken up by an organism either directly from exposure to a contaminated medium or by consumption of food containing the chemical.

- **Bioconcentration.** A process by which there is a net accumulation of a chemical directly from an exposure medium into an organism.

- **Biomagnification.** Result of the process of bioaccumulation and biotransfer by which tissue concentrations of chemicals in organisms at one trophic level exceed tissue concentrations in organisms at the next lower trophic level in a food chain.

3.1 Exposure Analysis

An exposure analysis combining the spatial and temporal distribution of the assessment receptors and the COPECs was performed to evaluate potential exposure. The exposure analysis focused on the amount of the COPECs assumed to be bioavailable and the pathways by which the ecological receptors would be exposed. The focus of the analysis was dependent on the assessment receptors evaluated and the assessment and measurement endpoints.

Contamination of biota could result from exposure to one or more COPECs. Bioavailability is an important contaminant characteristic that influences the degree of chemical-receptor interaction. Bioavailable substances are those that a receptor can extract from the environment. Bioavailability of a chemical is a function of its physical and chemical environmental factors including grain size and organic carbon content and its tendency to partition between one environmental medium and another (e.g., soil to water) or to the receptor.

Exposure pathways for biota may be direct (bioconcentration) or through the food web via the consumption of contaminated organisms (bioaccumulation and biomagnification). Direct exposure routes include ingestion, inhalation, dermal contact, and absorption. Examples of direct exposure include animals incidentally ingesting contaminated soil or sediment (e.g., during burrowing or dust-bathing activities); animals ingesting surface water; plants absorbing contaminants by uptake from contaminated sediment or soil; and the dermal contact of aquatic organisms with contaminated surface water or sediment. Food web exposure can occur when terrestrial or aquatic fauna consume contaminated biota. Examples of food web exposure include animals at higher trophic levels consuming plants or animals that bioaccumulate contaminants.

Exposure pathways consist of four primary components: source and mechanism of contaminant release, transport or exposure medium, potential receptors, and exposure route. A chemical may also be transferred between several intermediate media before reaching the potential receptor. All of these components are addressed in this SLERA. The major fate and transport properties associated with site contaminants are presented in subsequent sections. These properties directly affect a contaminant's behavior in each of the exposure pathway components.

For terrestrial faunal receptors, calculation of exposure rates relied upon determination of an organism's exposure to COPECs found in surface soil and on transfer factors used to estimate potential food-chain exposure. Exposure rates for terrestrial wildlife receptors were based on ingestion of contaminants from these media and from consumption of other organisms. Given the scarcity of available data for dermal and inhalation exposure of wildlife, potential risk from these pathways was not estimated. In addition, dermal and inhalation pathways were generally considered to be incidental for most species, with the possible exception of burrowing animals and dust-bathing birds.

The first step in estimating exposure rates for terrestrial wildlife involved the determination of food ingestion and drinking water intake rates for assessment receptors. EPA (1993) includes exposure parameters for a number of avian and mammalian species. Available data for feeding and watering rates and dietary composition were obtained for species, or were estimated using allometric equations (Nagy, 1987). Data gathered on incidental ingestion of soil were also incorporated for the assessment receptors. Species-specific exposure parameters are presented in Table 3-1.

Equations have been developed for terrestrial vertebrate receptors accounting for exposure via incidental ingestion of contaminated soil, ingestion of contaminated water, ingestion of plants grown in contaminated soil, and prey items. Singular equations have been developed for soil to plant uptake and for animal bioaccumulation (transfer factors). The basic equation for estimating dose through the dietary pathway is:

$$D_p = \sum_{k=1}^{m} \left(C_k \cdot F_k \cdot I_k \right) / W \qquad \textbf{Eq 3 .1}$$

where:

D_p = the potential average daily dose (milligram per kilogram per day [mg/kg-day])

C_k = the average COPEC concentration in the kth food type (milligrams per kilogram [mg/kg] dry weight)

F_k = the fraction of the kth food type that is contaminated

I_k = the ingestion rate of the kth food type (kilogram [kg] dry weight/day)

W = the body weight of the receptor (kg wet weight)

For sediment or soil, the percent carbon present is critical to partitioning. For these matrices, the octanol/water partition coefficient (K_{ow}) was converted to a soil adsorption coefficient (K_{oc}) value (EPA, 1996b) as follows:

$$Log\ K_{oc} = 0.00028 + (0.983x \log K_{ow})$$ **Eq. 3.2**

where:

K_{oc} = chemical-specific organic carbon partition coefficient

K_{ow} = chemical-specific octanol/water partition coefficient

This equation was chosen because it is the best fit for site-related compounds (semivolatile, nonionizing organic compounds).

Per EPA (1995) guidance, aquatic bioaccumulation factors (BAFs) were estimated by one of four methods, listed in order of preference:

- A measured BAF for an inorganic or organic chemical derived from a field study.
- A predicted BAF for an organic chemical derived from a field-measured biota-sediment accumulation factor.
- A predicted BAF for an inorganic or organic chemical derived from a laboratory-measured bioconcentration factor (BCF) and a food chain multiplier (FCM).
- A predicted BAF for an organic chemical derived from a K_{ow} and an FCM.

The EPA guidance notes that for chemicals for which no K_{ow} is available and for which no BCF is calculable, a default FCM of 1.0 should be used. Accordingly, for inorganics not thought to biomagnify and/or for which no literature value was available, the value of 1.0 was used at each trophic level.

In addition to the aquatic food web, FCMs were also related to an organism's trophic status as predator/prey, producer/consumer, etc., in the terrestrial food web. Although exposures of terrestrial floral and faunal receptors are significant considerations for many hazardous waste sites, well accepted models for predicting the fate of many contaminants in terrestrial systems are less developed. Trophic level compartments and transfer between compartments based on uptake, storage, and loss processes are not as well defined in terrestrial systems as in aquatic systems. In addition, the relationship between K_{ow} and bioconcentration is less well delineated by trophic level in terrestrial ecosystems. For this SLERA, soil-to-plant and food-to-muscle BAFs were obtained from EPA's *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (1999b) or estimated for organic constituents using the log K_{ow} relationships developed by Travis and Arms (1988). Soil-to-insect BAFs were obtained from EPA (1999b) or based on log K_{ow} relationships developed by Connell and Markwell (1990). Inorganic constituent BAFs were obtained from EPA (1999b) or based on literature values such as those found in Baes, et al. (1984), International Atomic Energy Agency (1994), and Ma (1982).

Literature values for receptor-specific sediment ingestion rates were used, where available; however, such values generally were not available. Where sediment ingestion rates could not be found, the receptor-specific incidental soil ingestion rate was used for sediment ingestion as well, where the receptor's life history profile suggested a significant aquatic component.

Tissue concentrations in vertebrate prey species were estimated from the daily intake of the COPECs through the use of transfer factors obtained from EPA (1999b) (Table 3-2). The total concentration of COPEC intake (including ingested soil and surface water) was then used in the calculation of tissue concentrations in prey species and the dietary exposure rate in all assessment receptors.

Exposure to four categories of environmental media are addressed in this SLERA, as discussed in the following subsections.

Soil Exposure Pathway. Soil exposure pathways are potentially important for terrestrial plants and animals at the site. For non-burrowing animal exposure, only surface soil samples were used. For burrowing animals such as the shrew, surface and subsurface soil samples were used.

For plant exposure, surface and subsurface soil samples were used because feeder roots may reach deeply into the subsurface. Thus, the white-tailed deer was assumed to ingest vegetation translocating COPECs from subsoils (Figure 2-4).

Environmental conditions including soil moisture, soil pH, and cation exchange capacities significantly influence whether potential soil contaminants remain chemically bound in the soil matrix or can be chemically mobilized in a bioavailable form and released for plant absorption. Literature values for soil-to-plant transfer rates for inorganic soil contaminants were used (Table 3-2).

Sediment Exposure Pathway. Sediment consists of materials precipitated or settled out of suspension in surface water or native soils underlying flowing or standing surface water bodies. Potential contaminant sources for sediment include buried or stored waste, and contaminated surface water, groundwater, and soil. The release mechanisms include storm-water runoff, groundwater discharge, and airborne deposition. Potential receptors to chemicals in contaminated sediment include aquatic flora and fauna. Direct exposure routes for contaminated sediment include contact by benthic-dwelling organisms such as amphipod invertebrates, uptake by aquatic flora, and ingestion by aquatic fauna. Indirect exposure pathways from sediment include consumption of bioaccumulated contaminants by consumers in the food chain. Chemical bioavailability of many nonpolar organic compounds such as PCBs and pesticides decreases with increasing concentrations of total organic carbon in the sediment; however, these compounds can still bioaccumulate up the food chain (Landrum and Robbins, 1990).

Surface Water Exposure Pathway. Surface water represents a potential exposure and transport medium for COPECs. However, no surface water data exists because the drainage ditches associated with 2BG are ephemeral and were dry at the time of sampling. Potential sources for contaminated surface water include buried or stored waste, contaminated soil and groundwater, and deposition of airborne contaminants. Release mechanisms include stormwater runoff, leaching, and groundwater seepage. Potential receptors of contaminated surface water include terrestrial and aquatic fauna and aquatic flora. Exposure routes for contaminated surface water include ingestion by terrestrial fauna and uptake and absorption by aquatic flora and fauna. Consumption of bioaccumulated contaminants represents a potential indirect exposure pathway for faunal receptors. Piscivorous receptor's exposure to fish was not quantified because of the lack of suitable habitat at the site. Chemical bioavailability of some metals and other chemicals is controlled by water hardness, pH, and total suspended solids.

Groundwater Exposure Pathway. Groundwater represents a potential transport medium for COPECs. Potential contaminant sources for groundwater include contaminated soil and buried or stored waste. The release mechanism for contaminants into groundwater is direct transfer of contaminants from waste materials to water as water passes through the materials.

Groundwater is not an exposure medium for ecological receptors. However, contaminant transport along the shallow groundwater pathway was considered an exposure route to aquatic life, wetlands, and some wildlife where the groundwater discharges to surface water. A groundwater assessment was not included in this SLERA due to the absence springs or other water resources at Site 2BG.

3.2 Exposure Characterization Summary

The estimated chemical intakes for each potentially exposed assessment receptor for each exposure pathway and scenario are presented in Tables 3-3 through 3-9 for the area within the 2BG and Tables 3-10 through 3-16 for the area outside of the Burning Ground. The intake estimates were combined with the COPEC TRVs, discussed in the following section, to derive estimates of potential adverse ecological effects. The uncertainties associated with the estimation of potential adverse effects are discussed in Section 5.4. The basis for each uncertainty has been identified, with the degree of uncertainty estimated qualitatively (low, medium, or high) or quantitatively, and the impact of the uncertainty estimated qualitatively (overestimate or underestimate, as appropriate).

4.0 ECOLOGICAL EFFECTS CHARACTERIZATION

The ecological effects characterization includes the selection of literature benchmark values and TRVs.

4.1 Selection of Literature Benchmark Values

Appropriate sources for literature benchmark values included *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (EPA, 1999b), *Toxicological Benchmarks for Wildlife* (Sample, et al., 1996); *Development of Toxicity Reference Values for Conducting Ecological Risk Assessments at Naval Facilities in California* (Engineering Field Activity, West, 1998); *Review of the Navy - EPA Region 9 BTAG Toxicity Reference Values for Wildlife* (CH2M-Hill, 2000); and LD_{50} values from data bases such as the Registry of Toxic Effects Concentrations (RTEC) (extrapolated to chronic NOAEL or LOAEL values using recommended Tri-Service [Wentsel et al., 1996] uncertainty factors). The primary source of benchmark values for this SLERA was EPA (1999b).

4.2 Selection of Toxicity Reference Values

The primary source of TRVs for this SLERA was EPA (1999b). These TRVs focus on the growth, survival, and reproduction of species and/or populations. TRVs were available for the specific receptor-endpoint combinations in most instances. However, for some COPECs, data on surrogate species was used. The NOAEL is the dose for a COPEC that has produced no known adverse effects in the test species. The NOAEL was judged to be an appropriate toxicological endpoint since it provides the greatest degree of protection to the receptor species. In instances where TRVs were unavailable for a site-associated COPEC, toxicological information for surrogate chemicals was used. This process is described in the following paragraphs.

Toxicity information pertinent to identified receptors was gathered for those analytes identified as COPECs. As previously noted, where data were unavailable for the exposure of a receptor to a COPEC, data for a surrogate chemical (e.g., benzo(a)pyrene for other PAHs) were gathered for use in the SLERA. No TRVs were calculated for this SLERA (Table 4-1).

Test species body weights used for COPEC TRVs are provided in Table 4-1. These factors were used together to derive a final adjusted TRV, also presented in Table 4-1. TRV uncertainties are discussed in Section 5.4.

Exposure rate TRVs provide a reference point for the comparison of potential toxicological effects from exposure to a contaminant. To complete this comparison, receptor exposures to site contaminants were calculated or, as in the case of plant receptors, exposure was estimated using the soil concentration.

The potential toxicity of essential nutrients is assessed in Appendix C, with maximum tolerance levels presented for several essential nutrients.

The equilibrium partitioning approach has been used by the EPA and OME in the preparation of sediment quality criteria for the protection of aquatic life. These criteria were used, as available, to assess sediment risks to aquatic receptors.

5.0 RISK CHARACTERIZATION

Risk characterization integrates information on exposure, exposure-effects relationships, and defined or presumed target populations. The result is an estimate of the likelihood, severity, and characteristics of potential adverse effects from environmental stressors present at a site. Qualitative and semiquantitative approaches were taken to estimate the likelihood of adverse effects occurring as a result of potential exposure of the assessment receptors to COPECs. Potential adverse affects to terrestrial plants were qualitatively assessed by comparing plant toxicity benchmarks with COPEC concentrations. Potential adverse impacts to aquatic biota were qualitatively assessed by comparing sediment quality criteria for the protection of aquatic life to sediment COPEC concentrations.

For the semiquantitative predictive assessment, TRVs and estimated exposure rates were used to generate hazard quotients (HQs) by dividing the receptor exposure rate for each contaminant by the TRV. HQs are a means of estimating the potential for adverse effects to organisms at a contaminated site and for assessing the potential for toxicological effects to occur.

Risk characterizations have been completed for soils inside the burn area and outside the burn area. For both areas, soils to a maximum depth of 5-feet bgs were used.

5.1 Terrestrial Plant Impact Assessment

The EPCs were compared with available benchmark concentrations developed for the protection of terrestrial plants to assess the potential impact of COPEC concentrations in surface soil on terrestrial plant species inside and outside the burn area. As shown in Table 2-2, benchmarks were exceeded by the COPEC EPC for multiple constituents. Additionally, benchmarks were not available for some of the COPECs retained for the SLERA. However, no signs of vegetative stress were noted inside or outside the burn area based on site reconnaissance surveys performed in May and October 2008 (Section 2.1.4).

5.2 Aquatic Biota Impact Assessment

The EPCs from 2BG were compared with available benchmark concentrations developed for the protection of aquatic life in sediments (benthic organisms) to assess the potential impact of COPEC concentrations in sediment on aquatic biota. Only sediment was evaluated because the drainage ditches are ephemeral and were dry at the time of sampling and dry at the time of the ecological surveys in the spring and fall. The ecological surveys concluded that there is limited to no aquatic habitat present at Site 2BG. As shown in Table 2-2, sediment concentrations for select metals, PAHs, 2,3,7,8-TCDD, and VOCs (acetone, methyl ethyl ketone, and cyclohexane) were initially identified as sediment COPECs. Of the metals, only selenium exceeded its background value and selenium is not a risk driver at the site. The VOCs identified as COPECs are commonly associated with laboratory contamination. No explosives were detected in the sediment samples. It is important to note that aquatic habitat is very poor at 2BG and is not a major habitat type.

5.3 Predictive Risk Estimation for Terrestrial Wildlife

Estimates of potential for risks associated with exposure to 2BG environmental media inside the burn area and outside the burn area were evaluated (Tables 5-1 through 5-14) through a series of quantitative HQ calculations that compared receptor-specific exposure values with TRVs.

The HQs were compared according to HQ guidelines for assessing the risk posed from contaminants. HQs less than or equal to 1 represent no probable risk. HQs from 1 up to but less than 10 represent a low potential for adverse ecological effects. HQs from 10 up to but less than 100 represent a significant potential that effects could result from greater exposure. HQs greater than 100 represent the highest potential for expected effects (Wentsel, et al., 1996). OEPA considers HQs greater than 1.0 to be potentially significant. It should also be noted that HQs are not measures of risk, are not population-based statistics, or linearly scaled statistics. Accordingly, an HQ above 1, even exceedingly so, does not necessarily mean that there is even one individual expressing the toxicological effect associated with a given chemical to which it was exposed (Tannenbaum, 2001; Bartell, 1996).

Conservative NOAEL-based HQs greater than 10 for terrestrial receptors inside the Burning Ground and outside of the burn area at 2BG were:

	HQ	
	Inside 2BG	**Outside the Burn Area**
Deer Mouse	(Table 5-4)	(Table 5-11)
2,3,7,8-TCDD TEQ	45	
2,4-Dinitrotoluene	19,010	59
2,6-Dinitrotoluene	661	23
Aluminum	121	128
Barium	20	
Iron	20	17
Acenaphthene	139	
Naphthalene	33	
Short-Tailed Shrew	(Table 5-1)	(Table 5-8)
2,4-Dinitrotoluene	87	14
2,6-Dinitrotoluene	20	4
Aluminum	275	5
Iron	36	21
Marsh Wren	(Table 5-3)	(Table 5-10)
2,3,7,8-TCDD TEQ	58	
2,4-Dinitrotoluene	10,460	32
2,6-Dinitrotoluene	292	10
Aluminum	137	145
Barium	13	
Iron	23	20
Acenaphthene	181	
Naphthalene	42	
Raccoon	(Table 5-7)	(Table 5-14)
2,3,7,8-TCDD TEQ	11	
2,4-Dinitrotoluene	105	
2,4,6-Trinitrotoluene		4,532
Aluminum		505
Iron		3,686
Eastern Cottontail	(Table 5-5)	(Table 5-12)
2,4-Dinitrotoluene	8,230	26

	HQ	
	Inside 2BG	**Outside the Burn Area**
2,6-Dinitrotoluene	326	11
Aluminum	34	36
White Tailed Deer	(Table 5-2)	(Table 5-9)
2,4-Dinitrotoluene	63	
Red Tailed Hawk	(Table 5-6)	(Table 5-13)
2,4-Dinitrotoluene	121	

Important routes of exposure for COPECS in soils were invertebrate and plant intake. Only terrestrial hazards were estimated for the raccoon because of the limited extent of aquatic habitat at the site.

5.4 Uncertainty Analysis

The results of the SLERA are influenced to some degree by variability and uncertainty. In theory, investigators might reduce variability by increasing sample size of the media or species sampled. Alternatively, uncertainty within the risk analysis can be reduced by using species-specific and site-specific data to better quantify contamination of media, vegetation, and prey through direct field measurements, toxicity testing of site-specific media, and field studies using site-specific receptor species. Detailed media, prey, and receptor field studies are costly; therefore, the preliminary predictive analyses of risk were conducted to limit the potential use of these resource-intensive techniques to only those COPECs that continue to show a relatively high potential for ecological risk. The results of the screening and predictive assessments are considered conservative because assessment criteria were developed based on conservative assumptions. This has the effect of maximizing the likelihood of accepting a false positive (Type I error: the rejection of a true H_o) and simultaneously minimizing the likelihood of accepting a true negative (Type II error: the acceptance of a false H_o).

A number of factors contribute to the overall variability and uncertainty inherent in ecological risk assessments. Variability is due primarily to measurement error. Laboratory media analyses and receptor study design are the major sources of this kind of error. Uncertainty, on the other hand, is associated primarily with deficiency or irrelevancy of effects, exposure, or habitat data to actual ecological conditions at the site. Species physiology, feeding patterns, and nesting behavior are poorly predictable; therefore, all toxicity information derived from toxicity testing, field studies, or observation will have uncertainties associated with them. Laboratory studies conducted to obtain site-specific, measured information often suffer from poor relevance to the actual exposure and uptake conditions on site (i.e., bioavailability, exposure, assimilation, etc., are generally greater under laboratory conditions as compared to field conditions). Calculating an estimated value based on a large number of assumptions is often the only alternative to the accurate, albeit costly, method of direct field or laboratory observation, measurement, or testing. Finally, habitat- or site-specific species may be misidentified if, for example, the observational assessment results are based on only one or even two brief site reconnaissance surveys.

The uncertainty analysis lists:

- many of the major assumptions made for the SLERA;

- the direction of bias caused by each assumption, i.e., whether the uncertainty results in an overestimate or underestimate of risk;
- the likely magnitude of impact as high, medium, low, or unknown; and,
- where possible, a description of recommendations for minimizing the identified uncertainties if the SLERA progresses to higher level assessment phases (EPA, 1992b).

The uncertainty analysis identifies and, where possible, quantifies the uncertainty in the individual preliminary scoping assessment, problem formulation, exposure and effects assessment, and risk characterization of this SLERA. The most important uncertainties associated with this SLERA are discussed in the following subsections.

Assumptions of bioavailability. The assumption that COPECs are 100 percent bioavailable likely overestimates the potential for adverse effects. The duration since the contaminant release affects bioavailability as the contaminant becomes sequestrated or transformed within the environmental media. Sequestration, transformation, and bioavailability are influenced by medium characteristics including pH, temperature, and organic carbon content.

Use of laboratory-derived or empirically-estimated partitioning and transfer factors. The use of laboratory-derived or empirically-estimated partitioning and transfer factors to predict COPEC concentrations in plants, invertebrates, prey species, and sediment pore water likely overestimates potential risks. As discussed above, the incorporation of COPECs into the food chain is influenced by the characteristics of the exposure medium which likely differs from that used in the laboratory to derive partitioning and transfer factors.

Use of laboratory-derived toxicity reference values. The use of laboratory-derived TRVs may over- or under-estimate the potential for adverse effects. The method of administration of the contaminant in the laboratory is significantly different than that experienced in the wild by the receptors.

Use of the HQ method to estimate risks to populations or communities. Many of the HQs presented in this SLERA are unrealistically high and toxicologically impossible. Estimated HQs greater than 1000 should be considered suspect.

Sampling and Analytical Limitations. It is not possible to completely characterize the nature and extent of contamination on any site. Uncertainties arise from limits on the number of locations that can be sampled. The sampling protocol used at 2BG, however, was designed to optimize efficiency of the sampling effort and reduce uncertainty by focusing on areas around former process buildings, storage structures, and potential transfer piping. Focusing on these most likely contaminated areas will bias potential soil contaminant concentrations higher than that for the entire region to provide a more conservative estimate of potential risk.

The sampling and analytical data are sufficient to identify explosives as the major contaminants in soil inside the burn area and to a lesser extent outside the burn area. Select metals were also identified as risk drivers but none of the metals exceeded their respective background values. 2,3,7,8-TCDD was also identified as a risk driver in soils inside the burn area but was not identified as a risk drivers for soils outside the burn area.

Selection and Quantification of Chemicals of Potential Ecological Concern. Uncertainty associated with the processes used to identify COPECs and estimate EPCs arises from the following:

1. Identifying background chemicals. Metals are judged to be present at concentrations comparable to background if the MDC does not exceed the BSC, or if statistical testing demonstrates that the site data and background data are drawn from the same population. Statistical testing of site data versus background was performed for this RA. All inorganic constituents detected in environmental media were initially carried through the ecological risk assessment to provide a conservative estimate of potential risks associated with exposure to site media. However after this was completed, the MDCs for all metals in soils and sediments were compared to their respective background criteria and all metals were determined to be below background with the exception of lead. However, lead was not a risk driver in soils or sediments. Some organic chemicals, such as PAHs, may be considered to be anthropogenic background. A limited number of PAHs were identified in soil and sediment at 2BG. There are no site-specific background data for the PAHs, and several were selected as contaminants of concern (COCs). PAH concentrations at 2BG fall within global background levels for urban areas. Only acenaphthene and naphthalene were risk drivers for soils inside the burn area.

2. Estimated EPCs are uncertain. For statistical purposes, if a constituent is positively identified at a site and has at least a single positive hit, all the samples with nondetects are assumed to have a value equal to half the reporting limit and are included in the data set. This process may introduce a conservative bias into the risk assessment. Computed UCL_{95} values are only estimates of the actual UCLs associated with each data set. Examples of factors affecting the uncertainty of these estimates include the number of samples, proportion of nondetects, conformance with an assumed mathematical distribution, imprecision of laboratory data, elevated detection limits (from dilutions, matrix interference, etc.), and statistical methodology. The confidence of computed UCLs for this project were qualitatively evaluated and identified as high, moderate, low and indeterminate. For indeterminate data sets, the MDC was used for the UCL. Uncertainties associated with the statistical determination of EPCs for the COCs in each medium are:

    a. A limited number of samples may not completely characterize the site because they provide less information about the population from which they are drawn than do larger sample sets. Accordingly, small sets tend to have a greater variability, which results in the calculation of wide confidence intervals on the mean concentration and high EPCs. In some cases, the UCL_{95} was greater than the maximum value for the SLERA; thus, the maximum value was chosen as the EPC. High confidence limits may introduce a conservative bias into the risk assessment.

    b. Biased soil sampling was completed within the burn area of 2BG. For each burn area soil sample the ash layer was visually identified and soil samples collected from that layer. The biased sampling approach likely overestimates chemical concentrations in the burn area resulting in greater chemical concentrations and predicted risk.

    c. Laboratory analytical techniques have a degree of uncertainty associated with them. These uncertainties are documented by using data qualifiers to reflect the degree of certainty of measurement. For example, some data were estimated (e.g.,

J-qualified), while other data were rejected (i.e., R-qualified). The direction of bias is unclear.

Consistent with EPA guidance (1992a), the UCL_{95} was used for the EPC. Therefore, the exposure assessment is likely to underestimate the EPCs in 5 percent of the cases and overestimate exposures in 95 percent of cases, imparting an overall conservative bias to the risk assessment. It should be noted that many of the maximum concentrations of COPECs measured in sediment were used as source-term concentrations due to the limited number of samples; an additional sampling effort could potentially reduce the hazard estimate.

6.0 SUMMARY AND CONCLUSIONS

This section briefly summarizes the results of the SLERA and interprets the results in light of the uncertainties associated with their estimation. Conclusions are derived from the risk assessment based on the responses to the assessment hypotheses.

The predictive assessment results may serve as the foci of discussions among risk managers and regulatory agencies concerning the potential need for additional investigation at 2BG to reduce the uncertainty associated with ecological risk estimates. The uncertainties associated with this SLERA likely resulting in an overestimation of the potential for adverse ecological effects include: assuming that COPECs are 100 percent bioavailable; use of laboratory-derived or empirically-estimated partitioning and transfer factors to predict COPEC concentrations in plants, invertebrates, prey species, and sediment pore water; use of laboratory-derived TRVs; and use of the HQ method to estimate risks to populations or communities. It is important to note that many conservative assumptions and modeling approaches were used in the predictive assessment, and that actual hazards to wildlife may be orders of magnitude lower than predicted herein. Estimated HQs greater than 1000 should be considered particularly suspect.

For soils, ecological risk was evaluated separately between the burn area and areas outside the burn area. Hence, two separate risk characterizations were completed for soils associated with 2BG. Soil data, from the 0 to 5-ft bgs interval, were used to characterize potential ecological risk in the burn area and outside the burn area. This was completed because the burn area itself is expected to contain greater chemical concentrations than areas outside the burn area, and therefore, greater risk to ecological receptors. The separate risk evaluation of the two areas (the burn area and outside the burn area) was completed to assist in future remedial decision-making for the site, if warranted. Ecological risk associated with drainage ditch sediments have been assessed across the entire 2 BG site.

Soil COPEC impacts to terrestrial plants are estimated to be generally insignificant as no vegetative stress was observed inside or outside the burn areas associated with 2BG.

Inside the burn area, terrestrial receptors are predicted to incur elevated hazards from exposure to 2,3,7,8-TCDD, explosives, and two PAHs (acenaphthene and naphthalene), based on the NOAEL-based HQ approach (Section 5.3). Several metals had elevated HQs but the metals concentrations are within the range of naturally occurring background. Estimated HQs are above 1,000 for some receptors using the NOAEL-based approach. However, the estimated HQs that are above 1,000 using the NOAEL-based approach are considered unrealistic and toxicologically impossible. The white-tailed deer and red-tailed hawk had no HQ exceedances greater than 10 outside of the burn area and only an HQ greater than 10 for 2,4-dinitrotoluene inside 2BG.

Outside the burn area, terrestrial receptors are predicted to incur elevated hazards from exposure to explosives only with 2,4,6-trinitrotoluene being the greatest risk driver for the raccoon only. The white-tailed deer and red-tailed hawk had no HQ exceedances greater than 10.

Sediment-dwelling aquatic receptors are predicted to have potentially elevated hazards from exposure to 2,3,7,8-TCDD and PAHs based on a comparison of sediment data to RBSLs. However, given the limited to poor quality aquatic habitat at the site, the potential for adverse impacts to aquatic biota is considered negligible.

Based on uncertainties associated with estimates of EPCs and potential COPEC toxicity, and on the fact that no wildlife RTE species have been confirmed at the site, remedial actions solely to address ecological concerns do not appear to be warranted at this time. However, a removal action within the burn area is anticipated based on the results of the human health risk assessment. If completed, calculated cleanup goals in support of the removal action will be protective of both human health and ecological receptors.

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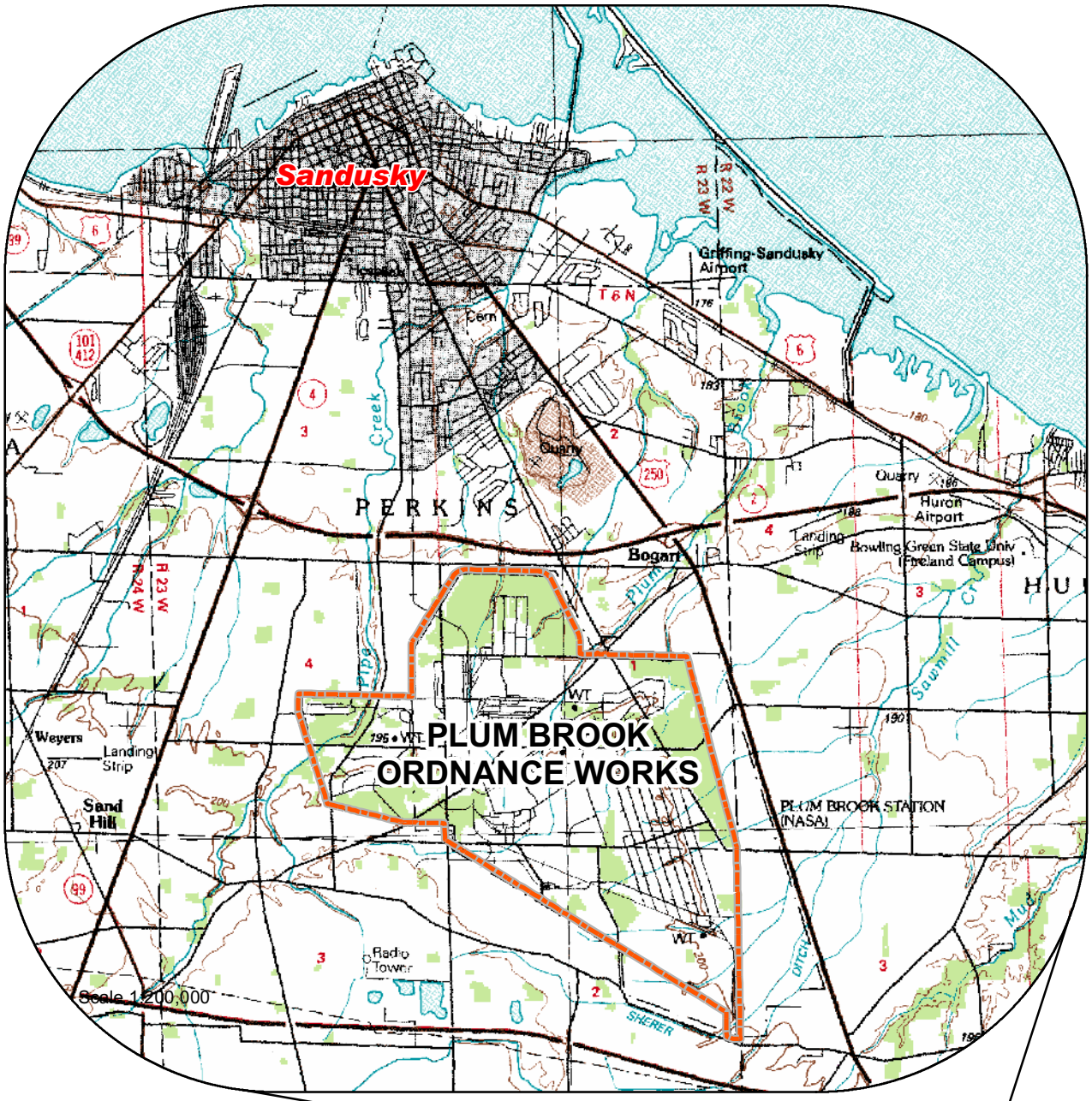
FIGURES



0 0.5 1 2 Miles

Legend

Plum Brook Ordnance Works Boundary

N

JACOBS

Location Map,
Plum Brook Ordnance Works
Sandusky, Ohio

Plumbrook Ordnance Works
Sandusky, Ohio

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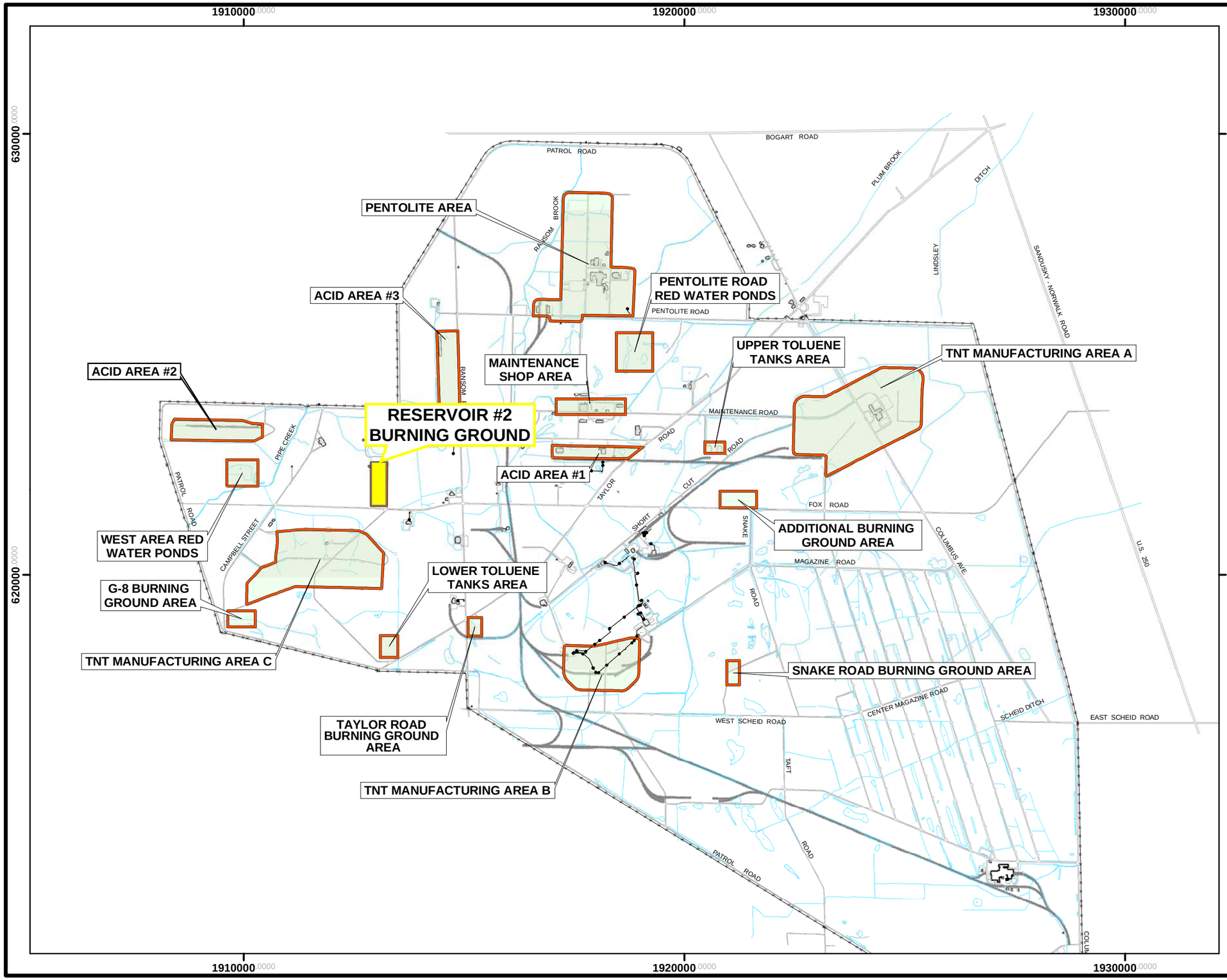
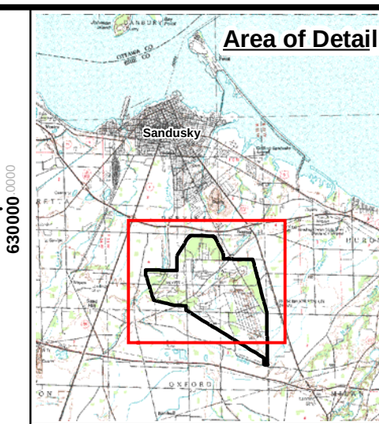
Figure 1-1



Area of Detail



Legend

Area of Concern

Creek, Ditch, Conveyance

N

0 2,000 4,000 Feet

Sources

Data mapped to Ohio State Plane North NAD83, map grid units in feet.

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Location Map, Reservoir No. 2 Burning Ground

Plum Brook Ordnance Works
Sandusky, Ohio

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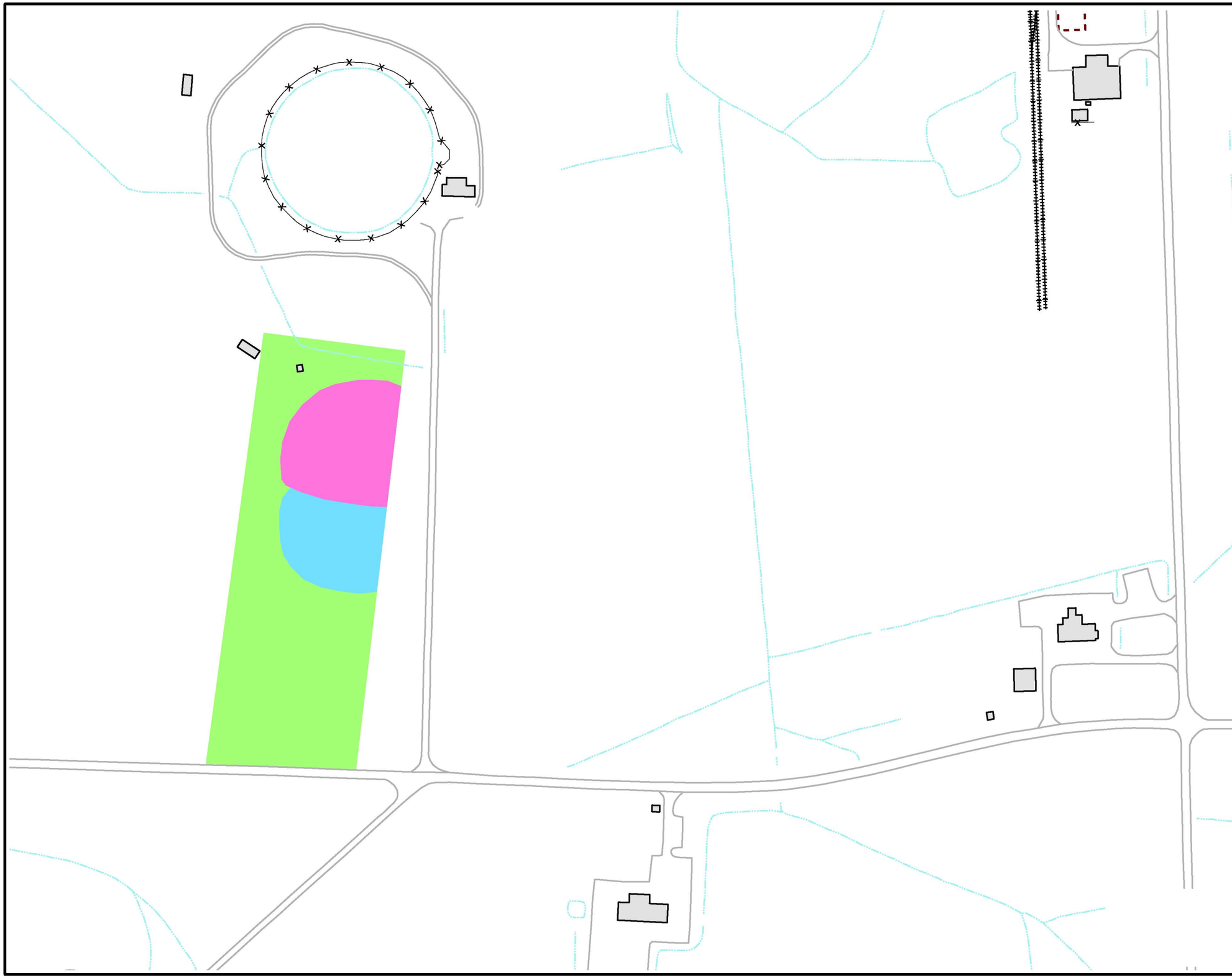
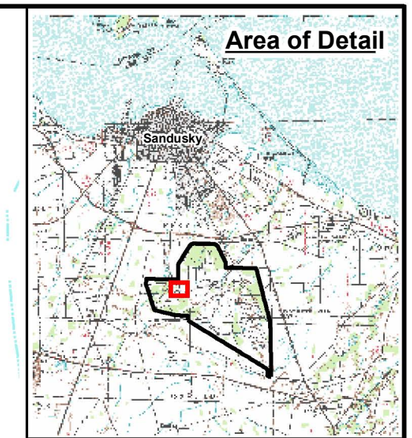
Figure 1-2





Legend

- Upland Old Fields
- Shrub Thickets
- Successional Woods

Note:
bgs = below ground surface
Bkg. = Background Sample (values are provided in units consistent with the reported sample values)
PRG = Preliminary Remediation Goal (values are provided in units consistent with the reported sample values)

- Storage Tank Areas from Engineering Drawings
- Creek, Ditch, Conveyance
- Buildings
- Railway

0 50 100 200 Feet

N

Sources
Data mapped to Ohio State Plane North NAD83, map grid units in feet.

JACOBS™

Reservoir #2 Burning Ground - Habitat Map

Plum Brook Ordnance Works
Sandusky, Ohio

12/16/08 JP X:/GIS/Projects/Plumbrook/Projects /AA1_Draft_RI/ArcGIS/AA1_burn2_habitat_map.mxd

Figure 2-1

Figure 2-2

Simplified Terrestrial Food Web Conceptual Site Model (CSM)
Plum Brook Ordinance Works, Sandusky, Ohio

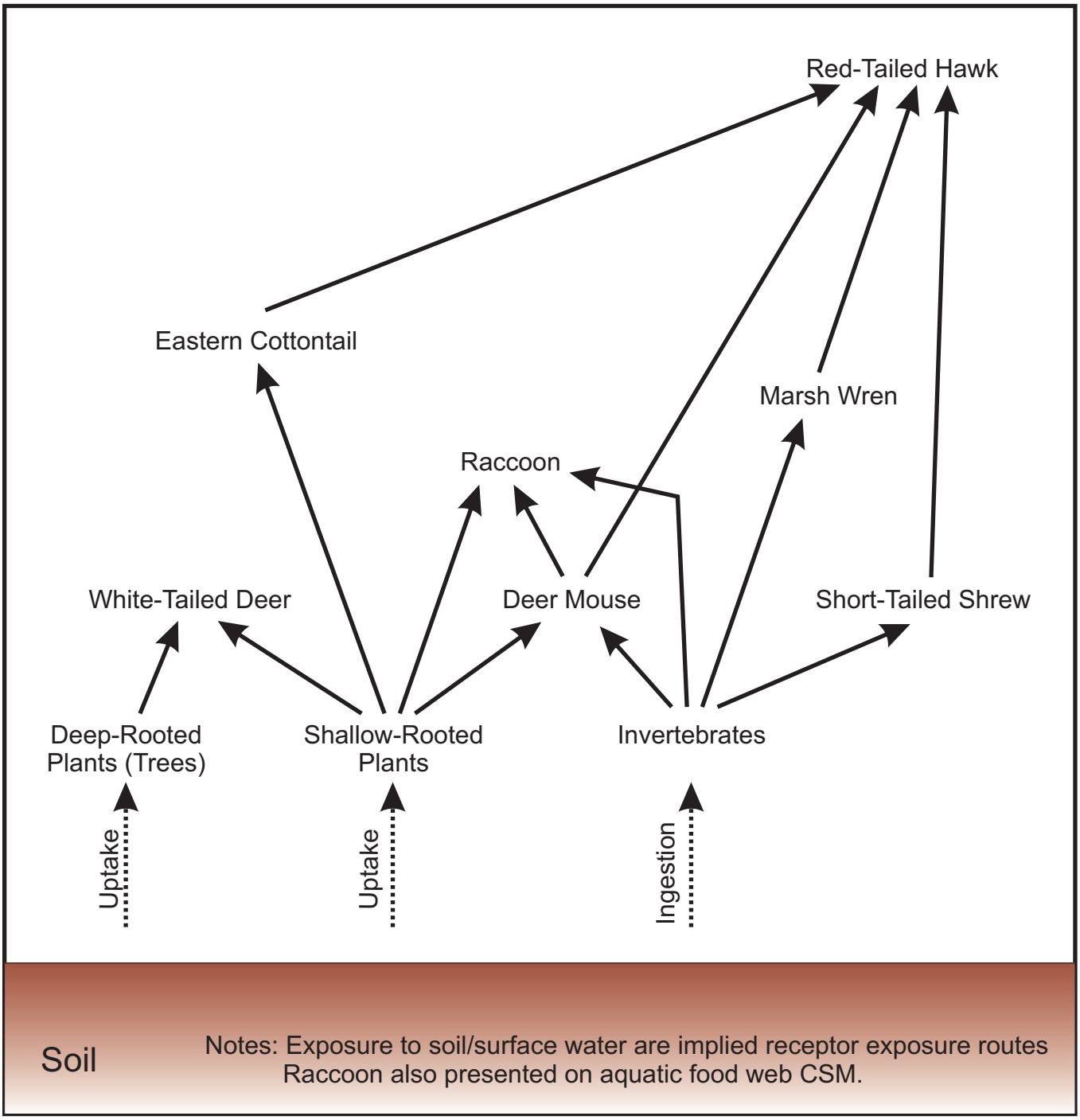
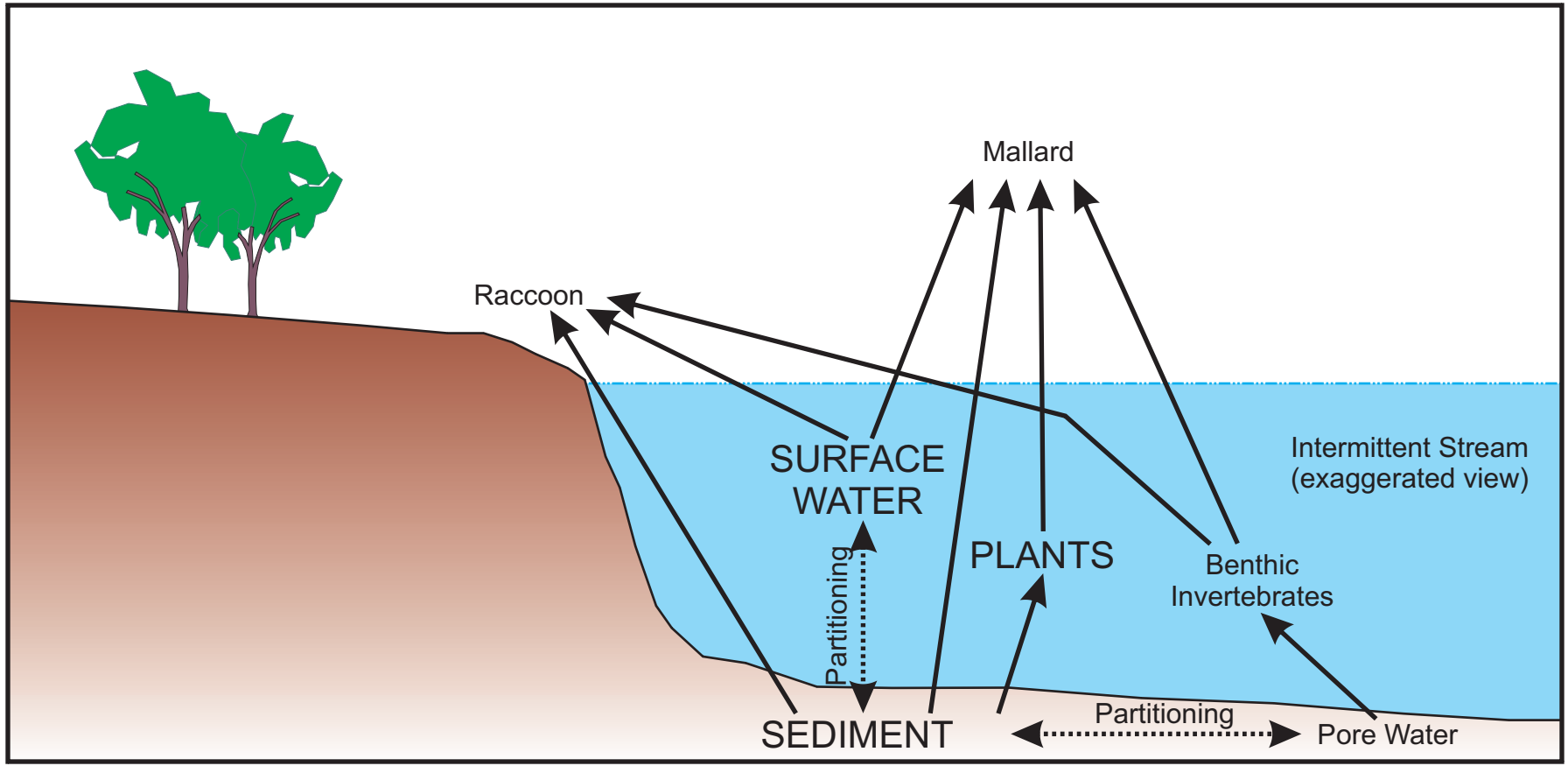
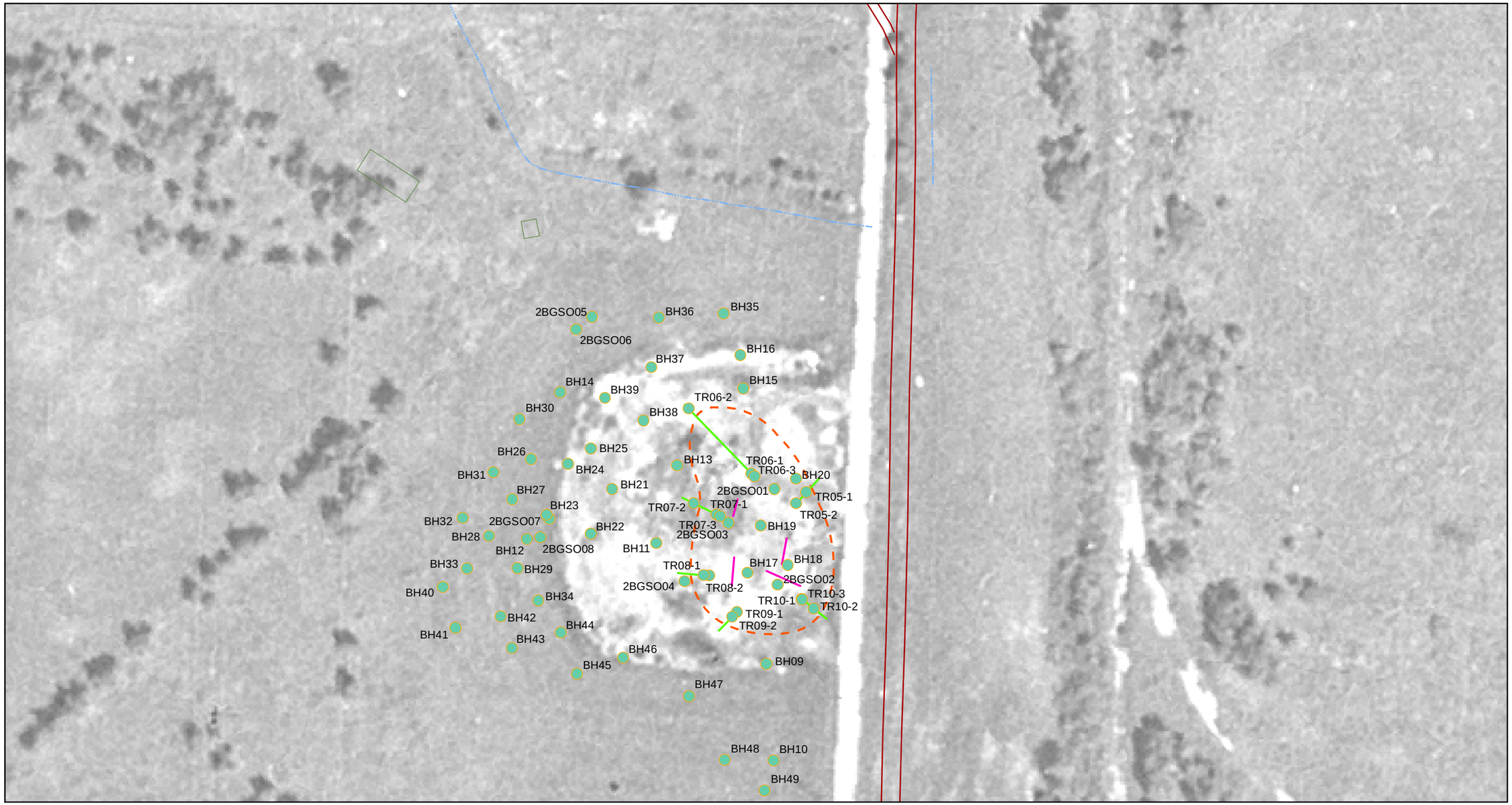


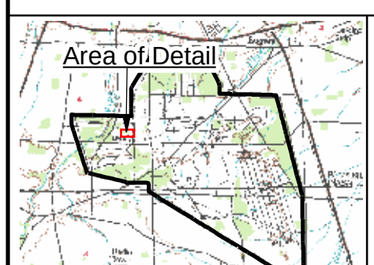
Figure 2-3

Simplified Aquatic Food Web Conceptual Site Model (CSM)
Plum Brook Ordinance Works, Sandusky, Ohio



Notes: Raccoon also presented on terrestrial food web CSM.





Legend

- Creek, Ditch, Conveyance
- Buildings
- 1997 Trenches
- Jacobs Trenches 2004
- Soil Samples

0 50 100 200
Feet

Notes: *Aerial Photography from 2005.*
Data mapped to Ohio State Plane North NAD83, map units are feet.

3

JACOBS

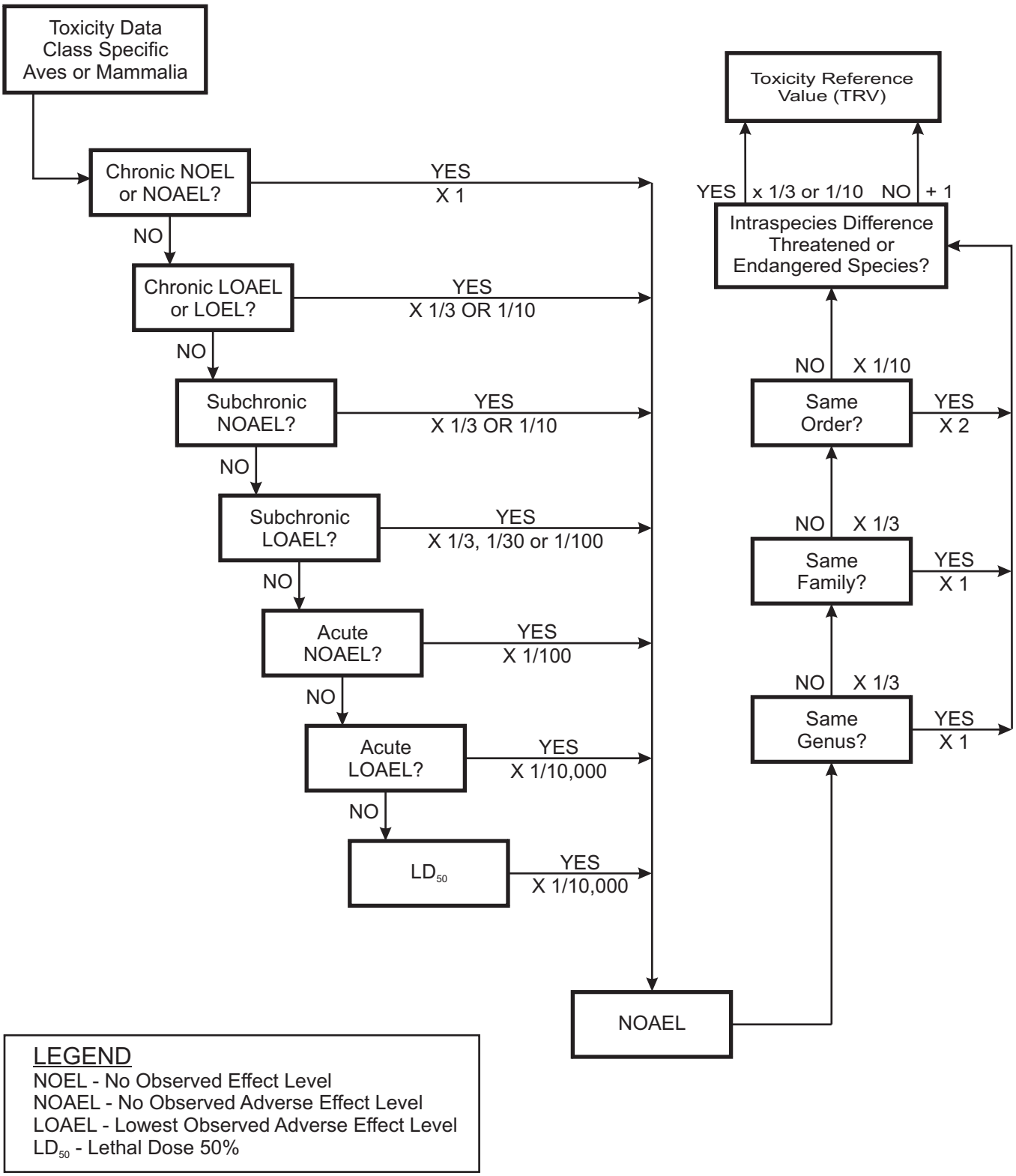
Sampling Locations
Burning Ground Reservoir No. 2
Plum Brook Ordnance Works
Sandusky, Ohio

12/19/08 DMF S:/GIS/Projects/Plumbrook/Projects/ ResNo2_BurningGround_RI_Report/ArcGIS/ ResNo2GB_Sampling_Locs 0-5ft.mxd

Figure 2-4

Figure 4-1

Procedural Flow Chart for Deriving Toxicity Reference Values (TRVs)
from Class-Specific Toxicity Data
Plum Brook Ordinance Works, Sandusky, Ohio



LEGEND
NOEL - No Observed Effect Level
NOAEL - No Observed Adverse Effect Level
LOAEL - Lowest Observed Adverse Effect Level
LD_{50} - Lethal Dose 50%

Credit: Adapted from Ohio ERA & ERR Ecological Risk Assessment and Guidance, 2003

TABLES

Table 2-1
NASA Plum Brook
Sandusky, Ohio
Reservoir No. 2 Burning Ground Species List
May 14 and October 2, 2008

Scientific Name	Common Name
FAUNAL SPECIES	
Buteo jamaicensis	red-tailed hawk
Cardinalis cardinalis	Northern cardinal
Catharus guttatus	Hermit thrush
Colaptes auratus	common flicker
Columba livia	rock dove
Cyanocitta cristata	blue jay
Dumetella carolinensis	gray catbird
Hylocichla mustelina	wood thrush
Icterus galbula	Northern oriole
Melanerpes erythrocephalus	red-headed woodpecker
Melospiza melodia	song sparrow
Molothrus ater	brown-headed cowbird
Passerina cyanea	indigo bunting
Pheucticus ludovicianus	rose-breasted grosbeak
Piranga olivacea	scarlet tanager
Quiscalus quiscula	common grackle
Sitta carolinensis	white-breasted nuthatch
Spinus tristis	American goldfinch
Spizella pusilla	field sparrow
Sturnus vulgaris	European starling
Troglodytes aedon	house wren
Turdus migratorius	American robin
Zenaida macroura	mourning dove
Odocoileus virginianus	white-tailed deer
Procyon lotor	raccoon
FLORAL SPECIES	
Acer negundo	box elder
Acer rubrum	red maple
Achillea millefolium	yarrow
Agrimonia parviflora	small-flowered groovebur
Alliaria petiolata	garlic mustard
Allium vineale	field garlic

Scientific Name	Common Name
Andropogon virginicus	broom sedge
Apocynum cannabinum	dogbane
Asplenium platyneuron	ebony spleenwort
Aster divaricatus	white wood aster
Aster lateriflorus	calico aster
Aster pilosus	heath aster
Berberis thunbergii	barberry
Botrychium virginianum	grape fern
Brassica nigra	yellow rocket
Carex gracillima	graceful sedge
Carex hirtifolia	sedge
Carex radiata	sedge
Carya ovata	shagbark hickory
Cirsium arvense	creeping thistle
Cornus racemosa	gray dogwood
Crataegus sp.	hawthorn
Cryptotaenia canadensis	honewort
Dactylis glomerata	orchard grass
Daucus carota	Queen Anne's lace
Dryopteris carthusiana	spinulose wood fern
Eleagnus umbellata	autumn olive
Elymus riparius	river bank wild rye
Equisetum arvense	field horsetail
Erigeron philadelphicus	common fleabane
Eupatorium rugosum	white snakeroot
Festuca sp.	fescue
Fragaria virginiana	strawberry
Fraxinus pennsylvanica	green ash
Galium aparine	cleavers
Galium asprellum	rough bedstraw
Galium circaezans	wild licorice
Galium triflorum	sweet bedstraw
Glechoma hederacea	ground ivy
Gleditsia triacanthos	honeylocust
Juglans nigra	black walnut
Leersia virginica	white grass
Lonicera tatarica	Tartarian honeysuckle
Maclura pomifera	osage orange
Medicago lupulina	black medick
Monarda fistulosa	wild bergamot
Morus alba	mulberry
Oxalis stricta	sorrel
Panicum virgatum	switch grass
Parthenocissus quinquefolia	Virginia creeper
Penstemon digitalis	beard tongue
Phleum pratense	timothy
Phryma leptostachya	lopseed

Scientific Name	Common Name
Plantago lanceolata	English plantain
Plantago major	common plantain
Platanus occidentalis	American sycamore
Poa alsodes	blue grass
Polygonatum biflorum	Solomon's seal
Polygonum virginianum	Virginia knotweed
Populus deltoides	cottonwood
Potentilla norvegica	cinquefoil
Prunus avium	pin cherry
Prunus serotina	black cherry
Pyrus coronaria	crabapple
Quercus palustris	pin oak
Ranunculus abortivus	kidney leaved buttercup
Ranunculus recurvatus	cursed crowfoot
Rosa multiflora	multiflora rose
Rosa setigera	prairie rose
Rubus allegheniensis	Allegheny blackberry
Rubus flagellaris	dewberry
Rubus occidentalis	black raspberry
Satureja vulgaris	wild basil
Setaria glauca	yellow bristle grass
Solanum carolinense	horse nettle
Taraxacum officinale	dandelion
Teucrium canadense	germander
Toxicodendron radicans	poison ivy
Trifolium repens	white clover
Ulmus americana	American elm
Verbesina alternifolia	wingstem
Vernonia gigantea	ironweed
Viola papilionacea	blue violet
Vitis aestivalus	summer grape
Vitis riparia	riverbank grape

Table 2-2
Summary Statistics and Identification of COPECs for Constituents Detected in Environmental Media at the Reservoir Number 2 Burning Ground
Plum Brook Ordnance Works, Sandusky, Ohio

Type	Analyte	Number of Samples	Number of Detects	Percent Detect	Units	Range of Detection Limits	Minimum Detected Concentration	Maximum Detected Concentration	95% UCL on Arithmetic Mean	Background	Toxicity Screening Level	COPEC
Inside the Burn Area												
Surface Soil												
DIO	2,3,7,8-TCDD TEQ	14	14	100	ng/Kg		0.69882	1187.33234	131.34547		0.199	YES
HE	1,3,5-Trinitrobenzene	19	5	26	ug/Kg	125 - 50000	686	85400	12584.92105		376	YES
HE	1,3-Dinitrobenzene	19	1	5	ug/Kg	125 - 50000	3545	3545	2995.78947		655	YES
HE	2,4,6-Trinitrotoluene	19	16	84	ug/Kg	125 - 250	394	35400000	4163046.526			YES
HE	2,4-Dinitrotoluene	19	14	74	ug/Kg	125 - 50000	370	9700000	919530.1579		1280	YES
HE	2,6-Dinitrotoluene	19	7	37	ug/Kg	125 - 50000	352	1400000	105162.7105		32.8	YES
HE	2-Amino-4,6-Dinitrotoluene	13	7	54	ug/Kg	125 - 125	2960	342000	45055			YES
HE	2-Nitrotoluene	19	3	16	ug/Kg	125 - 50000	782	7040	3432.21053			YES
HE	3-Nitrotoluene	19	1	5	ug/Kg	125 - 50000	777	777	2850.10526			YES
HE	4-Amino-2,6-Dinitrotoluene	19	4	21	ug/Kg	125 - 250000	2180	10600	12564.34211			YES
HE	4-Nitrotoluene	13	3	23	ug/Kg	125 - 12500	444	6670	1868			YES
INO	Aluminum	19	19	100	mg/Kg		4640	17390	10141.31579	15500	50	YES
INO	Antimony	19	6	32	mg/Kg	0.404 - 7.7	0.963	5.55	1.98047	9.3	0.142	YES
INO	Arsenic	19	19	100	mg/Kg		4.7	27.8	10.03474	36.5	5.7	YES
INO	Barium	19	19	100	mg/Kg		57.8	3965	468.8	826	1.04	YES
INO	Beryllium	19	16	84	mg/Kg	0.59 - 0.64	0.548	1.27	0.66584	1	1.06	YES
INO	Cadmium	19	14	74	mg/Kg	0.59 - 0.64	0.0657	2.04	0.53402		0.00222	YES
INO	Calcium	19	19	100	mg/Kg		2945	21120	7977.10526	52300		YES
INO	Chromium	19	19	100	mg/Kg		8.86	81.45	22.60579	29	0.4	YES
INO	Cobalt	19	18	95	mg/Kg	6.3 - 6.3	6.23	25.2	10.78632	116	0.14	YES
INO	Copper	19	19	100	mg/Kg		9.815	1580	157.07974	56.2	5.4	YES
INO	Iron	19	19	100	mg/Kg		13130	36260	23037.10526	234000	200	YES
INO	Lead	19	19	100	mg/Kg		8.94	8220	929.54053	48.6	0.0537	YES
INO	Magnesium	19	19	100	mg/Kg		2300	7830	4433.42105	10400		YES
INO	Manganese	19	19	100	mg/Kg		152	1000	334.81579	3506	100	YES
INO	Mercury	19	17	89	mg/Kg	0.039 - 0.04	0.0218	0.409	0.13854	0.1	0.1	YES
INO	Moisture, Percent	19	19	100	PERCENT		15.6	29.98	20.6			YES
INO	Nickel	19	19	100	mg/Kg		16.4	103	41.47368	55.1	13.6	YES
INO	Potassium	19	18	95	mg/Kg	626 - 626	928	2870	1614.78947	3390		YES
INO	Selenium	19	18	95	mg/Kg	0.59 - 0.59	0.267	4.47	1.4145	2	0.0276	YES
INO	Silver	19	13	68	mg/Kg	0.108 - 1.3	0.132	1.285	0.53195	11.1	2	
INO	Sodium	19	13	68	mg/Kg	592 - 639	64.7	1390	400.21842			YES
INO	Thallium	19	14	74	mg/Kg	1.18 - 1.26	1.3	3.32	1.69	1.3	0.0569	YES
INO	Tin	3	1	33	mg/Kg	0.467 - 0.472	5.31	5.31	1.9265		7.62	
INO	Vanadium	19	19	100	mg/Kg		10.5	40.8	24.95789	40.9	1.59	YES
INO	Zinc	19	19	100	mg/Kg		48.55	1540	308.02368	322	6.62	YES

Table 2-2
Summary Statistics and Identification of COPECs for Constituents Detected in Environmental Media at the Reservoir Number 2 Burning Ground
Plum Brook Ordnance Works, Sandusky, Ohio

type	Analyte	Number of Samples	Number of Detects	Percent Detect	Units	Range of Detection Limits	Minimum Detected Concentration	Maximum Detected Concentration	Average	Background	Toxicity Screening Level	COPEC
PAH	Acenaphthene	19	11	58	ug/Kg	73.1 - 420	90.9	67400	7898.44737		20000	YES
PAH	Acenaphthylene	19	12	63	ug/Kg	39.9 - 420	42.2	131000	14785.69737		682000	
PAH	Anthracene	19	6	32	ug/Kg	4.55 - 410	4.69	73.2	75.39974		1480000	
PAH	Benzo(a)anthracene	19	8	42	ug/Kg	8.04 - 420	9.7	501	128.85342		5210	
PAH	Benzo(a)pyrene	19	5	26	ug/Kg	9.65 - 420	18.9	108	109.18342		1520	
PAH	Benzo(b)fluoranthene	19	10	53	ug/Kg	3.82 - 420	4	212	113.83158		59800	
PAH	Benzo(g,h,i)perylene	19	3	16	ug/Kg	13.9 - 601	47.4	103	116.70526		119000	
PAH	Benzo(k)fluoranthene	19	9	47	ug/Kg	13.8 - 420	42.3	469	143.34737		148000	
PAH	Chrysene	19	10	53	ug/Kg	5.68 - 410	38.9	928	157.82421		4730	
PAH	Dibenz(a,h)anthracene	19	3	16	ug/Kg	3.18 - 420	16.1	302	106.30921		18400	
PAH	Fluoranthene	19	9	47	ug/Kg	22.5 - 973	56	720	215.92632		122000	
PAH	Fluorene	19	4	21	ug/Kg	24.7 - 1040	25.6	317	160.42895		30000	
PAH	Indeno(1,2,3-cd)pyrene	19	4	21	ug/Kg	3.43 - 420	33.9	151	88.44289		109000	
PAH	Naphthalene	19	10	53	ug/Kg	26 - 420	234	51300	5908.93421		99.4	YES
PAH	Phenanthrene	19	10	53	ug/Kg	19.2 - 420	68.8	1550	349.79737		45700	
PAH	Pyrene	19	4	21	ug/Kg	26.6 - 1150	44	203	140.9		78500	
PCB	PCB-1254 (Aroclor 1254)	19	2	11	ug/Kg	40 - 14200	1660	3670	2003.78947		40000	
PCB	PCB-1260 (Aroclor 1260)	19	11	58	ug/Kg	39 - 8620	632	11600	2932.86842			YES
VOC	1,1,1-Trichloroethane	19	3	16	ug/Kg	0.463 - 31	1.085	140	9.32663		29800	
VOC	1,1-Dichloroethane	19	1	5	ug/Kg	0.411 - 31	10.1	10.1	2.34782		20100	
VOC	1,1-Dichloroethene	19	7	37	ug/Kg	0.508 - 31	0.62	2.55	2.28505		8280	
VOC	2-Butanone (Methyl ethyl ketone)	19	3	16	ug/Kg	3.27 - 120	3.6	54	10.61658		89600	
VOC	Acetone	19	8	42	ug/Kg	3.07 - 26	8.7	300	38.35447		2500	
VOC	Benzene	19	7	37	ug/Kg	0.393 - 31	1.4	20.6	3.83095		255	
VOC	Chloroform	19	1	5	ug/Kg	0.454 - 31	2	2	1.96245		1190	
VOC	Cyclohexane	13	5	38	ug/Kg	0.419 - 1.05	0.83	24.9	4.58158			YES
VOC	Ethylbenzene	19	1	5	ug/Kg	0.332 - 31	2.3	2.3	1.90529		5160	
VOC	Isopropylbenzene (Cumene)	12	1	8	ug/Kg	0.393 - 1.11	1.3	1.3	0.39075			YES
VOC	Methylcyclohexane	10	4	40	ug/Kg	0.445 - 1.12	1.1	23.9	3.01935			YES
VOC	Methylene Chloride	19	1	5	ug/Kg	1.18 - 31	1.9	1.9	2.33263		4050	
VOC	Tetrachloroethene (PCE)	19	1	5	ug/Kg	0.332 - 31	0.87	0.87	1.84076		9920	
VOC	Toluene	19	7	37	ug/Kg	0.297 - 31	0.99	1570	88.90084		5450	
VOC	Xylenes, Total	19	2	11	ug/Kg	0.341 - 31	0.78	12.5	2.46963		10000	

Table 2-2
Summary Statistics and Identification of COPECs for Constituents Detected in Environmental Media at the Reservoir Number 2 Burning Ground
Plum Brook Ordnance Works, Sandusky, Ohio

type	Analyte	Number of Samples	Number of Detects	Percent Detect	Units	Range of Detection Limits	Minimum Detected Concentration	Maximum Detected Concentration	Average	Background	Toxicity Screening Level	COPEC
Outside the Burn Area												
Surface Soil												
HE	1,3,5-Trinitrobenzene	55	13	24	ug/Kg	87 - 5000	210	15000	576.32727		376	YES
HE	1,3-Dinitrobenzene	55	3	5	ug/Kg	83 - 12000	120	220	228.22727		655	
HE	2,4,6-Trinitrotoluene	55	33	60	ug/Kg	87 - 250	140	2270000	50035.18182			YES
HE	2,4-Dinitrotoluene	55	25	45	ug/Kg	110 - 250	240	200000	5302.47273		1280	YES
HE	2,6-Dinitrotoluene	55	14	25	ug/Kg	110 - 12000	152	78000	1897.71818		32.8	YES
HE	2-Amino-4,6-Dinitrotoluene	45	16	36	ug/Kg	125 - 625	150	26000	1076.54444			YES
HE	2-Nitrotoluene	55	6	11	ug/Kg	87 - 12000	110	2000	268.23636			YES
HE	4-Amino-2,6-Dinitrotoluene	55	16	29	ug/Kg	87 - 110000	130	27000	2130.89091			YES
HE	4-Nitrotoluene	45	1	2	ug/Kg	87 - 625	260	260	69.08889			YES
HE	HMX	55	4	7	ug/Kg	87 - 25000	150	820	424.15455			YES
HE	Nitrobenzene	65	1	2	ug/Kg	92 - 12000	180	180	221.70769		1310	
HE	RDX	55	2	4	ug/Kg	87 - 25000	270	540	416.21818			YES
INO	Aluminum	45	45	100	mg/Kg		8840	16450	11571.33333	15500	50	YES
INO	Antimony	45	3	7	mg/Kg	0.401 - 7.8	0.534	0.782	1.37022	9.3	0.142	YES
INO	Arsenic	45	45	100	mg/Kg		5.13	21.7	8.62778	36.5	5.7	YES
INO	Barium	45	45	100	mg/Kg		47.1	263	102.50889	826	1.04	YES
INO	Beryllium	45	40	89	mg/Kg	0.6 - 0.65	0.515	0.946	0.62764	1	1.06	
INO	Cadmium	45	35	78	mg/Kg	0.0572 - 0.65	0.0771	1.74	0.40024		0.00222	YES
INO	Calcium	45	45	100	mg/Kg		2320	61200	8862.55556	52300		YES
INO	Chromium	45	45	100	mg/Kg		10.7	26.7	17.78667	29	0.4	YES
INO	Cobalt	45	45	100	mg/Kg		4.02	30.1	8.51567	116	0.14	YES
INO	Copper	45	45	100	mg/Kg		13	534	48.11222	56.2	5.4	YES
INO	Iron	45	45	100	mg/Kg		11550	33300	20664.66667	234000	200	YES
INO	Lead	55	55	100	mg/Kg		7.88	603	143.99918	48.6	0.0537	YES
INO	Magnesium	45	45	100	mg/Kg		993	20100	3962.84444	10400		YES
INO	Manganese	45	45	100	mg/Kg		147	3870	423.45556	3506	100	YES
INO	Mercury	45	40	89	mg/Kg	0.038 - 0.041	0.0152	0.518	0.10182	0.1	0.1	YES
INO	Moisture, Percent	30	30	100	PERCENT		12.2	35.66	20.85033			YES
INO	Nickel	45	45	100	mg/Kg		11.6	96.5	24.46111	55.1	13.6	YES
INO	Potassium	45	45	100	mg/Kg		598	2620	1562.43333	3390		YES
INO	Selenium	45	21	47	mg/Kg	0.202 - 0.83	0.527	2.13	0.72742	2	0.0276	YES
INO	Silver	45	8	18	mg/Kg	0.105 - 1.3	0.138	0.973	0.25151	11.1	2	
INO	Sodium	45	21	47	mg/Kg	245 - 646	45.9	402	154.13222			YES
INO	Thallium	45	10	22	mg/Kg	0.31 - 23.6	1.2	2.1	0.91422	1.3	0.0569	YES
INO	Tin	4	1	25	mg/Kg	0.474 - 0.486	3.78	3.78	1.12425		7.62	
INO	Vanadium	45	45	100	mg/Kg		20.3	41.4	27.39444	40.9	1.59	YES
INO	Zinc	45	45	100	mg/Kg		35.7	498	120.45556	322	6.62	YES
INX	Cyanide	25	12	48	mg/Kg	0.15 - 0.65	0.17	1	0.2838		1.33	

Table 2-2
Summary Statistics and Identification of COPECs for Constituents Detected in Environmental Media at the Reservoir Number 2 Burning Ground
Plum Brook Ordnance Works, Sandusky, Ohio

type	Analyte	Number of Samples	Number of Detects	Percent Detect	Units	Range of Detection Limits	Minimum Detected Concentration	Maximum Detected Concentration	Average	Background	Toxicity Screening Level	COPEC
PAH	Acenaphthene	55	11	20	ug/Kg	24 - 430	34.2	697	100.57455		20000	
PAH	Acenaphthylene	55	12	22	ug/Kg	14.7 - 430	26.8	1960	166.22091		682000	
PAH	Anthracene	55	13	24	ug/Kg	1.67 - 430	2.74	55	44.26191		1480000	
PAH	Benzo(a)anthracene	55	21	38	ug/Kg	2.96 - 430	4.08	186	63.28927		5210	
PAH	Benzo(a)pyrene	55	26	47	ug/Kg	3.65 - 430	10.6	360	78.66227		1520	
PAH	Benzo(b)fluoranthene	55	24	44	ug/Kg	1.44 - 430	5.125	820	100.51936		59800	
PAH	Benzo(g,h,i)perylene	55	18	33	ug/Kg	5.25 - 430	13.05	270	65.90064		119000	
PAH	Benzo(k)fluoranthene	55	27	49	ug/Kg	1.37 - 430	30.9	430	101.49973		148000	
PAH	Chrysene	55	25	45	ug/Kg	2.15 - 430	8.3	297	78.23682		4730	
PAH	Dibenz(a,h)anthracene	55	5	9	ug/Kg	3.17 - 430	10.4	124	48.26945		18400	
PAH	Fluoranthene	55	29	53	ug/Kg	8.51 - 430	21.3	350	94.78282		122000	
PAH	Fluorene	55	9	16	ug/Kg	9.1 - 430	10.7	91.3	51.34627		30000	
PAH	Indeno(1,2,3-cd)pyrene	55	18	33	ug/Kg	1.3 - 430	8.2	230	60.74418		109000	
PAH	Naphthalene	55	11	20	ug/Kg	9.84 - 430	23.4	1737.5	104.26945		99.4	YES
PAH	Phenanthrene	55	25	45	ug/Kg	7.06 - 430	12.8	190	70.46264		45700	
PAH	Pyrene	55	25	45	ug/Kg	10.1 - 430	13	295	83.91182		78500	
PCB	PCB-1260 (Aroclor 1260)	55	33	60	ug/Kg	38 - 13300	13	44400	1596.83636			YES
SV	1,4-Dichlorobenzene	30	1	3	ug/Kg	0.304 - 430	0.42	0.42	67.29775		546	
SV	2-Methylnaphthalene	35	4	11	ug/Kg	24 - 430	36	110	72.75714		3240	
SV	bis(2-Ethylhexyl)phthalate	10	1	10	ug/Kg	380 - 430	61	61	186.6		925	
VOC	1,1,1-Trichloroethane	30	5	17	ug/Kg	0.435 - 32	0.8	11.9	3.5978		29800	
VOC	1,1-Dichloroethane	30	2	7	ug/Kg	0.386 - 32	0.66	0.67	2.85762		20100	
VOC	1,1-Dichloroethene	30	8	27	ug/Kg	0.446 - 32	0.48	1	2.95477		8280	
VOC	Acetone	30	6	20	ug/Kg	2.89 - 130	4.6	18	13.05567		2500	
VOC	Cyclohexane	20	2	10	ug/Kg	0.394 - 0.586	0.72	3.9	0.44798			YES
VOC	Styrene	30	1	3	ug/Kg	0.32 - 32	1	1	2.82807		4690	
VOC	Tetrachloroethene (PCE)	30	7	23	ug/Kg	0.312 - 32	0.39	3.4	3.13308		9920	
VOC	Toluene	30	2	7	ug/Kg	0.279 - 32	1.5	1.9	2.69532		5450	

Table 2-3
Burning Ground Reservoir No. 2 Proposed Ecological Assessment and Measurement Endpoints
NASA Plum Brook
Sandusky, Ohio

Assessment Endpoint	Selected Receptor and Exposure Routes	Measurement Endpoint
Protection of long-term survival and reproductive capabilities for soil invertebrates.	Terrestrial Invertebrates Ingestion of soil and direct exposure to soil.	Comparison of soil concentrations to critical effect values.
Protection of long-term survival and reproductive capabilities for herbivorous mammals.	Eastern cottontail (*Sylvilagus floridanus*) White-tailed deer (*Odocoileus virginianus*) Ingestion of plants, water, and incidental soil	Comparison of total daily dose to species-specific toxifity endpoint values.
Protection of long-term survival and reproductive capabilities for omnivorous mammals.	Raccoon (*Procyon lotor*) Ingestion of terrestrial plants, invertebrates, small mammals, water, and incidental soil. Deer mouse (*Peromyscus maniculatus*) Ingestion of terrestrial invertebrates, plants, water, and incidental soil.	Comparison of total daily dose to species-specific toxicity endpoint values.
Protection of long-term survival and reproductive capabilities for carnivorous birds.	Red-tailed hawk (*Buteo jamacencis*) Ingestion of small mammals, birds, water, incidental soil.	Comparison of total daily dose to species-specific toxicity endpoint values.
Protection of long-term survival and reproductive capabilities for small insectivorous mammals	Short-tailed shrew (*Blarnia brevicauda*) Ingestion of terrestrial invertebrates, water, and incidental soil.	Comparison of total daily dose to species-specific toxicity endpoint values.
Protection of long-term survival and reproductive capabilities for insectivorous birds.	March wren (*Cistorthorus palustris*) Ingestion of terrestrial invertebrates, water, and incidental soil.	Comparison of total daily dose to species-specific toxicity endpoint values.
Protection of long-term survival and reproductive capabilities for benthic invertebrates.	benthic invertebrates Ingestion of sediment and direct exposure to surface water.	Comparison of sediment concentrations to sediment critical effects values.
Protection of long-term survival and reproductive capabilities for aquatic invertebrates (crustaceans).	Aquatic invertebrates Direct exposure to water	Comparison of surface water concentrations to aquatic critical effects values.
Protection of long-term survival and reproductive capabilities for semi-aquatic omnivorous mammals.	Raccoon (*Procyon lotor*) Ingestion of aquatic invertebrates, water and incidental sediment	Comparison of total daily dose to species-specific toxicity endpoint values.
Protection of long-term survival and reproductive capabilities for aquatic birds	Mallard (*Anas platyrhynchos*) Ingestion of aquatic and benthic invertebrates, water, and incidental sediment.	Comparison of total daily dose to species-specific toxicity endpoint values.

Table 3-1
Species-Specific Exposure Parameters,
Plum Brook Ordnance Works, Sandusky, Ohio

Species	Parameter	Value	Units	Source
Short-tailed shrew	Home range factor[1]	1	unitless	calculated value
Blarina brevicauda	Diet: Plants	0	percent	EPA 1993
	Invertebrates	100	percent	EPA 1993
	Vertebrates (fish)	0	percent	EPA 1993
	Sediment	10.4	percent	EPA 1993
	Ingestion Rate: Food	0.0022	kg/day (dry wt.)	EPA 1993
	Water	0.0023	L/day	EPA 1993
	Body weight	0.015	kg	EPA 1993
	Exposure duration	12	months	EPA 1993
	Home range (ha)	0.39	ha	EPA 1993
White-tailed deer	Home range factor[1]	.02/.03	unitless	calculated value
Odocoileus virginianus	Diet: Plants	100	percent	EPA 1993
	Invertebrates	0	percent	EPA 1993
	Vertebrates (fish)	0	percent	EPA 1993
	Soil	2	percent	EPA 1993
	Ingestion Rate: Food	2	kg/day (dry wt.)	EPA 1993
	Water	4	L/day	EPA 1993
	Body weight	61	g (wet wt.)	Gottschang, 1981
	Exposure duration	12	months	EPA 1993
	Home range (ha)	518	ha	Gottschang, 1981
Marsh wren	Home range factor[1]	1	unitless	calculated value
Cistothorus palustris	Diet: Plants	0	percent	EPA 1993
	Invertebrates	100	percent	EPA 1993
	Vertebrates (fish)	0	percent	EPA 1993
	Soil	2	percent	EPA 1993
	Ingestion Rate: Food	0.0029	g/day (wet wt.)	EPA 1993
	Water	0.0027	L/day	EPA 1993
	Body weight	0.01	g (wet wt.)	EPA 1993
	Exposure duration	4	months	EPA 1993
	Home range (ha)	0.054	ha	EPA 1993
Deer Mouse	Home range factor[1]	1	unitless	calculated value
Peromyscus maniculatus	Diet: Plants	61	percent	EPA 1993
	Invertebrates	39	percent	EPA 1993
	Vertebrates (fish)	0	percent	EPA 1993
	Soil	2	percent	EPA 1993
	Ingestion Rate: Food	0.0028	g/day (wet wt.)	EPA 1993
	Water	0.0022	L/day	EPA 1993
	Body weight	0.0148	g (wet wt.)	EPA 1993
	Exposure duration	12	months	EPA 1993
	Home range (ha)	0.062	ha	EPA 1993

Table 3-1
Species-Specific Exposure Parameters,
Plum Brook Ordnance Works, Sandusky, Ohio

Species	Parameter	Value	Units	Source
Eastern Cottontail	Home range factor[1]	1	unitless	calculated value
Sylvilagus floridanus	Diet: Plants	100	percent	EPA 1993
	Invertebrates	0	percent	EPA 1993
	Vertebrates	0	percent	EPA 1993
	Soil	6.3	percent	EPA 1993
	Ingestion Rate: Food	0.096	kg/day (dry wt.)	EPA 1993
	Water	0.11	L/day	EPA 1993
	Body weight	1.132	g (wet wt.)	EPA 1993
	Exposure duration	12	months	EPA 1993
	Home range (ha)	3.1	ha	EPA 1993
Red-Tailed Hawk	Home range factor[1]	.01/.02	unitless	calculated value
Buteo jamaicensis	Diet: Plants	0	percent	EPA 1993
	Invertebrates	0	percent	EPA 1993
	Vertebrates (mammals)	100	percent	EPA 1993
	Soil	2	percent	EPA 1993
	Ingestion Rate: Food	0.057	kg/day (dry wt.)	EPA 1993
	Water	0.057	L/day	EPA 1993
	Body weight	0.957	kg	EPA 1993
	Exposure duration	12	months	EPA 1993
	Home range (ha)	842	ha	EPA 1993
Raccoon	Home range factor[1]	.06/.1	unitless	calculated value
Procyon lotor	Diet: Plants	42	percent	EPA 1993
	Invertebrates	51	percent	EPA 1993
	Vertebrates	5	percent	EPA 1993
	Sediment	9.4	percent	EPA 1993
	Ingestion Rate: Food	0.26	kg/day (dry wt.)	EPA 1993
	Water	0.43	L/day	EPA 1993
	Body weight	5.1	kg	EPA 1993
	Exposure duration	8	months	EPA 1993
	Home range (ha)	156	ha	EPA 1993
Mallard Duck	Home range factor[1]	.02/.03	unitless	calculated value
Anas platyrhynchos	Diet: Plants	62.5	percent	EPA 1993
	Invertebrates	37.5	percent	EPA 1993
	Vertebrates (fish)	0	percent	EPA 1993
	Sediment	2	percent	EPA 1993
	Ingestion Rate: Food	0.063	kg/day (dry wt.)	EPA 1993
	Water	0.064	L/day	EPA 1993
	Body weight	1.13	kg (wet wt.)	EPA 1993
	Exposure duration	7	months	EPA 1993
	Home range (ha)	580	ha	EPA 1993

Notes:

[1]Home range factors are based on an estimated affected area of 10.1 and 16.2 hectares for AA2 and AA3, respectively. If the home range of the species was less than the affected area of the habitat, the home range factor was set at 1.0. If the home range of the species was greater than the affected area of the habitat, the home range factor was calculated by dividing the affected area by the home range.

kg = kilograms
g/day = grams per day
ha = hectares
L/day = liters per day
NA = not available
wt. = weight

Table 3-2
Bioconcentration Factors for Chemicals of Potential Ecological Concern
Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Octanol-Water Partition Coefficient (log K_{ow})[1]	Soil to Invertebrates (mg/kg wet tissue/mg/kg dry soil)[2]	Water to Invertebrates (mg/kg wet tissue/mg dissolved COPEC/L)[3]	Sediment to Invertebrates (mg/kg wet tissue/mg/kg dry sediment)[4]	Water to Fish (mg/kg wet tissue/mg dissolved COPEC/L)[5]	Soil/Sediment to Plants (mg/kg dry tissue/mg/kg dry soil or sediment)[6]	Water to Plants (mg/kg wet tissue/mg dissolved COPEC/L)[7]
Inorganics							
Aluminum	NA	0.22	4066.00	0.90	2.70	0.004	833
Antimony	NA	0.22	7.00	0.90	40.00	0.200	1475
Arsenic	NA	0.11	73.00	0.90	114.00	0.036	293
Barium	NA	0.22	200.00	0.90	633.00	0.150	260
Beryllium	NA	0.22	45.00	0.90	62.00	0.010	141
Cadmium	NA	0.96	3461.00	3.40	907.00	0.364	782
Chromium	NA	0.01	3000.00	0.39	19.00	0.008	4406
Cobalt	NA	0.22	4066.00	0.90	40.00	0.350	
Copper	NA	0.04	3718.00	0.30	710.00	0.400	541
Iron	NA	0.22	4066.00	0.90		0.001	
Lead	NA	0.03	5059.00	0.63	0.09	0.045	1706
Manganese	NA	0.32	4066.00	0.90	35.00	0.050	
Mercury	NA	0.04	20184.00	0.07	3530.00	0.038	24762
Nickel	NA	0.02	28.00	0.90	78.00	0.032	61
Selenium	NA	0.22	1262.00	0.90	129.00	0.016	1845
Thallium	NA	0.22	15000.00	0.90	10000.00	0.004	15000
Vanadium	NA	0.22	4066.00	0.90	633.00	0.003	
Zinc	NA	0.56	4578.00	0.57	2059.00	1.2E-12	2175
Cyanide	NA	1.12	4066.00	0.90	14.00		22
VOCs							
Acetone	-0.222	0.05	0.05	0.05	0.10	52.037	0.05
Benzene	2.13	3.97	3.97	3.97	14.20	2.274	3.97
Carbon Disulfide	2.24	4.88	4.88	4.88	17.88	1.965	4.88
Ethylbenzene	3.15	27.16	27.16	27.16	120.36	0.585	27.16
Methyl Acetate	-0.09	0.06	0.06	0.06	0.14	43.654	0.06
Toluene	2.73	12.30	12.30	12.30	49.92	1.023	12.30
Xylenes, Total	3.15	27.16	27.16	27.16	120.36	0.585	27.16
SVOCs							
1,3,5-Trinitrobenzene	1.18	0.66	13.00	58.00	21.04	8.053	2507
2-Butanone (Methyl ethyl ketone)	0.29	0.12	13.00	58.00	21.04	26.326	2507
2,4-Dinitrotoluene	1.996	3.08	13.00	58.00	21.04	2.718	2507
2,4,6-Trinitrotoluene	2.25	4.97	13.00	58.00	21.04	1.939	2507
2-Methylnaphthalene	3.9	111.71	111.71	111.71	579.43	0.216	111.71
3-nitrotoluene	2.45	7.25	7.25	7.25	27.77	1.486	7.25
2-Methylphenol (o-Cresol)	1.95	2.83	2.83	2.83	9.74	2.890	2.83
4-Methylphenol (p-Cresol)	1.963	2.90	2.90	2.90	9.54	2.840	2.90
4-Methyl-2-pentanone (Methyl isobutyl ketone)	1.19	0.67	0.67	0.67		7.947	0.67
Acenaphthene	3.92	116.01	116.01	116.01	604.22	0.210	116.01
Acenaphthylene	3.5	52.54	52.54	52.54	250.61	0.367	52.54
Acetophenone	1.58	1.41	1.41	1.41	4.49	4.729	1.41
Anthracene	4.55	380.58	380.58	380.58	2262.02	0.091	380.58
Benzaldehyde	1.48	1.16	1.16	1.16	3.64	5.402	1.16
Benzo(a)anthracene	5.679	0.03	12299.00	1.45	500.00	0.020	5258
Benzo(a)pyrene	6.129	0.07	4697.00	1.59	500.00	0.011	5258
Benzo(b)fluoranthene	6.202	0.07	4697.00	1.61	500.00	0.010	5258
Benzo(g,h,i)perylene	6.7	21943.20	21943.20	21943.20	204642.62	0.005	21943.20
Benzo(k)fluoranthene	6.2	0.08	13225.00	1.61	500.00	0.010	5258
Benzoic acid	1.87	2.43	2.43	2.43	8.24	3.215	2.43

Table 3-2
Bioconcentration Factors for Chemicals of Potential Ecological Concern
Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Octanol-Water Partition Coefficient (log K_{ow})[1]	Soil to Invertebrates (mg/kg wet tissue/mg/kg dry soil)[2]	Water to Invertebrates (mg/kg wet tissue/mg dissolved COPEC/L)[3]	Sediment to Invertebrates (mg/kg wet tissue/mg/kg dry sediment)[4]	Water to Fish (mg/kg wet tissue/mg dissolved COPEC/L)[5]	Soil/Sediment to Plants (mg/kg dry tissue/mg/kg dry soil or sediment)[6]	Water to Plants (mg/kg wet tissue/mg dissolved COPEC/L)[7]
Benzyl butyl phthalate	4.84	657.60	657.60	657.60	4153.34	0.062	657.60
bis(2-ethylhexyl)phthalate	5.205	1309	318.00	1308.87	70.00	0.038	9931
Carbazole	3.59	62.26	62.26	62.26	302.62	0.326	62.26
Chrysene	5.739	0.04	980.00	1.38	500.00	0.019	5258
Cyclohexane	3.44	46.92	46.92	46.92	221.00	0.398	46.92
Dibenzofuran	4.2	196.70	196.70	196.70	1086.42	0.145	196.70
Dibenz(a,h)anthracene	6.547	0.07	710.00	1.61	500.00	0.006	5258
Di-n-butylphthalate	4.13	172.37	172.37	172.37	938.20	0.159	172.37
Fluoranthene	4.95	809.19	809.19	809.19	5229.94	0.053	809.19
Fluorene	4.21	200.44	200.44	200.44	1109.42	0.143	200.44
HMX	0.59	0.22	0.22	0.22	0.56	17.660	0.22
Indeno(1,2,3-cd)pyrene	6.915	0.08	4697.00	1.61	500.00	0.004	5258
methylcyclohexane	3.61	64.65	64.65	64.65	315.57	0.317	64.65
n-nitroso-di-n-propylamine	1.36	0.93	0.93	0.93	2.83	6.338	0.93
Naphthalene	3.3	36.03	36.03	36.03	164.82	0.479	36.03
PCB-1254	6.207	1.13	5538.00	0.53	230394.00	0.010	476829
PCB-1260	6.91	32605.44	32605.44	32605.44	317757.62	0.004	32605.44
Phenanthrene	4.57	395.21	395.21	395.21	2358.83	0.088	395.21
Phenol	1.46	1.12	1.12	1.12	3.49	5.548	1.12
Pyrene	5.11	1094.18	1094.18	1094.18	7313.02	0.043	1094.18
RDX	0.87	0.37	0.37	0.37	1.01	12.166	0.37

NA = not applicable

1. Values taken from Karickhoff and Long 1995, except for acetone and bis(2-ethylhexyl)phthalate whose values were obtained from EPA 1995a. Octanol-water partition coefficients for inorganics do not exist and therefore are not presented.
2. Value taken from EPA 1999c, Appendix C, Table C-1 or calculated using recommended equations.
3. Value taken from EPA 1999c, Appendix C, Table C-3 or calculated using recommended equations.
4. Value taken from EPA 1999c, Appendix C, Table C-6 or calculated using recommended equations.
5. Value taken from EPA 1999c, Appendix C, Table C-5 or calculated using recommended equations.
6. Value taken from EPA 1999c, Appendix C, Table C-2 or calculated using recommended equations.
7. Value taken from EPA 1999c, Appendix C, Table C-4 or calculated using recommended equations.

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Table 3-3
Maximum Exposure Doses for Short-tailed Shrew (*Blarina brevicauda*) for Exposures at Reservoir No. 2 Burning Ground, Inside the Burn Area, Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Conc. Soil mg/g_{sed} (dry wt)	BCF_{inv} mg/kg wet	IC mg/g_{inv} (wet wt)	P_{inv}	P_{plant}	P_{soil}	IR kg_{diet}/day (Dry wt)	II mg/day inv	IS mg/day soil	HRF	ED fraction of year	BW kg	OD mg/kg/day
2,3,7,8-TCDD TEQ	3.71E-04	1.59E+00	5.9E-04	1.00	0	0.104	0.0022	1.3E-06	8.5E-08	1.00E+00	1.000	0.015	9.2E-05
2,4-Dinitrotoluene	6.98E+03	3.08E+00	2.2E+04	1.00	0	0.104	0.0022	4.7E+01	1.6E+00	1.00E+00	1.000	0.015	3.3E+03
2,6-Dinitrotoluene	2.40E+02	2.50E+00	6.0E+02	1.00	0	0.104	0.0022	1.3E+00	5.5E-02	1.00E+00	1.000	0.015	9.2E+01
1,3,5-Trinitrobenzene	5.12E+01	6.61E-01	3.4E+01	1.00	0	0.104	0.0022	7.4E-02	1.2E-02	1.00E+00	1.000	0.015	5.7E+00
Aluminum	1.14E+04	2.20E-01	2.5E+03	1.00	0	0.104	0.0022	5.5E+00	2.6E+00	1.00E+00	1.000	0.015	5.4E+02
Arsenic	1.23E+01	1.10E-01	1.4E+00	1.00	0	0.104	0.0022	3.0E-03	2.8E-03	1.00E+00	1.000	0.015	3.9E-01
Barium	2.76E+03	2.20E-01	6.1E+02	1.00	0	0.104	0.0022	1.3E+00	6.3E-01	1.00E+00	1.000	0.015	1.3E+02
Beryllium	7.87E-01	2.20E-01	1.7E-01	1.00	0	0.104	0.0022	3.8E-04	1.8E-04	1.00E+00	1.000	0.015	3.7E-02
Cadmium	1.10E+00	9.60E-01	1.1E+00	1.00	0	0.104	0.0022	2.3E-03	2.5E-04	1.00E+00	1.000	0.015	1.7E-01
Cobalt	1.29E+01	2.20E-01	2.8E+00	1.00	0	0.104	0.0022	6.2E-03	3.0E-03	1.00E+00	1.000	0.015	6.1E-01
Chromium	2.91E+01	1.00E-02	2.9E-01	1.00	0	0.104	0.0022	6.4E-04	6.7E-03	1.00E+00	1.000	0.015	4.9E-01
Copper	2.83E+02	4.00E-02	1.1E+01	1.00	0	0.104	0.0022	2.5E-02	6.5E-02	1.00E+00	1.000	0.015	6.0E+00
Iron	2.58E+04	2.20E-01	5.7E+03	1.00	0	0.104	0.0022	1.3E+01	5.9E+00	1.00E+00	1.000	0.015	1.2E+03
Mercury	1.87E-01	4.00E-02	7.5E-03	1.00	0	0.104	0.0022	1.6E-05	4.3E-05	1.00E+00	1.000	0.015	3.9E-03
Manganese	5.59E+02	3.20E-01	1.8E+02	1.00	0	0.104	0.0022	3.9E-01	1.3E-01	1.00E+00	1.000	0.015	3.5E+01
Nickel	5.30E+01	2.00E-02	1.1E+00	1.00	0	0.104	0.0022	2.3E-03	1.2E-02	1.00E+00	1.000	0.015	9.6E-01
Lead	2.04E+03	3.00E-02	6.1E+01	1.00	0	0.104	0.0022	1.3E-01	4.7E-01	1.00E+00	1.000	0.015	4.0E+01
Antimony	2.50E+00	2.20E-01	5.5E-01	1.00	0	0.104	0.0022	1.2E-03	5.7E-04	1.00E+00	1.000	0.015	1.2E-01
Selenium	1.86E+00	2.20E-01	4.1E-01	1.00	0	0.104	0.0022	9.0E-04	4.3E-04	1.00E+00	1.000	0.015	8.8E-02
Thallium	2.14E+00	2.20E-01	4.7E-01	1.00	0	0.104	0.0022	1.0E-03	4.9E-04	1.00E+00	1.000	0.015	1.0E-01
Vanadium	2.79E+01	2.20E-01	6.1E+00	1.00	0	0.104	0.0022	1.3E-02	6.4E-03	1.00E+00	1.000	0.015	1.3E+00
Zinc	4.71E+02	5.60E-01	2.6E+02	1.00	0	0.104	0.0022	5.8E-01	1.1E-01	1.00E+00	1.000	0.015	4.6E+01
Acenaphthene	1.61E+01	1.16E+02	1.9E+03	1.00	0	0.104	0.0022	4.1E+00	3.7E-03	1.00E+00	1.000	0.015	2.7E+02
Naphthalene	1.21E+01	3.60E+01	4.4E+02	1.00	0	0.104	0.0022	9.6E-01	2.8E-03	1.00E+00	1.000	0.015	6.4E+01

BCF_{inv} = bioconcentration factor for contaminants from sediment into inve
BCF_{sed} = bioaccumulation factor for contaminants from sediment into aqu
BW = organism body weight
C = moisture content correction factor (dry weight basis to wet weigl
ED = migration factor is the proportion of year in which exposure coul
g_{diet}/day = grams of dietary intake per day
HRF = home range factor (site area/home range area; estimated to be
IC = concentration in invertebrate tissue (SC x BAF_{inv})
II = daily intake concentration from invertebrates (IC x P_{inv} x IR)
IP = daily intake concentration from plant material (PC x P_{plant} x IR)
IR = daily ingestion rate (wet wt)
IS = daily intake concentration from direct sediment ingestion (SC x
IW = daily intake concentration from direct water ingestion (WC x IRV
kg = kilograms

milligrams per day from food item (inv = invertebrate; plant; sed = sediment)
milligrams per gram of food item (inv = invertebrate; plant; sed = sediment)
milligrams per kilogram body weight per day
milligrams per liter of water
not applicable
contaminant not detected in medium at a concentration above its reporting limit
exposure dose to the omnivore = ([II+IP+IS+IW] x HRF x ED) / BW
proportion of ingestion composed of food item (inv = invertebrate; plant; sed = sediment)
concentration in plant material (SC x C x SCF_{sed})
maximum detected concentration in sediment
maximum detected concentration in surface water
weight
daily water ingestion rate

Table 3-4
Maximum Exposure Doses for White-tailed Deer (*Odocoileus virginianus*) for Exposures at Reservoir No. 2 Burning Ground, Inside the Burn Area, Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Conc. Soil mg/g_{sed} (dry wt)	BCF_{plants} mg/kg (dry wt)	PC mg/g_{plant} (dry wt)	P_{plant}	P_{soil}	IR kg_{diet}/day (Dry wt)	IP mg/day plant	IS mg/day soil	HRF	ED fraction of year	BW kg	OD mg/kg/day
2,3,7,8-TCDD TEQ	3.71E-04	5.60E-03	2.08E-06	1	0.02	2	4.2E-06	1.5E-05	2.00E-02	1.000	61	6.2E-09
2,4-Dinitrotoluene	6.98E+03	2.72E+00	1.90E+04	1	0.02	2	3.8E+04	2.8E+02	2.00E-02	1.000	61	1.3E+01
2,6-Dinitrotoluene	2.40E+02	3.15E+00	7.55E+02	1	0.02	2	1.5E+03	9.6E+00	2.00E-02	1.000	61	5.0E-01
1,3,5-Trinitrobenzene	5.12E+01	8.05E+00	4.12E+02	1	0.02	2	8.2E+02	2.0E+00	2.00E-02	1.000	61	2.7E-01
Aluminum	1.14E+04	4.00E-03	4.55E+01	1	0.02	2	9.1E+01	4.6E+02	2.00E-02	1.000	61	1.8E-01
Arsenic	1.23E+01	3.60E-02	4.44E-01	1	0.02	2	8.9E-01	4.9E-01	2.00E-02	1.000	61	4.5E-04
Barium	2.76E+03	1.50E-01	4.15E+02	1	0.02	2	8.3E+02	1.1E+02	2.00E-02	1.000	61	3.1E-01
Beryllium	7.87E-01	1.00E-02	7.87E-03	1	0.02	2	1.6E-02	3.1E-02	2.00E-02	1.000	61	1.5E-05
Cadmium	1.10E+00	3.64E-01	4.02E-01	1	0.02	2	8.0E-01	4.4E-02	2.00E-02	1.000	61	2.8E-04
Cobalt	1.29E+01	3.50E-01	4.52E+00	1	0.02	2	9.0E+00	5.2E-01	2.00E-02	1.000	61	3.1E-03
Chromium	2.91E+01	7.50E-03	2.18E-01	1	0.02	2	4.4E-01	1.2E+00	2.00E-02	1.000	61	5.3E-04
Copper	2.83E+02	4.00E-01	1.13E+02	1	0.02	2	2.3E+02	1.1E+01	2.00E-02	1.000	61	7.8E-02
Iron	2.58E+04	1.00E-03	2.58E+01	1	0.02	2	5.2E+01	1.0E+03	2.00E-02	1.000	61	3.6E-01
Mercury	1.87E-01	3.75E-02	7.01E-03	1	0.02	2	1.4E-02	7.5E-03	2.00E-02	1.000	61	7.1E-06
Manganese	5.59E+02	5.00E-02	2.80E+01	1	0.02	2	5.6E+01	2.2E+01	2.00E-02	1.000	61	2.6E-02
Nickel	5.30E+01	3.20E-02	1.70E+00	1	0.02	2	3.4E+00	2.1E+00	2.00E-02	1.000	61	1.8E-03
Lead	2.04E+03	4.50E-02	9.18E+01	1	0.02	2	1.8E+02	8.2E+01	2.00E-02	1.000	61	8.7E-02
Antimony	2.50E+00	2.00E-01	5.00E-01	1	0.02	2	1.0E+00	1.0E-01	2.00E-02	1.000	61	3.6E-04
Selenium	1.86E+00	1.60E-02	2.97E-02	1	0.02	2	5.9E-02	7.4E-02	2.00E-02	1.000	61	4.4E-05
Thallium	2.14E+00	4.00E-03	8.56E-03	1	0.02	2	1.7E-02	8.6E-02	2.00E-02	1.000	61	3.4E-05
Vanadium	2.79E+01	3.00E-03	8.36E-02	1	0.02	2	1.7E-01	1.1E+00	2.00E-02	1.000	61	4.2E-04
Zinc	4.71E+02	1.20E-12	5.66E-10	1	0.02	2	1.1E-09	1.9E+01	2.00E-02	1.000	61	6.2E-03
Acenaphthene	1.61E+01	2.10E-01	3.39E+00	1	0.02	2	6.8E+00	6.5E-01	2.00E-02	1.000	61	2.4E-03
Naphthalene	1.21E+01	4.79E-01	5.79E+00	1	0.02	2	1.2E+01	4.8E-01	2.00E-02	1.000	61	4.0E-03

BCF_{inv} = bioconcentration factor for contaminants from sedi
BCF_{sed} = bioaccumulation factor for contaminants from sedi
BW = organism body weight
C = moisture content correction factor (dry weight basi
ED = migration factor is the proportion of year in which e
g_{diet}/day = grams of dietary intake per day
HRF = home range factor (site area/home range area; est
IC = concentration in invertebrate tissue (SC x BAF_{inv})
II = daily intake concentration from invertebrates (IC x
IP = daily intake concentration from plant material (PC
IR = daily ingestion rate (wet wt)
IS = daily intake concentration from direct sediment ing
IW = daily intake concentration from direct water ingesti
kg = kilograms
mg/day = milligrams per day from food item (inv = invertebrate; plant; sed = sediment)
mg/g = milligrams per gram of food item (inv = invertebrate; plant; sed = sediment)
mg/kg/day = milligrams per kilogram body weight per day
mg/L = milligrams per liter of water
NA = not applicable
ND = contaminant not detected in medium at a concentration above its reporting limit
OD = exposure dose to the omnivore = ([II+IP+IS+IW] x HRF x ED) / BW
P = proportion of ingestion composed of food item (inv = invertebrate; plant; sed = sediment)
PC = concentration in plant material (SC x C x SCF_{sed})
SC_{max} = maximum detected concentration in sediment
WC_{max} = maximum detected concentration in surface water
wt = weight
WI = daily water ingestion rate

Table 3-5
Maximum Exposure Doses for Marsh Wren (*Cistothorus palustris*) for Exposures at Reservoir No. 2 Burning Ground, Inside the Burn Area, Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Conc. Soil mg/g_{sed} (dry wt)	BCF_{inv} mg/kg wet	IC mg/g_{inv} (wet wt)	P_{inv}	P_{soil}	IR kg_{diet}/day (Dry wt)	II mg/day inv	IS mg/day soil	HRF	ED fraction of year	BW kg	OD mg/kg/day
2,3,7,8-TCDD TEQ	3.71E-04	1.59E+00	5.9E-04	1.00	0.02	0.0029	1.7E-06	2.2E-08	1.00E+00	0.333	0.01	5.8E-05
2,4-Dinitrotoluene	6.98E+03	3.08E+00	2.2E+04	1.00	0.02	0.0029	6.2E+01	4.0E-01	1.00E+00	0.333	0.01	2.1E+03
2,6-Dinitrotoluene	2.40E+02	2.50E+00	6.0E+02	1.00	0.02	0.0029	1.7E+00	1.4E-02	1.00E+00	0.333	0.01	5.8E+01
1,3,5-Trinitrobenzene	5.12E+01	6.61E-01	3.4E+01	1.00	0.02	0.0029	9.8E-02	3.0E-03	1.00E+00	0.333	0.01	3.4E+00
Aluminum	1.14E+04	2.20E-01	2.5E+03	1.00	0.02	0.0029	7.3E+00	6.6E-01	1.00E+00	0.333	0.01	2.6E+02
Arsenic	1.23E+01	1.10E-01	1.4E+00	1.00	0.02	0.0029	3.9E-03	7.2E-04	1.00E+00	0.333	0.01	1.6E-01
Barium	2.76E+03	2.20E-01	6.1E+02	1.00	0.02	0.0029	1.8E+00	1.6E-01	1.00E+00	0.333	0.01	6.4E+01
Beryllium	7.87E-01	2.20E-01	1.7E-01	1.00	0.02	0.0029	5.0E-04	4.6E-05	1.00E+00	0.333	0.01	1.8E-02
Cadmium	1.10E+00	9.60E-01	1.1E+00	1.00	0.02	0.0029	3.1E-03	6.4E-05	1.00E+00	0.333	0.01	1.0E-01
Cobalt	1.29E+01	2.20E-01	2.8E+00	1.00	0.02	0.0029	8.2E-03	7.5E-04	1.00E+00	0.333	0.01	3.0E-01
Chromium	2.91E+01	1.00E-02	2.9E-01	1.00	0.02	0.0029	8.4E-04	1.7E-03	1.00E+00	0.333	0.01	8.4E-02
Copper	2.83E+02	4.00E-02	1.1E+01	1.00	0.02	0.0029	3.3E-02	1.6E-02	1.00E+00	0.333	0.01	1.6E+00
Iron	2.58E+04	2.20E-01	5.7E+03	1.00	0.02	0.0029	1.6E+01	1.5E+00	1.00E+00	0.333	0.01	6.0E+02
Mercury	1.87E-01	4.00E-02	7.5E-03	1.00	0.02	0.0029	2.2E-05	1.1E-05	1.00E+00	0.333	0.01	1.1E-03
Manganese	5.59E+02	3.20E-01	1.8E+02	1.00	0.02	0.0029	5.2E-01	3.2E-02	1.00E+00	0.333	0.01	1.8E+01
Nickel	5.30E+01	2.00E-02	1.1E+00	1.00	0.02	0.0029	3.1E-03	3.1E-03	1.00E+00	0.333	0.01	2.0E-01
Lead	2.04E+03	3.00E-02	6.1E+01	1.00	0.02	0.0029	1.8E-01	1.2E-01	1.00E+00	0.333	0.01	9.9E+00
Antimony	2.50E+00	2.20E-01	5.5E-01	1.00	0.02	0.0029	1.6E-03	1.5E-04	1.00E+00	0.333	0.01	5.8E-02
Selenium	1.86E+00	2.20E-01	4.1E-01	1.00	0.02	0.0029	1.2E-03	1.1E-04	1.00E+00	0.333	0.01	4.3E-02
Thallium	2.14E+00	2.20E-01	4.7E-01	1.00	0.02	0.0029	1.4E-03	1.2E-04	1.00E+00	0.333	0.01	5.0E-02
Vanadium	2.79E+01	2.20E-01	6.1E+00	1.00	0.02	0.0029	1.8E-02	1.6E-03	1.00E+00	0.333	0.01	6.5E-01
Zinc	4.71E+02	5.60E-01	2.6E+02	1.00	0.02	0.0029	7.7E-01	2.7E-02	1.00E+00	0.333	0.01	2.6E+01
Acenaphthene	1.61E+01	1.16E+02	1.9E+03	1.00	0.02	0.0029	5.4E+00	9.4E-04	1.00E+00	0.333	0.01	1.8E+02
Naphthalene	1.21E+01	3.60E+01	4.4E+02	1.00	0.02	0.0029	1.3E+00	7.0E-04	1.00E+00	0.333	0.01	4.2E+01

BCF_{inv} =	bioconcentration factor for contaminants from sediment into inver	milligrams per day from food item (inv = invertebrate; plant; sed = sediment)
BCF_{sed} =	bioaccumulation factor for contaminants from sediment into aqua	milligrams per gram of food item (inv = invertebrate; plant; sed = sediment)
BW =	organism body weight	milligrams per kilogram body weight per day
C =	moisture content correction factor (dry weight basis to wet weight	milligrams per liter of water
ED =	migration factor is the proportion of year in which exposure could	not applicable
g_{diet}/day =	grams of dietary intake per day	contaminant not detected in medium at a concentration above its reporting limit
HRF =	home range factor (site area/home range area; estimated to be 0	exposure dose to the omnivore = ([II+IP+IS+IW] x HRF x ED) / BW
IC =	concentration in invertebrate tissue (SC x BAF_{inv})	proportion of ingestion composed of food item (inv = invertebrate; plant; sed = sediment)
II =	daily intake concentration from invertebrates (IC x P_{inv} x IR)	concentration in plant material (SC x C x SCF_{sed})
IP =	daily intake concentration from plant material (PC x P_{plant} x IR)	maximum detected concentration in sediment
IR =	daily ingestion rate (wet wt)	maximum detected concentration in surface water
IS =	daily intake concentration from direct sediment ingestion (SC x P_s	weight
IW =	daily intake concentration from direct water ingestion (WC x IRW)	daily water ingestion rate
kg =	kilograms	

Table 3-6
Maximum Exposure Doses for Deer Mouse (*Peromyscus maniculatus*) for Exposures at Reservoir No. 2 Burning Ground, Inside the Burn Area, Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Conc. Soil	BCF_{inv}	IC	BCF_{plants}	PC	P_{inv}	P_{plant}	P_{soil}	IR	II	IP	IS	HRF	ED	BW	OD
	mg/g_{sed} (dry wt)	mg/kg wet	mg/g_{inv} (wet wt)	mg/kg (dry wt)	mg/g_{plant} (dry wt)				kg_{diet}/day (Dry wt)	mg/day inv	mg/day plant	mg/day soil		fraction of year	kg	mg/kg/day
2,3,7,8-TCDD TEQ	3.71E-04	1.59E+00	5.9E-04	5.60E-03	2.08E-06	0.39	0.61	0.02	0.0028	6.4E-07	3.6E-09	2.1E-08	1.00E+00	1.000	0.0148	4.5E-05
2,4-Dinitrotoluene	6.98E+03	3.08E+00	2.2E+04	2.72E+00	1.90E+04	0.39	0.61	0.02	0.0028	2.3E+01	3.2E+01	3.9E-01	1.00E+00	1.000	0.0148	3.8E+03
2,6-Dinitrotoluene	2.40E+02	2.50E+00	6.0E+02	3.15E+00	7.55E+02	0.39	0.61	0.02	0.0028	6.5E-01	1.3E+00	1.3E-02	1.00E+00	1.000	0.0148	1.3E+02
1,3,5-Trinitrobenzene	5.12E+01	6.61E-01	3.4E+01	8.05E+00	4.12E+02	0.39	0.61	0.02	0.0028	3.7E-02	7.0E-01	2.9E-03	1.00E+00	1.000	0.0148	5.0E+01
Aluminum	1.14E+04	2.20E-01	2.5E+03	4.00E-03	4.55E+01	0.39	0.61	0.02	0.0028	2.7E+00	7.8E-02	6.4E-01	1.00E+00	1.000	0.0148	2.3E+02
Arsenic	1.23E+01	1.10E-01	1.4E+00	3.60E-02	4.44E-01	0.39	0.61	0.02	0.0028	1.5E-03	7.6E-04	6.9E-04	1.00E+00	1.000	0.0148	2.0E-01
Barium	2.76E+03	2.20E-01	6.1E+02	1.50E-01	4.15E+02	0.39	0.61	0.02	0.0028	6.6E-01	7.1E-01	1.5E-01	1.00E+00	1.000	0.0148	1.0E+02
Beryllium	7.87E-01	2.20E-01	1.7E-01	1.00E-02	7.87E-03	0.39	0.61	0.02	0.0028	1.9E-04	1.3E-05	4.4E-05	1.00E+00	1.000	0.0148	1.7E-02
Cadmium	1.10E+00	9.60E-01	1.1E+00	3.64E-01	4.02E-01	0.39	0.61	0.02	0.0028	1.2E-03	6.9E-04	6.2E-05	1.00E+00	1.000	0.0148	1.3E-01
Cobalt	1.29E+01	2.20E-01	2.8E+00	3.50E-01	4.52E+00	0.39	0.61	0.02	0.0028	3.1E-03	7.7E-03	7.2E-04	1.00E+00	1.000	0.0148	7.8E-01
Chromium	2.91E+01	1.00E-02	2.9E-01	7.50E-03	2.18E-01	0.39	0.61	0.02	0.0028	3.2E-04	3.7E-04	1.6E-03	1.00E+00	1.000	0.0148	1.6E-01
Copper	2.83E+02	4.00E-02	1.1E+01	4.00E-01	1.13E+02	0.39	0.61	0.02	0.0028	1.2E-02	1.9E-01	1.6E-02	1.00E+00	1.000	0.0148	1.5E+01
Iron	2.58E+04	2.20E-01	5.7E+03	1.00E-03	2.58E+01	0.39	0.61	0.02	0.0028	6.2E+00	4.4E-02	1.4E+00	1.00E+00	1.000	0.0148	5.2E+02
Mercury	1.87E-01	4.00E-02	7.5E-03	3.75E-02	7.01E-03	0.39	0.61	0.02	0.0028	8.2E-06	1.2E-05	1.0E-05	1.00E+00	1.000	0.0148	2.1E-03
Manganese	5.59E+02	3.20E-01	1.8E+02	5.00E-02	2.80E+01	0.39	0.61	0.02	0.0028	2.0E-01	4.8E-02	3.1E-02	1.00E+00	1.000	0.0148	1.9E+01
Nickel	5.30E+01	2.00E-02	1.1E+00	3.20E-02	1.70E+00	0.39	0.61	0.02	0.0028	1.2E-03	2.9E-03	3.0E-03	1.00E+00	1.000	0.0148	4.7E-01
Lead	2.04E+03	3.00E-02	6.1E+01	4.50E-02	9.18E+01	0.39	0.61	0.02	0.0028	6.7E-02	1.6E-01	1.1E-01	1.00E+00	1.000	0.0148	2.3E+01
Antimony	2.50E+00	2.20E-01	5.5E-01	2.00E-01	5.00E-01	0.39	0.61	0.02	0.0028	6.0E-04	8.5E-04	1.4E-04	1.00E+00	1.000	0.0148	1.1E-01
Selenium	1.86E+00	2.20E-01	4.1E-01	1.60E-02	2.97E-02	0.39	0.61	0.02	0.0028	4.5E-04	5.1E-05	1.0E-04	1.00E+00	1.000	0.0148	4.1E-02
Thallium	2.14E+00	2.20E-01	4.7E-01	4.00E-03	8.56E-03	0.39	0.61	0.02	0.0028	5.1E-04	1.5E-05	1.2E-04	1.00E+00	1.000	0.0148	4.4E-02
Vanadium	2.79E+01	2.20E-01	6.1E+00	3.00E-03	8.36E-02	0.39	0.61	0.02	0.0028	6.7E-03	1.4E-04	1.6E-03	1.00E+00	1.000	0.0148	5.7E-01
Zinc	4.71E+02	5.60E-01	2.6E+02	1.20E-12	5.66E-10	0.39	0.61	0.02	0.0028	2.9E-01	9.7E-13	2.6E-02	1.00E+00	1.000	0.0148	2.1E+01
Acenaphthene	1.61E+01	1.16E+02	1.9E+03	2.10E-01	3.39E+00	0.39	0.61	0.02	0.0028	2.0E+00	5.8E-03	9.0E-04	1.00E+00	1.000	0.0148	1.4E+02
Naphthalene	1.21E+01	3.60E+01	4.4E+02	4.79E-01	5.79E+00	0.39	0.61	0.02	0.0028	4.8E-01	9.9E-03	6.8E-04	1.00E+00	1.000	0.0148	3.3E+01

BCF_{inv} = bioconcentration factor for contaminants from sediment into invertebrates (wet w
BCF_{sed} = bioaccumulation factor for contaminants from sediment into aquatic plants (dry w
BW = organism body weight
C = moisture content correction factor (dry weight basis to wet weight basis)
ED = migration factor is the proportion of year in which exposure could occur
g_{diet}/day = grams of dietary intake per day
HRF = home range factor (site area/home range area; estimated to be 0.85)
IC = concentration in invertebrate tissue (SC x BAF_{inv})
II = daily intake concentration from invertebrates (IC x P_{inv} x IR)
IP = daily intake concentration from plant material (PC x P_{plant} x IR)
IR = daily ingestion rate (wet wt)
IS = daily intake concentration from direct sediment ingestion (SC x P_{sed} x IR)
IW = daily intake concentration from direct water ingestion (WC x IRW)
kg = kilograms

mg/day = milligrams per day from food item (inv = invertebrate; plant; sed = sediment)
mg/g = milligrams per gram of food item (inv = invertebrate; plant; sed = sediment)
mg/kg/day = milligrams per kilogram body weight per day
mg/L = milligrams per liter of water
NA = not applicable
ND = contaminant not detected in medium at a concentration above its reporting limit
OD = exposure dose to the omnivore = ([II+IP+IS+IW] x HRF x ED) / BW
P = proportion of ingestion composed of food item (inv = invertebrate; plant; sed = sediment)
PC = concentration in plant material (SC x C x SCF_{sed})
SC_{max} = maximum detected concentration in sediment
WC_{max} = maximum detected concentration in surface water
wt = weight
WI = daily water ingestion rate

Table 3-7
Maximum Exposure Doses for Eastern Cottontail (*Sylvilagus floridanus*) for Exposures at Reservoir No. 2 Burning Ground, Inside the Burn Area, Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Conc. Soil mg/g_{sed} (dry wt)	BCF_{plants} mg/kg (dry wt)	PC mg/g_{plant} (dry wt)	P_{plant}	P_{soil}	IR kg_{diet}/day (Dry wt)	IP mg/day plant	IS mg/day soil	HRF	ED fraction of year	BW kg	OD mg/kg/day
2,3,7,8-TCDD TEQ	3.71E-04	5.60E-03	2.08E-06	1	0.063	0.096	2.0E-07	2.2E-06	1.00E+00	1.000	1.132	2.2E-06
2,4-Dinitrotoluene	6.98E+03	2.72E+00	1.90E+04	1	0.063	0.096	1.8E+03	4.2E+01	1.00E+00	1.000	1.132	1.6E+03
2,6-Dinitrotoluene	2.40E+02	3.15E+00	7.55E+02	1	0.063	0.096	7.2E+01	1.4E+00	1.00E+00	1.000	1.132	6.5E+01
1,3,5-Trinitrobenzene	5.12E+01	8.05E+00	4.12E+02	1	0.063	0.096	4.0E+01	3.1E-01	1.00E+00	1.000	1.132	3.5E+01
Aluminum	1.14E+04	4.00E-03	4.55E+01	1	0.063	0.096	4.4E+00	6.9E+01	1.00E+00	1.000	1.132	6.5E+01
Arsenic	1.23E+01	3.60E-02	4.44E-01	1	0.063	0.096	4.3E-02	7.5E-02	1.00E+00	1.000	1.132	1.0E-01
Barium	2.76E+03	1.50E-01	4.15E+02	1	0.063	0.096	4.0E+01	1.7E+01	1.00E+00	1.000	1.132	5.0E+01
Beryllium	7.87E-01	1.00E-02	7.87E-03	1	0.063	0.096	7.6E-04	4.8E-03	1.00E+00	1.000	1.132	4.9E-03
Cadmium	1.10E+00	3.64E-01	4.02E-01	1	0.063	0.096	3.9E-02	6.7E-03	1.00E+00	1.000	1.132	4.0E-02
Cobalt	1.29E+01	3.50E-01	4.52E+00	1	0.063	0.096	4.3E-01	7.8E-02	1.00E+00	1.000	1.132	4.5E-01
Chromium	2.91E+01	7.50E-03	2.18E-01	1	0.063	0.096	2.1E-02	1.8E-01	1.00E+00	1.000	1.132	1.7E-01
Copper	2.83E+02	4.00E-01	1.13E+02	1	0.063	0.096	1.1E+01	1.7E+00	1.00E+00	1.000	1.132	1.1E+01
Iron	2.58E+04	1.00E-03	2.58E+01	1	0.063	0.096	2.5E+00	1.6E+02	1.00E+00	1.000	1.132	1.4E+02
Mercury	1.87E-01	3.75E-02	7.01E-03	1	0.063	0.096	6.7E-04	1.1E-03	1.00E+00	1.000	1.132	1.6E-03
Manganese	5.59E+02	5.00E-02	2.80E+01	1	0.063	0.096	2.7E+00	3.4E+00	1.00E+00	1.000	1.132	5.4E+00
Nickel	5.30E+01	3.20E-02	1.70E+00	1	0.063	0.096	1.6E-01	3.2E-01	1.00E+00	1.000	1.132	4.3E-01
Lead	2.04E+03	4.50E-02	9.18E+01	1	0.063	0.096	8.8E+00	1.2E+01	1.00E+00	1.000	1.132	1.9E+01
Antimony	2.50E+00	2.00E-01	5.00E-01	1	0.063	0.096	4.8E-02	1.5E-02	1.00E+00	1.000	1.132	5.6E-02
Selenium	1.86E+00	1.60E-02	2.97E-02	1	0.063	0.096	2.9E-03	1.1E-02	1.00E+00	1.000	1.132	1.2E-02
Thallium	2.14E+00	4.00E-03	8.56E-03	1	0.063	0.096	8.2E-04	1.3E-02	1.00E+00	1.000	1.132	1.2E-02
Vanadium	2.79E+01	3.00E-03	8.36E-02	1	0.063	0.096	8.0E-03	1.7E-01	1.00E+00	1.000	1.132	1.6E-01
Zinc	4.71E+02	1.20E-12	5.66E-10	1	0.063	0.096	5.4E-11	2.9E+00	1.00E+00	1.000	1.132	2.5E+00
Acenaphthene	1.61E+01	2.10E-01	3.39E+00	1	0.063	0.096	3.3E-01	9.8E-02	1.00E+00	1.000	1.132	3.7E-01
Naphthalene	1.21E+01	4.79E-01	5.79E+00	1	0.063	0.096	5.6E-01	7.3E-02	1.00E+00	1.000	1.132	5.6E-01

BCF_{inv} = bioconcentration factor for contaminants from sed
BCF_{sed} = bioaccumulation factor for contaminants from sedi
BW = organism body weight
C = moisture content correction factor (dry weight basi
ED = migration factor is the proportion of year in which
g_{diet}/day = grams of dietary intake per day
HRF = home range factor (site area/home range area; es
IC = concentration in invertebrate tissue (SC x BAF_{inv})
II = daily intake concentration from invertebrates (IC x
IP = daily intake concentration from plant material (PC
IR = daily ingestion rate (wet wt)
IS = daily intake concentration from direct sediment ing
IW = daily intake concentration from direct water ingest
kg = kilograms
mg/day = milligrams per day from food item (inv = invertebrate; plant; sed = sediment)
mg/g = milligrams per gram of food item (inv = invertebrate; plant; sed = sediment)
mg/kg/day = milligrams per kilogram body weight per day
mg/L = milligrams per liter of water
NA = not applicable
ND = contaminant not detected in medium at a concentration above its reporting limit
OD = exposure dose to the omnivore = ([II+IP+IS+IW] x HRF x ED) / BW
P = proportion of ingestion composed of food item (inv = invertebrate; plant; sed = sediment)
PC = concentration in plant material (SC x C x SCF_{sed})
SC_{max} = maximum detected concentration in sediment
WC_{max} = maximum detected concentration in surface water
wt = weight
WI = daily water ingestion rate

Table 3-8
Maximum Exposure Doses for Red-tailed Hawk (*Buteo jamaicensis*) for Exposures at Reservoir No. 2 Burning Ground, Inside the Burn Area, Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Conc. Soil	BCF_{inv}	IC	BCF_{plants}	VC	Pvert	P_{soil}	IR	IR	WI	IV	IS	HRF	ED	BW	OD
	mg/g_{sed} (dry wt)	mg/kg wet	mg/g_{inv} (wet wt)	mg/kg (dry wt)	mg/g_{vert} (dry wt)			kg_{diet}/day (Dry wt)	kg_{diet}/day (wet wt)	L/day	mg/day inv	mg/day soil		fraction of year	kg	mg/kg/day
2,3,7,8-TCDD TEQ	3.71E-04	1.59E+00	5.9E-04	5.60E-03	5.92E-04	1.00	0.02	0.057		5.7E-02	3.4E-05	4.2E-07	1.00E-02	1.000	0.957	3.6E-07
2,4-Dinitrotoluene	6.98E+03	3.08E+00	2.2E+04	2.72E+00	4.05E+04	1.00	0.02	0.057		5.7E-02	2.3E+03	8.0E+00	1.00E-02	1.000	0.957	2.4E+01
2,6-Dinitrotoluene	2.40E+02	2.50E+00	6.0E+02	3.15E+00	1.35E+03	1.00	0.02	0.057		5.7E-02	7.7E+01	2.7E-01	1.00E-02	1.000	0.957	8.1E-01
1,3,5-Trinitrobenzene	5.12E+01	6.61E-01	3.4E+01	8.05E+00	4.46E+02	1.00	0.02	0.057		5.7E-02	2.5E+01	5.8E-02	1.00E-02	1.000	0.957	2.7E-01
Aluminum	1.14E+04	2.20E-01	2.5E+03	4.00E-03	2.55E+03	1.00	0.02	0.057		5.7E-02	1.5E+02	1.3E+01	1.00E-02	1.000	0.957	1.7E+00
Arsenic	1.23E+01	1.10E-01	1.4E+00	3.60E-02	1.80E+00	1.00	0.02	0.057		5.7E-02	1.0E-01	1.4E-02	1.00E-02	1.000	0.957	1.2E-03
Barium	2.76E+03	2.20E-01	6.1E+02	1.50E-01	1.02E+03	1.00	0.02	0.057		5.7E-02	5.8E+01	3.2E+00	1.00E-02	1.000	0.957	6.4E-01
Beryllium	7.87E-01	2.20E-01	1.7E-01	1.00E-02	1.81E-01	1.00	0.02	0.057		5.7E-02	1.0E-02	9.0E-04	1.00E-02	1.000	0.957	1.2E-04
Cadmium	1.10E+00	9.60E-01	1.1E+00	3.64E-01	1.46E+00	1.00	0.02	0.057		5.7E-02	8.3E-02	1.3E-03	1.00E-02	1.000	0.957	8.8E-04
Cobalt	1.29E+01	2.20E-01	2.8E+00	3.50E-01	7.36E+00	1.00	0.02	0.057		5.7E-02	4.2E-01	1.5E-02	1.00E-02	1.000	0.957	4.5E-03
Chromium	2.91E+01	1.00E-02	2.9E-01	7.50E-03	5.10E-01	1.00	0.02	0.057		5.7E-02	2.9E-02	3.3E-02	1.00E-02	1.000	0.957	6.5E-04
Copper	2.83E+02	4.00E-02	1.1E+01	4.00E-01	1.25E+02	1.00	0.02	0.057		5.7E-02	7.1E+00	3.2E-01	1.00E-02	1.000	0.957	7.8E-02
Iron	2.58E+04	2.20E-01	5.7E+03	1.00E-03	5.71E+03	1.00	0.02	0.057		5.7E-02	3.3E+02	2.9E+01	1.00E-02	1.000	0.957	3.7E+00
Mercury	1.87E-01	4.00E-02	7.5E-03	3.75E-02	1.45E-02	1.00	0.02	0.057		5.7E-02	8.3E-04	2.1E-04	1.00E-02	1.000	0.957	1.1E-05
Manganese	5.59E+02	3.20E-01	1.8E+02	5.00E-02	2.07E+02	1.00	0.02	0.057		5.7E-02	1.2E+01	6.4E-01	1.00E-02	1.000	0.957	1.3E-01
Nickel	5.30E+01	2.00E-02	1.1E+00	3.20E-02	2.75E+00	1.00	0.02	0.057		5.7E-02	1.6E-01	6.0E-02	1.00E-02	1.000	0.957	2.3E-03
Lead	2.04E+03	3.00E-02	6.1E+01	4.50E-02	1.53E+02	1.00	0.02	0.057		5.7E-02	8.7E+00	2.3E+00	1.00E-02	1.000	0.957	1.2E-01
Antimony	2.50E+00	2.20E-01	5.5E-01	2.00E-01	1.05E+00	1.00	0.02	0.057		5.7E-02	6.0E-02	2.9E-03	1.00E-02	1.000	0.957	6.6E-04
Selenium	1.86E+00	2.20E-01	4.1E-01	1.60E-02	4.38E-01	1.00	0.02	0.057		5.7E-02	2.5E-02	2.1E-03	1.00E-02	1.000	0.957	2.8E-04
Thallium	2.14E+00	2.20E-01	4.7E-01	4.00E-03	4.80E-01	1.00	0.02	0.057		5.7E-02	2.7E-02	2.4E-03	1.00E-02	1.000	0.957	3.1E-04
Vanadium	2.79E+01	2.20E-01	6.1E+00	3.00E-03	6.21E+00	1.00	0.02	0.057		5.7E-02	3.5E-01	3.2E-02	1.00E-02	1.000	0.957	4.0E-03
Zinc	4.71E+02	5.60E-01	2.6E+02	1.20E-12	2.64E+02	1.00	0.02	0.057		5.7E-02	1.5E+01	5.4E-01	1.00E-02	1.000	0.957	1.6E-01
Acenaphthene	1.61E+01	1.16E+02	1.9E+03	2.10E-01	1.88E+03	1.00	0.02	0.057		5.7E-02	1.1E+02	1.8E-02	1.00E-02	1.000	0.957	1.1E+00
Naphthalene	1.21E+01	3.60E+01	4.4E+02	4.79E-01	4.41E+02	1.00	0.02	0.057		5.7E-02	2.5E+01	1.4E-02	1.00E-02	1.000	0.957	2.6E-01

BCF_{inv} = bioconcentration factor for contaminants from sediment into invertebrates (wet w
BCF_{sed} = bioaccumulation factor for contaminants from sediment into aquatic plants (dry w
BW = organism body weight
C = moisture content correction factor (dry weight basis to wet weight basis)
ED = migration factor is the proportion of year in which exposure could occur
g_{diet}/day = grams of dietary intake per day
HRF = home range factor (site area/home range area; estimated to be 0.85)
IC = concentration in invertebrate tissue (SC x BAF_{inv})
II = daily intake concentration from invertebrates (IC x P_{inv} x IR)
IP = daily intake concentration from plant material (PC x P_{plant} x IR)
IR = daily ingestion rate (wet wt)
IS = daily intake concentration from direct sediment ingestion (SC x P_{sed} x IR)
IW = daily intake concentration from direct water ingestion (WC x IRW)
kg = kilograms
mg/day = milligrams per day from food item (inv = invertebrate; plant; sed = sediment)
mg/g = milligrams per gram of food item (inv = invertebrate; plant; sed = sediment)
mg/kg/day = milligrams per kilogram body weight per day
mg/L = milligrams per liter of water
NA = not applicable
ND = contaminant not detected in medium at a concentration above its reporting limit
OD = exposure dose to the omnivore = ([II+IP+IS+IW] x HRF x ED) / BW
P = proportion of ingestion composed of food item (inv = invertebrate; plant; sed = sediment)
PC = concentration in plant material (SC x C x SCF_{sed})
SC_{max} = maximum detected concentration in sediment
WC_{max} = maximum detected concentration in surface water
wt = weight
WI = daily water ingestion rate

Table 3-9
Maximum Exposure Doses for Racoon (*Procyon lotor*) for
Exposures at Reservoir No. 2 Burning Ground, Inside the Burn Area,
Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Conc. Soil mg/g_{sed} (dry wt)	BCF_{inv} mg/kg wet	IC mg/g_{inv} (wet wt)	BCF_{plants} mg/kg (dry wt)	VC mg/g_{vert} (dry wt)	PC mg/g_{plant} (dry wt)	P_{vert}	P_{inv}	P_{plant}	P_{soil}	IR kg_{diet}/day (Dry wt)	II mg/day inv	IV mg/day vert	IP mg/day plant	IS mg/day soil	HRF	ED fraction of year	BW kg	OD mg/kg/day
2,3,7,8-TCDD TEQ	3.71E-04	1.59E+00	5.9E-04	5.60E-03	9.84E-03	2.08E-06	0.05	0.51	0.42	0.094	0.26	7.8E-05	1.3E-03	2.3E-07	9.1E-06	6.00E-02	0.667	5.1	1.1E-05
2,4-Dinitrotoluene	6.98E+03	2.72E+00	1.9E+04	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	2.5E+03	0.0E+00	0.0E+00	1.7E+02	6.00E-02	0.667	5.1	2.1E+01
2,6-Dinitrotoluene	2.40E+02	3.15E+00	7.5E+02	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	1.0E+02	0.0E+00	0.0E+00	5.9E+00	6.00E-02	0.667	5.1	8.3E-01
2,4,6-Trinitrotoluene	6.05E+03	1.94E+00	1.2E+04	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	1.6E+03	0.0E+00	0.0E+00	1.5E+02	6.00E-02	0.667	5.1	1.3E+01
1,3,5-Trinitrobenzene	5.12E+01	8.05E+00	4.1E+02	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	5.5E+01	0.0E+00	0.0E+00	1.3E+00	6.00E-02	0.667	5.1	4.4E-01
Aluminum	1.14E+04	4.00E-03	4.6E+01	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	6.0E+00	0.0E+00	0.0E+00	2.8E+02	6.00E-02	0.667	5.1	2.2E+00
Arsenic	1.23E+01	3.60E-02	4.4E-01	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	5.9E-02	0.0E+00	0.0E+00	3.0E-01	6.00E-02	0.667	5.1	2.8E-03
Barium	2.76E+03	1.50E-01	4.1E+02	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	5.5E+01	0.0E+00	0.0E+00	6.8E+01	6.00E-02	0.667	5.1	9.6E-01
Beryllium	7.87E-01	1.00E-02	7.9E-03	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	1.0E-03	0.0E+00	0.0E+00	1.9E-02	6.00E-02	0.667	5.1	1.6E-04
Cadmium	1.10E+00	3.64E-01	4.0E-01	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	5.3E-02	0.0E+00	0.0E+00	2.7E-02	6.00E-02	0.667	5.1	6.3E-04
Cobalt	1.29E+01	3.50E-01	4.5E+00	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	6.0E-01	0.0E+00	0.0E+00	3.2E-01	6.00E-02	0.667	5.1	7.2E-03
Chromium	2.91E+01	7.50E-03	2.2E-01	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	2.9E-02	0.0E+00	0.0E+00	7.1E-01	6.00E-02	0.667	5.1	5.8E-03
Copper	2.83E+02	4.00E-01	1.1E+02	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	1.5E+01	0.0E+00	0.0E+00	6.9E+00	6.00E-02	0.667	5.1	1.7E-01
Iron	2.58E+04	1.00E-03	2.6E+01	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	3.4E+00	0.0E+00	0.0E+00	6.3E+02	6.00E-02	0.667	5.1	5.0E+00
Mercury	1.87E-01	3.75E-02	7.0E-03	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	9.3E-04	0.0E+00	0.0E+00	4.6E-03	6.00E-02	0.667	5.1	4.3E-05
Manganese	5.59E+02	5.00E-02	2.8E+01	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	3.7E+00	0.0E+00	0.0E+00	1.4E+01	6.00E-02	0.667	5.1	1.4E-01
Nickel	5.30E+01	3.20E-02	1.7E+00	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	2.2E-01	0.0E+00	0.0E+00	1.3E+00	6.00E-02	0.667	5.1	1.2E-02
Lead	2.04E+03	4.50E-02	9.2E+01	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	1.2E+01	0.0E+00	0.0E+00	5.0E+01	6.00E-02	0.667	5.1	4.9E-01
Antimony	2.50E+00	2.00E-01	5.0E-01	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	6.6E-02	0.0E+00	0.0E+00	6.1E-02	6.00E-02	0.667	5.1	1.0E-03
Selenium	1.86E+00	1.60E-02	3.0E-02	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	3.9E-03	0.0E+00	0.0E+00	4.5E-02	6.00E-02	0.667	5.1	3.9E-04
Thallium	2.14E+00	4.00E-03	8.6E-03	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	1.1E-03	0.0E+00	0.0E+00	5.2E-02	6.00E-02	0.667	5.1	4.2E-04
Vanadium	2.79E+01	3.00E-03	8.4E-02	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	1.1E-02	0.0E+00	0.0E+00	6.8E-01	6.00E-02	0.667	5.1	5.4E-03
Zinc	4.71E+02	1.20E-12	5.7E-10	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	7.5E-11	0.0E+00	0.0E+00	1.2E+01	6.00E-02	0.667	5.1	9.0E-02
Acenaphthene	1.61E+01	2.10E-01	3.4E+00	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	4.5E-01	0.0E+00	0.0E+00	3.9E-01	6.00E-02	0.667	5.1	6.6E-03
Naphthalene	1.21E+01	4.79E-01	5.8E+00	0.00E+00	0.00E+00	0.00E+00	0.05	0.51	0.42	0.094	0.26	7.7E-01	0.0E+00	0.0E+00	3.0E-01	6.00E-02	0.667	5.1	8.3E-03

BCF_{inv} = bioconcentration factor for contaminants from sediment into invertebrates (wet
BCF_{sed} = bioaccumulation factor for contaminants from sediment into aquatic plants (dry
BW = organism body weight
C = moisture content correction factor (dry weight basis to wet weight basis)
ED = migration factor is the proportion of year in which exposure could occur
g_{diet}/day = grams of dietary intake per day
HRF = home range factor (site area/home range area; estimated to be 0.85)
IC = concentration in invertebrate tissue (SC x BAF_{inv})
II = daily intake concentration from invertebrates (IC x P_{inv} x IR)
IP = daily intake concentration from plant material (PC x P_{plant} x IR)
IR = daily ingestion rate (wet wt)
IS = daily intake concentration from direct sediment ingestion (SC x P_{sed} x IR)
IW = daily intake concentration from direct water ingestion (WC x IRW)
kg = kilograms

mg/day = mg/day = milligra milligrams per day from food item (inv = invertebrate; plant; sed = sediment)
mg/g = mg/g = milligra milligrams per gram of food item (inv = invertebrate; plant; sed = sediment)
mg/kg/day = mg/kg/day = milligra milligrams per kilogram body weight per day
mg/L = mg/L = milligra milligrams per liter of water
NA = NA = not ap not applicable
ND = ND = contar contaminant not detected in medium at a concentration above its reporting limit
OD = OD = expos exposure dose to the omnivore = ([II+IP+IS+IW] x HRF x ED) / BW
P = P = propor proportion of ingestion composed of food item (inv = invertebrate; plant; sed = sediment)
PC = PC = conce concentration in plant material (SC x C x SCF_{sed})
SC_{max} = SC_{max} = maxim maximum detected concentration in sediment
WC_{max} = WC_{max} = maxim maximum detected concentration in surface water
wt = wt = weight weight
WI = WI = daily w daily water ingestion rate

Table 3-10
Maximum Exposure Doses for Short-tailed Shrew (*Blarina brevicauda*) for Exposures at Reservoir No. 2 Burning Ground, Outside the Burn Area, Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Conc. Soil	BCF_{inv}	IC	P_{inv}	P_{plant}	P_{soil}	IR	II	IS	HRF	ED	BW	OD
	mg/g_{sed} (dry wt)	mg/kg wet	mg/g_{inv} (wet wt)				kg_{diet}/day (Dry wt)	mg/day inv	mg/day soil		fraction of year	kg	mg/kg/day
2,4-Dinitrotoluene	2.17E+01	3.08E+00	6.7E+01	1.00	0	0.104	0.0022	1.5E-01	5.0E-03	1.00E+00	1.000	0.015	1.0E+01
2,6-Dinitrotoluene	8.22E+00	2.50E+00	2.1E+01	1.00	0	0.104	0.0022	4.5E-02	1.9E-03	1.00E+00	1.000	0.015	3.1E+00
1,3,5-Trinitrobenzene	1.27E+00	6.61E-01	8.4E-01	1.00	0	0.104	0.0022	1.8E-03	2.9E-04	1.00E+00	1.000	0.015	1.4E-01
Aluminum	1.21E+04	2.20E-01	2.7E+03	1.00	0	0.104	0.0022	5.8E+00	2.8E+00	1.00E+00	1.000	0.015	5.7E+02
Arsenic	9.38E+00	1.10E-01	1.0E+00	1.00	0	0.104	0.0022	2.3E-03	2.1E-03	1.00E+00	1.000	0.015	2.9E-01
Barium	1.14E+02	2.20E-01	2.5E+01	1.00	0	0.104	0.0022	5.5E-02	2.6E-02	1.00E+00	1.000	0.015	5.4E+00
Cadmium	4.77E-01	9.60E-01	4.6E-01	1.00	0	0.104	0.0022	1.0E-03	1.1E-04	1.00E+00	1.000	0.015	7.4E-02
Cobalt	9.73E+00	2.20E-01	2.1E+00	1.00	0	0.104	0.0022	4.7E-03	2.2E-03	1.00E+00	1.000	0.015	4.6E-01
Chromium	1.87E+01	1.00E-02	1.9E-01	1.00	0	0.104	0.0022	4.1E-04	4.3E-03	1.00E+00	1.000	0.015	3.1E-01
Copper	9.99E+01	4.00E-02	4.0E+00	1.00	0	0.104	0.0022	8.8E-03	2.3E-02	1.00E+00	1.000	0.015	2.1E+00
Iron	2.20E+04	2.20E-01	4.8E+03	1.00	0	0.104	0.0022	1.1E+01	5.0E+00	1.00E+00	1.000	0.015	1.0E+03
Mercury	1.33E-01	4.00E-02	5.3E-03	1.00	0	0.104	0.0022	1.2E-05	3.0E-05	1.00E+00	1.000	0.015	2.8E-03
Manganese	7.85E+02	3.20E-01	2.5E+02	1.00	0	0.104	0.0022	5.5E-01	1.8E-01	1.00E+00	1.000	0.015	4.9E+01
Nickel	2.78E+01	2.00E-02	5.6E-01	1.00	0	0.104	0.0022	1.2E-03	6.4E-03	1.00E+00	1.000	0.015	5.1E-01
Lead	2.43E+02	3.00E-02	7.3E+00	1.00	0	0.104	0.0022	1.6E-02	5.6E-02	1.00E+00	1.000	0.015	4.8E+00
Selenium	9.67E-01	2.20E-01	2.1E-01	1.00	0	0.104	0.0022	4.7E-04	2.2E-04	1.00E+00	1.000	0.015	4.6E-02
Thallium	1.40E+00	2.20E-01	3.1E-01	1.00	0	0.104	0.0022	6.8E-04	3.2E-04	1.00E+00	1.000	0.015	6.7E-02
Vanadium	2.86E+01	2.20E-01	6.3E+00	1.00	0	0.104	0.0022	1.4E-02	6.5E-03	1.00E+00	1.000	0.015	1.4E+00
Zinc	1.89E+02	5.60E-01	1.1E+02	1.00	0	0.104	0.0022	2.3E-01	4.3E-02	1.00E+00	1.000	0.015	1.8E+01
Naphthalene	1.38E-01	3.60E+01	5.0E+00	1.00	0	0.104	0.0022	1.1E-02	3.2E-05	1.00E+00	1.000	0.015	7.3E-01

BCF_{inv} =	bioconcentration factor for contaminants from sediment into inve	milligrams per day from food item (inv = invertebrate; plant; sed = sediment)
BCF_{sed} =	bioaccumulation factor for contaminants from sediment into aqu	milligrams per gram of food item (inv = invertebrate; plant; sed = sediment)
BW =	organism body weight	milligrams per kilogram body weight per day
C =	moisture content correction factor (dry weight basis to wet weigh	milligrams per liter of water
ED =	migration factor is the proportion of year in which exposure coul	not applicable
g_{diet}/day =	grams of dietary intake per day	contaminant not detected in medium at a concentration above its reporting limit
HRF =	home range factor (site area/home range area; estimated to be	exposure dose to the omnivore = ([II+IP+IS+IW] x HRF x ED) / BW
IC =	concentration in invertebrate tissue (SC x BAF_{inv})	proportion of ingestion composed of food item (inv = invertebrate; plant; sed = sediment)
II =	daily intake concentration from invertebrates (IC x P_{inv} x IR)	concentration in plant material (SC x C x SCF_{sed})
IP =	daily intake concentration from plant material (PC x P_{plant} x IR)	maximum detected concentration in sediment
IR =	daily ingestion rate (wet wt)	maximum detected concentration in surface water
IS =	daily intake concentration from direct sediment ingestion (SC x F	weight
IW =	daily intake concentration from direct water ingestion (WC x IRW	daily water ingestion rate
kg =	kilograms	

Table 3-11
Maximum Exposure Doses for White-tailed Deer (*Odocoileus virginianus*) for Exposures at Reservoir No. 2 Burning Ground, Outside the Burn Area, Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Conc. Soil mg/g_{sed} (dry wt)	BCF_{plants} mg/kg (dry wt)	PC mg/g_{plant} (dry wt)	P_{plant}	P_{soil}	IR kg_{diet}/day (Dry wt)	IP mg/day plant	IS mg/day soil	HRF	ED fraction of year	BW kg	OD mg/kg/day
2,4-Dinitrotoluene	2.17E+01	2.72E+00	5.89E+01	1	0.02	2	1.2E+02	8.7E-01	2.00E-02	1.000	61	3.9E-02
2,6-Dinitrotoluene	8.22E+00	3.15E+00	2.59E+01	1	0.02	2	5.2E+01	3.3E-01	2.00E-02	1.000	61	1.7E-02
1,3,5-Trinitrobenzene	1.27E+00	8.05E+00	1.02E+01	1	0.02	2	2.0E+01	5.1E-02	2.00E-02	1.000	61	6.7E-03
Aluminum	1.21E+04	4.00E-03	4.83E+01	1	0.02	2	9.7E+01	4.8E+02	2.00E-02	1.000	61	1.9E-01
Arsenic	9.38E+00	3.60E-02	3.38E-01	1	0.02	2	6.8E-01	3.8E-01	2.00E-02	1.000	61	3.4E-04
Barium	1.14E+02	1.50E-01	1.71E+01	1	0.02	2	3.4E+01	4.5E+00	2.00E-02	1.000	61	1.3E-02
Cadmium	4.77E-01	3.64E-01	1.74E-01	1	0.02	2	3.5E-01	1.9E-02	2.00E-02	1.000	61	1.2E-04
Cobalt	9.73E+00	3.50E-01	3.41E+00	1	0.02	2	6.8E+00	3.9E-01	2.00E-02	1.000	61	2.4E-03
Chromium	1.87E+01	7.50E-03	1.40E-01	1	0.02	2	2.8E-01	7.5E-01	2.00E-02	1.000	61	3.4E-04
Copper	9.99E+01	4.00E-01	4.00E+01	1	0.02	2	8.0E+01	4.0E+00	2.00E-02	1.000	61	2.8E-02
Iron	2.20E+04	1.00E-03	2.20E+01	1	0.02	2	4.4E+01	8.8E+02	2.00E-02	1.000	61	3.0E-01
Mercury	1.33E-01	3.75E-02	4.99E-03	1	0.02	2	1.0E-02	5.3E-03	2.00E-02	1.000	61	5.0E-06
Manganese	7.85E+02	5.00E-02	3.93E+01	1	0.02	2	7.9E+01	3.1E+01	2.00E-02	1.000	61	3.6E-02
Nickel	2.78E+01	3.20E-02	8.91E-01	1	0.02	2	1.8E+00	1.1E+00	2.00E-02	1.000	61	9.5E-04
Lead	2.43E+02	4.50E-02	1.09E+01	1	0.02	2	2.2E+01	9.7E+00	2.00E-02	1.000	61	1.0E-02
Selenium	9.67E-01	1.60E-02	1.55E-02	1	0.02	2	3.1E-02	3.9E-02	2.00E-02	1.000	61	2.3E-05
Thallium	1.40E+00	4.00E-03	5.61E-03	1	0.02	2	1.1E-02	5.6E-02	2.00E-02	1.000	61	2.2E-05
Vanadium	2.86E+01	3.00E-03	8.59E-02	1	0.02	2	1.7E-01	1.1E+00	2.00E-02	1.000	61	4.3E-04
Zinc	1.89E+02	1.20E-12	2.27E-10	1	0.02	2	4.5E-10	7.6E+00	2.00E-02	1.000	61	2.5E-03
Naphthalene	1.38E-01	4.79E-01	6.60E-02	1	0.02	2	1.3E-01	5.5E-03	2.00E-02	1.000	61	4.5E-05

BCF_{inv} = bioconcentration factor for contaminants from sedi
BCF_{sed} = bioaccumulation factor for contaminants from sedi
BW = organism body weight
C = moisture content correction factor (dry weight basi
ED = migration factor is the proportion of year in which e
g_{diet}/day = grams of dietary intake per day
HRF = home range factor (site area/home range area; est
IC = concentration in invertebrate tissue (SC x BAF_{inv})
II = daily intake concentration from invertebrates (IC x
IP = daily intake concentration from plant material (PC
IR = daily ingestion rate (wet wt)
IS = daily intake concentration from direct sediment ing
IW = daily intake concentration from direct water ingesti
kg = kilograms
mg/day = milligrams per day from food item (inv = invertebrate; plant; sed = sediment)
mg/g = milligrams per gram of food item (inv = invertebrate; plant; sed = sediment)
mg/kg/day = milligrams per kilogram body weight per day
mg/L = milligrams per liter of water
NA = not applicable
ND = contaminant not detected in medium at a concentration above its reporting limit
OD = exposure dose to the omnivore = ([II+IP+IS+IW] x HRF x ED) / BW
P = proportion of ingestion composed of food item (inv = invertebrate; plant; sed = sediment)
PC = concentration in plant material (SC x C x SCF_{sed})
SC_{max} = maximum detected concentration in sediment
WC_{max} = maximum detected concentration in surface water
wt = weight
WI = daily water ingestion rate

Table 3-12
Maximum Exposure Doses for Marsh Wren (*Cistothorus palustris*) for Exposures at Reservoir No. 2 Burning Ground, Outside the Burn Area, Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Conc. Soil mg/g_{sed} (dry wt)	BCF_{inv} mg/kg wet	IC mg/g_{inv} (wet wt)	P_{inv}	P_{soil}	IR kg_{diet}/day (Dry wt)	II mg/day inv	IS mg/day soil	HRF	ED fraction of year	BW kg	OD mg/kg/day
2,4-Dinitrotoluene	2.17E+01	3.08E+00	6.7E+01	1.00	0.02	0.0029	1.9E-01	1.3E-03	1.00E+00	0.333	0.01	6.5E+00
2,6-Dinitrotoluene	8.22E+00	2.50E+00	2.1E+01	1.00	0.02	0.0029	6.0E-02	4.8E-04	1.00E+00	0.333	0.01	2.0E+00
1,3,5-Trinitrobenzene	1.27E+00	6.61E-01	8.4E-01	1.00	0.02	0.0029	2.4E-03	7.4E-05	1.00E+00	0.333	0.01	8.4E-02
Aluminum	1.21E+04	2.20E-01	2.7E+03	1.00	0.02	0.0029	7.7E+00	7.0E-01	1.00E+00	0.333	0.01	2.8E+02
Arsenic	9.38E+00	1.10E-01	1.0E+00	1.00	0.02	0.0029	3.0E-03	5.4E-04	1.00E+00	0.333	0.01	1.2E-01
Barium	1.14E+02	2.20E-01	2.5E+01	1.00	0.02	0.0029	7.3E-02	6.6E-03	1.00E+00	0.333	0.01	2.6E+00
Cadmium	4.77E-01	9.60E-01	4.6E-01	1.00	0.02	0.0029	1.3E-03	2.8E-05	1.00E+00	0.333	0.01	4.5E-02
Cobalt	9.73E+00	2.20E-01	2.1E+00	1.00	0.02	0.0029	6.2E-03	5.6E-04	1.00E+00	0.333	0.01	2.3E-01
Chromium	1.87E+01	1.00E-02	1.9E-01	1.00	0.02	0.0029	5.4E-04	1.1E-03	1.00E+00	0.333	0.01	5.4E-02
Copper	9.99E+01	4.00E-02	4.0E+00	1.00	0.02	0.0029	1.2E-02	5.8E-03	1.00E+00	0.333	0.01	5.8E-01
Iron	2.20E+04	2.20E-01	4.8E+03	1.00	0.02	0.0029	1.4E+01	1.3E+00	1.00E+00	0.333	0.01	5.1E+02
Mercury	1.33E-01	4.00E-02	5.3E-03	1.00	0.02	0.0029	1.5E-05	7.7E-06	1.00E+00	0.333	0.01	7.7E-04
Manganese	7.85E+02	3.20E-01	2.5E+02	1.00	0.02	0.0029	7.3E-01	4.6E-02	1.00E+00	0.333	0.01	2.6E+01
Nickel	2.78E+01	2.00E-02	5.6E-01	1.00	0.02	0.0029	1.6E-03	1.6E-03	1.00E+00	0.333	0.01	1.1E-01
Lead	2.43E+02	3.00E-02	7.3E+00	1.00	0.02	0.0029	2.1E-02	1.4E-02	1.00E+00	0.333	0.01	1.2E+00
Selenium	9.67E-01	2.20E-01	2.1E-01	1.00	0.02	0.0029	6.2E-04	5.6E-05	1.00E+00	0.333	0.01	2.2E-02
Thallium	1.40E+00	2.20E-01	3.1E-01	1.00	0.02	0.0029	8.9E-04	8.1E-05	1.00E+00	0.333	0.01	3.3E-02
Vanadium	2.86E+01	2.20E-01	6.3E+00	1.00	0.02	0.0029	1.8E-02	1.7E-03	1.00E+00	0.333	0.01	6.6E-01
Zinc	1.89E+02	5.60E-01	1.1E+02	1.00	0.02	0.0029	3.1E-01	1.1E-02	1.00E+00	0.333	0.01	1.1E+01
Naphthalene	1.38E-01	3.60E+01	5.0E+00	1.00	0.02	0.0029	1.4E-02	8.0E-06	1.00E+00	0.333	0.01	4.8E-01

BCF_{inv} =	bioconcentration factor for contaminants from sediment into inver	milligrams per day from food item (inv = invertebrate; plant; sed = sediment)
BCF_{sed} =	bioaccumulation factor for contaminants from sediment into aqua	milligrams per gram of food item (inv = invertebrate; plant; sed = sediment)
BW =	organism body weight	milligrams per kilogram body weight per day
C =	moisture content correction factor (dry weight basis to wet weight	milligrams per liter of water
ED =	migration factor is the proportion of year in which exposure could	not applicable
g_{diet}/day =	grams of dietary intake per day	contaminant not detected in medium at a concentration above its reporting limit
HRF =	home range factor (site area/home range area; estimated to be 0	exposure dose to the omnivore = ([II+IP+IS+IW] x HRF x ED) / BW
IC =	concentration in invertebrate tissue (SC x BAF_{inv})	proportion of ingestion composed of food item (inv = invertebrate; plant; sed = sediment)
II =	daily intake concentration from invertebrates (IC x P_{inv} x IR)	concentration in plant material (SC x C x SCF_{sed})
IP =	daily intake concentration from plant material (PC x P_{plant} x IR)	maximum detected concentration in sediment
IR =	daily ingestion rate (wet wt)	maximum detected concentration in surface water
IS =	daily intake concentration from direct sediment ingestion (SC x P	weight
IW =	daily intake concentration from direct water ingestion (WC x IRW	daily water ingestion rate
kg =	kilograms	

Table 3-13
Maximum Exposure Doses for Deer Mouse (*Peromyscus maniculatus*) for Exposures at Reservoir No. 2 Burning Ground, Outside the Burn Area, Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Conc. Soil mg/g_{sed} (dry wt)	BCF_{inv} mg/kg wet	IC mg/g_{inv} (wet wt)	BCF_{plants} mg/kg (dry wt)	PC mg/g_{plant} (dry wt)	P_{inv}	P_{plant}	P_{soil}	IR kg_{diet}/day (Dry wt)	II mg/day inv	IP mg/day plant	IS mg/day soil	HRF	ED fraction of year	BW kg	OD mg/kg/day
2,4-Dinitrotoluene	2.17E+01	3.08E+00	6.7E+01	2.72E+00	5.89E+01	0.39	0.61	0.02	0.0028	7.3E-02	1.0E-01	1.2E-03	1.00E+00	1.000	0.0148	1.2E+01
2,6-Dinitrotoluene	8.22E+00	2.50E+00	2.1E+01	3.15E+00	2.59E+01	0.39	0.61	0.02	0.0028	2.2E-02	4.4E-02	4.6E-04	1.00E+00	1.000	0.0148	4.5E+00
1,3,5-Trinitrobenzene	1.27E+00	6.61E-01	8.4E-01	8.05E+00	1.02E+01	0.39	0.61	0.02	0.0028	9.2E-04	1.7E-02	7.1E-05	1.00E+00	1.000	0.0148	1.2E+00
Aluminum	1.21E+04	2.20E-01	2.7E+03	4.00E-03	4.83E+01	0.39	0.61	0.02	0.0028	2.9E+00	8.2E-02	6.8E-01	1.00E+00	1.000	0.0148	2.5E+02
Arsenic	9.38E+00	1.10E-01	1.0E+00	3.60E-02	3.38E-01	0.39	0.61	0.02	0.0028	1.1E-03	5.8E-04	5.3E-04	1.00E+00	1.000	0.0148	1.5E-01
Barium	1.14E+02	2.20E-01	2.5E+01	1.50E-01	1.71E+01	0.39	0.61	0.02	0.0028	2.7E-02	2.9E-02	6.4E-03	1.00E+00	1.000	0.0148	4.2E+00
Cadmium	4.77E-01	9.60E-01	4.6E-01	3.64E-01	1.74E-01	0.39	0.61	0.02	0.0028	5.0E-04	3.0E-04	2.7E-05	1.00E+00	1.000	0.0148	5.6E-02
Cobalt	9.73E+00	2.20E-01	2.1E+00	3.50E-01	3.41E+00	0.39	0.61	0.02	0.0028	2.3E-03	5.8E-03	5.5E-04	1.00E+00	1.000	0.0148	5.9E-01
Chromium	1.87E+01	1.00E-02	1.9E-01	7.50E-03	1.40E-01	0.39	0.61	0.02	0.0028	2.0E-04	2.4E-04	1.0E-03	1.00E+00	1.000	0.0148	1.0E-01
Copper	9.99E+01	4.00E-02	4.0E+00	4.00E-01	4.00E+01	0.39	0.61	0.02	0.0028	4.4E-03	6.8E-02	5.6E-03	1.00E+00	1.000	0.0148	5.3E+00
Iron	2.20E+04	2.20E-01	4.8E+03	1.00E-03	2.20E+01	0.39	0.61	0.02	0.0028	5.3E+00	3.8E-02	1.2E+00	1.00E+00	1.000	0.0148	4.4E+02
Mercury	1.33E-01	4.00E-02	5.3E-03	3.75E-02	4.99E-03	0.39	0.61	0.02	0.0028	5.8E-06	8.5E-06	7.4E-06	1.00E+00	1.000	0.0148	1.5E-03
Manganese	7.85E+02	3.20E-01	2.5E+02	5.00E-02	3.93E+01	0.39	0.61	0.02	0.0028	2.7E-01	6.7E-02	4.4E-02	1.00E+00	1.000	0.0148	2.6E+01
Nickel	2.78E+01	2.00E-02	5.6E-01	3.20E-02	8.91E-01	0.39	0.61	0.02	0.0028	6.1E-04	1.5E-03	1.6E-03	1.00E+00	1.000	0.0148	2.5E-01
Lead	2.43E+02	3.00E-02	7.3E+00	4.50E-02	1.09E+01	0.39	0.61	0.02	0.0028	8.0E-03	1.9E-02	1.4E-02	1.00E+00	1.000	0.0148	2.7E+00
Selenium	9.67E-01	2.20E-01	2.1E-01	1.60E-02	1.55E-02	0.39	0.61	0.02	0.0028	2.3E-04	2.6E-05	5.4E-05	1.00E+00	1.000	0.0148	2.1E-02
Thallium	1.40E+00	2.20E-01	3.1E-01	4.00E-03	5.61E-03	0.39	0.61	0.02	0.0028	3.4E-04	9.6E-06	7.9E-05	1.00E+00	1.000	0.0148	2.9E-02
Vanadium	2.86E+01	2.20E-01	6.3E+00	3.00E-03	8.59E-02	0.39	0.61	0.02	0.0028	6.9E-03	1.5E-04	1.6E-03	1.00E+00	1.000	0.0148	5.8E-01
Zinc	1.89E+02	5.60E-01	1.1E+02	1.20E-12	2.27E-10	0.39	0.61	0.02	0.0028	1.2E-01	3.9E-13	1.1E-02	1.00E+00	1.000	0.0148	8.5E+00
Naphthalene	1.38E-01	3.60E+01	5.0E+00	4.79E-01	6.60E-02	0.39	0.61	0.02	0.0028	5.4E-03	1.1E-04	7.7E-06	1.00E+00	1.000	0.0148	3.7E-01

BCF_{inv} = bioconcentration factor for contaminants from sediment into invertebrates (wet
BCF_{sed} = bioaccumulation factor for contaminants from sediment into aquatic plants (dry
BW = organism body weight
C = moisture content correction factor (dry weight basis to wet weight basis)
ED = migration factor is the proportion of year in which exposure could occur
g_{diet}/day = grams of dietary intake per day
HRF = home range factor (site area/home range area; estimated to be 0.85)
IC = concentration in invertebrate tissue (SC x BAF_{inv})
II = daily intake concentration from invertebrates (IC x P_{inv} x IR)
IP = daily intake concentration from plant material (PC x P_{plant} x IR)
IR = daily ingestion rate (wet wt)
IS = daily intake concentration from direct sediment ingestion (SC x P_{sed} x IR)
IW = daily intake concentration from direct water ingestion (WC x IRW)
kg = kilograms
mg/day = milligrams per day from food item (inv = invertebrate; plant; sed = sediment)
mg/g = milligrams per gram of food item (inv = invertebrate; plant; sed = sediment)
mg/kg/day = milligrams per kilogram body weight per day
mg/L = milligrams per liter of water
NA = not applicable
ND = contaminant not detected in medium at a concentration above its reporting limit
OD = exposure dose to the omnivore = ([II+IP+IS+IW] x HRF x ED) / BW
P = proportion of ingestion composed of food item (inv = invertebrate; plant; sed = sediment)
PC = concentration in plant material (SC x C x SCF_{sed})
SC_{max} = maximum detected concentration in sediment
WC_{max} = maximum detected concentration in surface water
wt = weight
WI = daily water ingestion rate

Table 3-14
Maximum Exposure Doses for Eastern Cottontail (*Sylvilagus floridanus*) for Exposures at Reservoir No. 2 Burning Ground, Outside the Burn Area, Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Conc. Soil mg/g_{sed} (dry wt)	BCF_{plants} mg/kg (dry wt)	PC mg/g_{plant} (dry wt)	P_{plant}	P_{soil}	IR kg_{diet}/day (Dry wt)	IP mg/day plant	IS mg/day soil	HRF	ED fraction of year	BW kg	OD mg/kg/day
2,4-Dinitrotoluene	2.17E+01	2.72E+00	5.89E+01	1	0.063	0.096	5.7E+00	1.3E-01	1.00E+00	1.000	1.132	5.1E+00
2,6-Dinitrotoluene	8.22E+00	3.15E+00	2.59E+01	1	0.063	0.096	2.5E+00	5.0E-02	1.00E+00	1.000	1.132	2.2E+00
1,3,5-Trinitrobenzene	1.27E+00	8.05E+00	1.02E+01	1	0.063	0.096	9.8E-01	7.7E-03	1.00E+00	1.000	1.132	8.7E-01
Aluminum	1.21E+04	4.00E-03	4.83E+01	1	0.063	0.096	4.6E+00	7.3E+01	1.00E+00	1.000	1.132	6.9E+01
Arsenic	9.38E+00	3.60E-02	3.38E-01	1	0.063	0.096	3.2E-02	5.7E-02	1.00E+00	1.000	1.132	7.9E-02
Barium	1.14E+02	1.50E-01	1.71E+01	1	0.063	0.096	1.6E+00	6.9E-01	1.00E+00	1.000	1.132	2.1E+00
Cadmium	4.77E-01	3.64E-01	1.74E-01	1	0.063	0.096	1.7E-02	2.9E-03	1.00E+00	1.000	1.132	1.7E-02
Cobalt	9.73E+00	3.50E-01	3.41E+00	1	0.063	0.096	3.3E-01	5.9E-02	1.00E+00	1.000	1.132	3.4E-01
Chromium	1.87E+01	7.50E-03	1.40E-01	1	0.063	0.096	1.3E-02	1.1E-01	1.00E+00	1.000	1.132	1.1E-01
Copper	9.99E+01	4.00E-01	4.00E+01	1	0.063	0.096	3.8E+00	6.0E-01	1.00E+00	1.000	1.132	3.9E+00
Iron	2.20E+04	1.00E-03	2.20E+01	1	0.063	0.096	2.1E+00	1.3E+02	1.00E+00	1.000	1.132	1.2E+02
Mercury	1.33E-01	3.75E-02	4.99E-03	1	0.063	0.096	4.8E-04	8.0E-04	1.00E+00	1.000	1.132	1.1E-03
Manganese	7.85E+02	5.00E-02	3.93E+01	1	0.063	0.096	3.8E+00	4.7E+00	1.00E+00	1.000	1.132	7.5E+00
Nickel	2.78E+01	3.20E-02	8.91E-01	1	0.063	0.096	8.6E-02	1.7E-01	1.00E+00	1.000	1.132	2.2E-01
Lead	2.43E+02	4.50E-02	1.09E+01	1	0.063	0.096	1.1E+00	1.5E+00	1.00E+00	1.000	1.132	2.2E+00
Selenium	9.67E-01	1.60E-02	1.55E-02	1	0.063	0.096	1.5E-03	5.8E-03	1.00E+00	1.000	1.132	6.5E-03
Thallium	1.40E+00	4.00E-03	5.61E-03	1	0.063	0.096	5.4E-04	8.5E-03	1.00E+00	1.000	1.132	8.0E-03
Vanadium	2.86E+01	3.00E-03	8.59E-02	1	0.063	0.096	8.2E-03	1.7E-01	1.00E+00	1.000	1.132	1.6E-01
Zinc	1.89E+02	1.20E-12	2.27E-10	1	0.063	0.096	2.2E-11	1.1E+00	1.00E+00	1.000	1.132	1.0E+00
Naphthalene	1.38E-01	4.79E-01	6.60E-02	1	0.063	0.096	6.3E-03	8.3E-04	1.00E+00	1.000	1.132	6.3E-03

BCF_{inv} = bioconcentration factor for contaminants from sedi
BCF_{sed} = bioaccumulation factor for contaminants from sedi
BW = organism body weight
C = moisture content correction factor (dry weight basi
ED = migration factor is the proportion of year in which e
g_{diet}/day = grams of dietary intake per day
HRF = home range factor (site area/home range area; est
IC = concentration in invertebrate tissue (SC x BAF_{inv})
II = daily intake concentration from invertebrates (IC x
IP = daily intake concentration from plant material (PC
IR = daily ingestion rate (wet wt)
IS = daily intake concentration from direct sediment ing
IW = daily intake concentration from direct water ingesti
kg = kilograms
mg/day = milligrams per day from food item (inv = invertebrate; plant; sed = sediment)
mg/g = milligrams per gram of food item (inv = invertebrate; plant; sed = sediment)
mg/kg/day = milligrams per kilogram body weight per day
mg/L = milligrams per liter of water
NA = not applicable
ND = contaminant not detected in medium at a concentration above its reporting limit
OD = exposure dose to the omnivore = ([II+IP+IS+IW] x HRF x ED) / BW
P = proportion of ingestion composed of food item (inv = invertebrate; plant; sed = sediment)
PC = concentration in plant material (SC x C x SCF_{sed})
SC_{max} = maximum detected concentration in sediment
WC_{max} = maximum detected concentration in surface water
wt = weight
WI = daily water ingestion rate

Table 3-15
Maximum Exposure Doses for Red-tailed Hawk (*Buteo jamaicensis*) for Exposures at Reservoir No. 2 Burning Ground, Outside the Burn Area, Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Conc. Soil mg/g_{sed} (dry wt)	BCF_{inv} mg/kg wet	IC mg/g_{inv} (wet wt)	BCF_{plants} mg/kg (dry wt)	VC mg/g_{vert} (dry wt)	Pvert	P_{soil}	IR kg_{diet}/day (Dry wt)	IR kg_{diet}/day (wet wt)	WI L/day	IV mg/day inv	IS mg/day soil	HRF	ED fraction of year	BW kg	OD mg/kg/day
2,4-Dinitrotoluene	2.17E+01	3.08E+00	6.7E+01	2.72E+00	1.26E+02	1.00	0.02	0.057		5.7E-02	7.2E+00	2.5E-02	1.00E-02	1.000	0.957	7.5E-02
2,6-Dinitrotoluene	8.22E+00	2.50E+00	2.1E+01	3.15E+00	4.65E+01	1.00	0.02	0.057		5.7E-02	2.6E+00	9.4E-03	1.00E-02	1.000	0.957	2.8E-02
1,3,5-Trinitrobenzene	1.27E+00	6.61E-01	8.4E-01	8.05E+00	1.11E+01	1.00	0.02	0.057		5.7E-02	6.3E-01	1.4E-03	1.00E-02	1.000	0.957	6.6E-03
Aluminum	1.21E+04	2.20E-01	2.7E+03	4.00E-03	2.70E+03	1.00	0.02	0.057		5.7E-02	1.5E+02	1.4E+01	1.00E-02	1.000	0.957	1.8E+00
Arsenic	9.38E+00	1.10E-01	1.0E+00	3.60E-02	1.37E+00	1.00	0.02	0.057		5.7E-02	7.8E-02	1.1E-02	1.00E-02	1.000	0.957	9.3E-04
Barium	1.14E+02	2.20E-01	2.5E+01	1.50E-01	4.21E+01	1.00	0.02	0.057		5.7E-02	2.4E+00	1.3E-01	1.00E-02	1.000	0.957	2.6E-02
Cadmium	4.77E-01	9.60E-01	4.6E-01	3.64E-01	6.32E-01	1.00	0.02	0.057		5.7E-02	3.6E-02	5.4E-04	1.00E-02	1.000	0.957	3.8E-04
Cobalt	9.73E+00	2.20E-01	2.1E+00	3.50E-01	5.55E+00	1.00	0.02	0.057		5.7E-02	3.2E-01	1.1E-02	1.00E-02	1.000	0.957	3.4E-03
Chromium	1.87E+01	1.00E-02	1.9E-01	7.50E-03	3.28E-01	1.00	0.02	0.057		5.7E-02	1.9E-02	2.1E-02	1.00E-02	1.000	0.957	4.2E-04
Copper	9.99E+01	4.00E-02	4.0E+00	4.00E-01	4.40E+01	1.00	0.02	0.057		5.7E-02	2.5E+00	1.1E-01	1.00E-02	1.000	0.957	2.7E-02
Iron	2.20E+04	2.20E-01	4.8E+03	1.00E-03	4.86E+03	1.00	0.02	0.057		5.7E-02	2.8E+02	2.5E+01	1.00E-02	1.000	0.957	3.2E+00
Mercury	1.33E-01	4.00E-02	5.3E-03	3.75E-02	1.03E-02	1.00	0.02	0.057		5.7E-02	5.9E-04	1.5E-04	1.00E-02	1.000	0.957	7.7E-06
Manganese	7.85E+02	3.20E-01	2.5E+02	5.00E-02	2.91E+02	1.00	0.02	0.057		5.7E-02	1.7E+01	9.0E-01	1.00E-02	1.000	0.957	1.8E-01
Nickel	2.78E+01	2.00E-02	5.6E-01	3.20E-02	1.45E+00	1.00	0.02	0.057		5.7E-02	8.3E-02	3.2E-02	1.00E-02	1.000	0.957	1.2E-03
Lead	2.43E+02	3.00E-02	7.3E+00	4.50E-02	1.82E+01	1.00	0.02	0.057		5.7E-02	1.0E+00	2.8E-01	1.00E-02	1.000	0.957	1.4E-02
Selenium	9.67E-01	2.20E-01	2.1E-01	1.60E-02	2.28E-01	1.00	0.02	0.057		5.7E-02	1.3E-02	1.1E-03	1.00E-02	1.000	0.957	1.5E-04
Thallium	1.40E+00	2.20E-01	3.1E-01	4.00E-03	3.14E-01	1.00	0.02	0.057		5.7E-02	1.8E-02	1.6E-03	1.00E-02	1.000	0.957	2.0E-04
Vanadium	2.86E+01	2.20E-01	6.3E+00	3.00E-03	6.38E+00	1.00	0.02	0.057		5.7E-02	3.6E-01	3.3E-02	1.00E-02	1.000	0.957	4.1E-03
Zinc	1.89E+02	5.60E-01	1.1E+02	1.20E-12	1.06E+02	1.00	0.02	0.057		5.7E-02	6.0E+00	2.2E-01	1.00E-02	1.000	0.957	6.5E-02
Naphthalene	1.38E-01	3.60E+01	5.0E+00	4.79E-01	5.03E+00	1.00	0.02	0.057		5.7E-02	2.9E-01	1.6E-04	1.00E-02	1.000	0.957	3.0E-03

BCF_{inv} = bioconcentration factor for contaminants from sediment into invertebrates (wet w
BCF_{sed} = bioaccumulation factor for contaminants from sediment into aquatic plants (dry w
BW = organism body weight
C = moisture content correction factor (dry weight basis to wet weight basis)
ED = migration factor is the proportion of year in which exposure could occur
g_{diet}/day = grams of dietary intake per day
HRF = home range factor (site area/home range area; estimated to be 0.85)
IC = concentration in invertebrate tissue (SC x BAF_{inv})
II = daily intake concentration from invertebrates (IC x P_{inv} x IR)
IP = daily intake concentration from plant material (PC x P_{plant} x IR)
IR = daily ingestion rate (wet wt)
IS = daily intake concentration from direct sediment ingestion (SC x P_{sed} x IR)
IW = daily intake concentration from direct water ingestion (WC x IRW)
kg = kilograms
mg/day = milligrams per day from food item (inv = invertebrate; plant; sed = sediment)
mg/g = milligrams per gram of food item (inv = invertebrate; plant; sed = sediment)
mg/kg/day = milligrams per kilogram body weight per day
mg/L = milligrams per liter of water
NA = not applicable
ND = contaminant not detected in medium at a concentration above its reporting limit
OD = exposure dose to the omnivore = ([II+IP+IS+IW] x HRF x ED) / BW
P = proportion of ingestion composed of food item (inv = invertebrate; plant; sed = sediment)
PC = concentration in plant material (SC x C x SCF_{sed})
SC_{max} = maximum detected concentration in sediment
WC_{max} = maximum detected concentration in surface water
wt = weight
WI = daily water ingestion rate

Table 3-16
Maximum Exposure Doses for Raccoon (*Procyon lotor*) for
Exposures at Reservoir No. 2 Burning Ground, Outside the Burn Area,
Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Conc. Soil mg/g_{sed} (dry wt)	BCF_{inv} mg/kg wet	IC mg/g_{inv} (wet wt)	BCF_{plants} mg/kg (dry wt)	VC mg/g_{vert} (dry wt)	PC mg/g_{plant} (dry wt)	P_{vert}	P_{inv}	P_{plant}	P_{soil}	IR kg_{diet}/day (Dry wt)	WI L/day	II mg/day inv	IV mg/day vert	IP mg/day plant	IS mg/day soil	HRF	ED fraction of year	BW kg	OD mg/kg/day
2,4-Dinitrotoluene	2.17E+01	3.08E+00	6.7E+01	2.72E+00	1.51E+03	5.89E+01	0.05	0.51	0.42	0.094	0.26	4.3E-01	8.9E+00	2.0E+02	6.4E+00	5.3E-01	1.00E-01	0.667	5.1	2.8E+00
2,6-Dinitrotoluene	8.22E+00	2.50E+00	2.1E+01	3.15E+00	1.95E+02	2.59E+01	0.05	0.51	0.42	0.094	0.26	4.3E-01	2.7E+00	2.6E+01	2.8E+00	2.0E-01	1.00E-01	0.667	5.1	4.1E-01
2,4,6-Trinitrotoluene	6.06E+02	4.97E+00	3.0E+03	1.94E+00	1.83E+06	1.17E+03	0.05	0.51	0.42	0.094	0.26	4.3E-01	4.0E+02	2.4E+05	1.3E+02	1.5E+01	1.00E-01	0.667	5.1	3.2E+03
1,3,5-Trinitrobenzene	1.27E+00	6.61E-01	8.4E-01	8.05E+00	1.13E+01	1.02E+01	0.05	0.51	0.42	0.094	0.26	4.3E-01	1.1E-01	1.5E+00	1.1E+00	3.1E-02	1.00E-01	0.667	5.1	3.6E-02
Aluminum	1.21E+04	2.20E-01	2.7E+03	4.00E-03	3.21E+07	4.83E+01	0.05	0.51	0.42	0.094	0.26	4.3E-01	3.5E+02	4.3E+06	5.3E+00	3.0E+02	1.00E-01	0.667	5.1	5.6E+04
Arsenic	9.38E+00	1.10E-01	1.0E+00	3.60E-02	1.00E+01	3.38E-01	0.05	0.51	0.42	0.094	0.26	4.3E-01	1.4E-01	1.3E+00	3.7E-02	2.3E-01	1.00E-01	0.667	5.1	2.3E-02
Barium	1.14E+02	2.20E-01	2.5E+01	1.50E-01	2.86E+03	1.71E+01	0.05	0.51	0.42	0.094	0.26	4.3E-01	3.3E+00	3.8E+02	1.9E+00	2.8E+00	1.00E-01	0.667	5.1	5.1E+00
Cadmium	4.77E-01	9.60E-01	4.6E-01	3.64E-01	3.92E-01	1.74E-01	0.05	0.51	0.42	0.094	0.26	4.3E-01	6.1E-02	5.2E-02	1.9E-02	1.2E-02	1.00E-01	0.667	5.1	1.9E-03
Cobalt	9.73E+00	2.20E-01	2.1E+00	3.50E-01	2.42E+01	3.41E+00	0.05	0.51	0.42	0.094	0.26	4.3E-01	2.8E-01	3.2E+00	3.7E-01	2.4E-01	1.00E-01	0.667	5.1	5.4E-02
Chromium	1.87E+01	1.00E-02	1.9E-01	7.50E-03	3.64E+00	1.40E-01	0.05	0.51	0.42	0.094	0.26	4.3E-01	2.5E-02	4.8E-01	1.5E-02	4.6E-01	1.00E-01	0.667	5.1	1.3E-02
Copper	9.99E+01	4.00E-02	4.0E+00	4.00E-01	4.39E+02	4.00E+01	0.05	0.51	0.42	0.094	0.26	4.3E-01	5.3E-01	5.8E+01	4.4E+00	2.4E+00	1.00E-01	0.667	5.1	8.6E-01
Iron	2.20E+04	2.20E-01	4.8E+03	1.00E-03	1.06E+08	2.20E+01	0.05	0.51	0.42	0.094	0.26	4.3E-01	6.4E+02	1.4E+07	2.4E+00	5.4E+02	1.00E-01	0.667	5.1	1.8E+05
Mercury	1.33E-01	4.00E-02	5.3E-03	3.75E-02	5.70E-03	4.99E-03	0.05	0.51	0.42	0.094	0.26	4.3E-01	7.1E-04	7.6E-04	5.4E-04	3.3E-03	1.00E-01	0.667	5.1	6.9E-05
Manganese	7.85E+02	3.20E-01	2.5E+02	5.00E-02	1.97E+05	3.93E+01	0.05	0.51	0.42	0.094	0.26	4.3E-01	3.3E+01	2.6E+04	4.3E+00	1.9E+01	1.00E-01	0.667	5.1	3.4E+02
Nickel	2.78E+01	2.00E-02	5.6E-01	3.20E-02	1.64E+01	8.91E-01	0.05	0.51	0.42	0.094	0.26	4.3E-01	7.4E-02	2.2E+00	9.7E-02	6.8E-01	1.00E-01	0.667	5.1	4.0E-02
Lead	2.43E+02	3.00E-02	7.3E+00	4.50E-02	1.79E+03	1.09E+01	0.05	0.51	0.42	0.094	0.26	4.3E-01	9.7E-01	2.4E+02	1.2E+00	5.9E+00	1.00E-01	0.667	5.1	3.2E+00
Selenium	9.67E-01	2.20E-01	2.1E-01	1.60E-02	2.21E-01	1.55E-02	0.05	0.51	0.42	0.094	0.26	4.3E-01	2.8E-02	2.9E-02	1.7E-03	2.4E-02	1.00E-01	0.667	5.1	1.1E-03
Thallium	1.40E+00	2.20E-01	3.1E-01	4.00E-03	4.38E-01	5.61E-03	0.05	0.51	0.42	0.094	0.26	4.3E-01	4.1E-02	5.8E-02	6.1E-04	3.4E-02	1.00E-01	0.667	5.1	1.7E-03
Vanadium	2.86E+01	2.20E-01	6.3E+00	3.00E-03	1.80E+02	8.59E-02	0.05	0.51	0.42	0.094	0.26	4.3E-01	8.3E-01	2.4E+01	9.4E-03	7.0E-01	1.00E-01	0.667	5.1	3.3E-01
Zinc	1.89E+02	5.60E-01	1.1E+02	1.20E-12	2.01E+04	2.27E-10	0.05	0.51	0.42	0.094	0.26	4.3E-01	1.4E+01	2.7E+03	2.5E-11	4.6E+00	1.00E-01	0.667	5.1	3.5E+01

BCF_{inv} = bioconcentration factor for contaminants from sediment into invertebrates (wet
BCF_{sed} = bioaccumulation factor for contaminants from sediment into aquatic plants (dry
BW = organism body weight
C = moisture content correction factor (dry weight basis to wet weight basis)
ED = migration factor is the proportion of year in which exposure could occur
g_{diet}/day = grams of dietary intake per day
HRF = home range factor (site area/home range area; estimated to be 0.85)
IC = concentration in invertebrate tissue (SC x BAF_{inv})
II = daily intake concentration from invertebrates (IC x P_{inv} x IR)
IP = daily intake concentration from plant material (PC x P_{plant} x IR)
IR = daily ingestion rate (wet wt)
IS = daily intake concentration from direct sediment ingestion (SC x P_{sed} x IR)
IW = daily intake concentration from direct water ingestion (WC x IRW)
kg = kilograms

mg/day = mg/day = milligr milligrams per day from food item (inv = invertebrate; plant; sed = sediment)
mg/g = mg/g = milligr milligrams per gram of food item (inv = invertebrate; plant; sed = sediment)
mg/kg/day = mg/kg/day = milligr milligrams per kilogram body weight per day
mg/L = mg/L = milligr milligrams per liter of water
NA = NA = not ap not applicable
ND = ND = contar contaminant not detected in medium at a concentration above its reporting limit
OD = OD = expos exposure dose to the omnivore = ([II+IP+IS+IW] x HRF x ED) / BW
P = P = propor proportion of ingestion composed of food item (inv = invertebrate; plant; sed = sediment)
PC = PC = conce concentration in plant material (SC x C x SCF_{sed})
SC_{max} = SC_{max} = maxim maximum detected concentration in sediment
WC_{max} = WC_{max} = maxim maximum detected concentration in surface water
wt = wt = weigh weight
WI = WI = daily w daily water ingestion rate

Table 4-1
Toxicity Reference Values,
Plum Brook Ordnance Works, Sandusky, Ohio

		Mammals			Birds			Source	
Method Group	Chemical Name	NOAEL (mg/kg/d)	Test Species	Body Wt. (kg)	NOAEL (mg/kg/d)	Test Species	Body Wt. (kg)	Mammals	Birds
DIO	2,3,7,8-TCDD TEQ	1.00E-06	rat	0.35					
HE	1,3,5-Trinitrobenzene	--	--	--	--	--	--	--	--
HE	2,4,6-Trinitrotoluene	1.60E+00	rat	0.35	7.00E-01	Bobwhite quail	0.19	Talmage et. al (1996)	Talmage et. al (1996)
HE	2,4-Dinitrotoluene	2.00E-01	beagle dog	11	7.00E-01	Bobwhite quail	0.19	IRIS	2,4,6-TNT as surrogate
HE	2,6-Dinitrotoluene	2.00E-01	beagle dog	11	7.00E-01	Bobwhite quail	0.19	2,4-DNT as surrogate	2,4,6-TNT as surrogate
MET	Aluminum	1.93E+00	mouse	0.03	1.10E+02	ringed dove	0.155	Sample et al. 1996	Sample et al. 1996
MET	Antimony	1.25E+00	mouse	0.03	--	--	--	ORNL TM86r3	--
MET	Arsenic	1.25E+00	mouse	0.03	2.46E+00	Brown-headed cowbird	--	ORNL TM86r3	EPA 1999
MET	Barium	5.10E+00	rat	0.435	2.08E+01	chicks	0.121	Sample et al. 1996	Sample et al. 1996
MET	Beryllium	6.60E-02	rat	0.273	--	--	--	Sample et al. 1996	Sample et al. 1996
MET	Cadmium	1.00E+00	rat	0.303	1.45E+00	mallard duck	1.153	Sample et al. 1996	Sample et al. 1996
MET	Chromium	2.74E+00	rat	0.35	1.00E+00	black duck	1.25	Sample et al. 1996	Sample et al. 1996
MET	Cobalt	1.20E+00	rat	0.35	--	--	--	Sample et al. 1996	Sample et al. 1996
MET	Copper	1.17E+01	mink	1	4.70E+01	chicks	0.534	Sample et al. 1996	Sample et al. 1996
MET	Iron	2.60E+01	rabbit	3.8	5.00E+01	poultry	1.6	Sample et al. 1996	Sample et al. 1996
MET	Lead	8.00E+00	rat	0.35	3.85E+00	Am. Kestrel	0.13	Sample et al. 1996	Sample et al. 1996
MET	Manganese	8.80E+01	rat	0.35	9.77E+02	Jap. Quail	0.072	Sample et al. 1996	Sample et al. 1996
MET	Mercury	1.00E+00	mink	1	4.50E-01	Jap. Quail	0.15	Sample et al. 1996	Sample et al. 1996
MET	Nickel	4.00E+01	rat	0.35	7.74E+01	mallard duck	0.782	Sample et al. 1996	Sample et al. 1996
MET	Selenium	2.00E-01	rat	0.35	5.00E-01	mallard duck	1	Sample et al. 1996	Sample et al. 1996
MET	Thallium	7.40E-02	rat	0.365	3.50E-01	Starling	--	Sample et al. 1996	EPA 1999
MET	Vanadium	2.10E-01	rat	0.26	1.14E+01	Mallard Duck	1.17	ORNL TM86r3	ORNL TM86r3
MET	Zinc	1.60E+02	rat	0.35	1.45E+01	hens	1.935	Sample et al. 1996	Sample et al. 1996
PAH	Acenaphthene	1.00E+00	mouse	0.03	--	--	--	Benzo(a)pyrene as surrogate	--
SV	Naphthalene	1.00E+00	mouse	0.03	--	--	--	Benzo(a)pyrene as surrogate	--

Table 5-1
Hazard Quotients for Short-tailed Shrew (*Blarina brevicauda*)
for Exposures at Reservoir No. 2 Burning Ground, Inside the Burn Area,
Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Effect Dose (mg/kg/day)	Exposure Dose Maximum (mg/kg/day)	HQ[1]
2,4-Dinitrotoluene	2.00E-01	1.75E+01	**9E+01**
2,6-Dinitrotoluene	2.00E-01	4.08E+00	**2E+01**
1,3,5-Trinitrobenzene	--	1.68E-01	NA
Silver	3.75E-01	9.41E-03	3E-02
Aluminum	1.93E+00	5.30E+02	**3E+02**
Arsenic	1.25E+00	2.46E-01	2E-01
Barium	5.10E+00	5.54E+00	**1E+00**
Beryllium	6.60E-02	3.11E-02	5E-01
Cadmium	1.00E+00	7.72E-02	8E-02
Cobalt	1.20E+00	3.66E-01	3E-01
Chromium	2.74E+00	3.01E-01	1E-01
Copper	1.17E+01	2.70E+00	2E-01
Iron	2.60E+01	9.40E+02	**4E+01**
Mercury	1.00E+00	3.51E-03	4E-03
Manganese	8.80E+01	1.91E+01	2E-01
Nickel	4.00E+01	4.07E-01	1E-02
Lead	8.00E+00	4.67E+00	6E-01
Selenium	2.00E-01	4.41E-02	2E-01
Thallium	7.40E-02	6.62E-02	9E-01
Vanadium	2.10E-01	1.23E+00	**6E+00**
Zinc	1.60E+02	1.84E+01	1E-01
Naphthalene	1.00E+00	9.08E-01	9E-01

Notes:

1-Values with bold and shading indicate an elevated potential for adverse ecological effects.

HQ = COPEC-specific hazard quotient

mg/kg/day = milligrams COPEC per kilogram body weight per day

Table 5-2
Hazard Quotients for White-tailed Deer (*Odocoileus virginianus*)
for Exposures at Reservoir No. 2 Burning Ground, Inside the Burn Area,
Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Effect Dose (mg/kg/day)	Exposure Dose Maximum (mg/kg/day)	HQ[1]
2,3,7,8-TCDD TEQ	1.00E-06	6.23E-09	6E-03
2,4-Dinitrotoluene	2.00E-01	1.25E+01	**6E+01**
2,6-Dinitrotoluene	2.00E-01	4.98E-01	**2E+00**
1,3,5-Trinitrobenzene	--	2.71E-01	NA
Aluminum	1.93E+00	1.79E-01	9E-02
Arsenic	1.25E+00	4.53E-04	4E-04
Barium	5.10E+00	3.08E-01	6E-02
Beryllium	6.60E-02	1.55E-05	2E-04
Cadmium	1.00E+00	2.78E-04	3E-04
Cobalt	1.20E+00	3.13E-03	3E-03
Chromium	2.74E+00	5.25E-04	2E-04
Copper	1.17E+01	7.80E-02	7E-03
Iron	2.60E+01	3.56E-01	1E-02
Mercury	1.00E+00	7.05E-06	7E-06
Manganese	8.80E+01	2.57E-02	3E-04
Nickel	4.00E+01	1.81E-03	5E-05
Lead	8.00E+00	8.69E-02	1E-02
Antimony	1.25E+00	3.61E-04	3E-04
Selenium	2.00E-01	4.39E-05	2E-04
Thallium	7.40E-02	3.37E-05	5E-04
Vanadium	2.10E-01	4.20E-04	2E-03
Zinc	1.60E+02	6.18E-03	4E-05
Acenaphthene	1.00E+00	2.43E-03	2E-03
Naphthalene	1.00E+00	3.95E-03	4E-03

Notes:

1-Values with bold and shading indicate an elevated potential for adverse ecological effects.

HQ = COPEC-specific hazard quotient

mg/kg/day = milligrams COPEC per kilogram body weight per day

Table 5-3
Hazard Quotients for Marsh Wren (*Cistothorus palustris*)
for Exposures at Reservoir No. 2 Burning Ground, Inside the Burn Area,
Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Effect Dose (mg/kg/day)	Exposure Dose Maximum (mg/kg/day)	HQ[1]
2,3,7,8-TCDD TEQ	1.00E-06	5.78E-05	**6E+01**
2,4-Dinitrotoluene	2.00E-01	2.09E+03	**1E+04**
2,6-Dinitrotoluene	2.00E-01	5.84E+01	**3E+02**
1,3,5-Trinitrobenzene	--	3.37E+00	NA
Aluminum	1.93E+00	2.64E+02	**1E+02**
Arsenic	1.25E+00	1.55E-01	1E-01
Barium	5.10E+00	6.41E+01	**1E+01**
Beryllium	6.60E-02	1.83E-02	3E-01
Cadmium	1.00E+00	1.05E-01	1E-01
Cobalt	1.20E+00	3.00E-01	2E-01
Chromium	2.74E+00	8.45E-02	3E-02
Copper	1.17E+01	1.64E+00	1E-01
Iron	2.60E+01	5.99E+02	**2E+01**
Mercury	1.00E+00	1.08E-03	1E-03
Manganese	8.80E+01	1.84E+01	2E-01
Nickel	4.00E+01	2.05E-01	5E-03
Lead	8.00E+00	9.86E+00	**1E+00**
Antimony	1.25E+00	5.80E-02	5E-02
Selenium	2.00E-01	4.31E-02	2E-01
Thallium	7.40E-02	4.97E-02	7E-01
Vanadium	2.10E-01	6.46E-01	**3E+00**
Zinc	1.60E+02	2.64E+01	2E-01
Acenaphthene	1.00E+00	1.81E+02	**2E+02**
Naphthalene	1.00E+00	4.21E+01	**4E+01**

Notes:

1-Values with bold and shading indicate an elevated potential for adverse ecological effects.

HQ = COPEC-specific hazard quotient

mg/kg/day = milligrams COPEC per kilogram body weight per day

Table 5-4
Hazard Quotients for Deer Mouse (*Peromyscus maniculatus*)
for Exposures at Reservoir No. 2 Burning Ground, Inside the Burn Area,
Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Effect Dose (mg/kg/day)	Exposure Dose Maximum (mg/kg/day)	HQ[1]
2,3,7,8-TCDD TEQ	1.00E-06	4.52E-05	**5E+01**
2,4-Dinitrotoluene	2.00E-01	3.80E+03	**2E+04**
2,6-Dinitrotoluene	2.00E-01	1.32E+02	**7E+02**
1,3,5-Trinitrobenzene	--	5.02E+01	NA
Aluminum	1.93E+00	2.33E+02	**1E+02**
Arsenic	1.25E+00	1.98E-01	2E-01
Barium	5.10E+00	1.03E+02	**2E+01**
Beryllium	6.60E-02	1.67E-02	3E-01
Cadmium	1.00E+00	1.29E-01	1E-01
Cobalt	1.20E+00	7.80E-01	6E-01
Chromium	2.74E+00	1.57E-01	6E-02
Copper	1.17E+01	1.50E+01	**1E+00**
Iron	2.60E+01	5.20E+02	**2E+01**
Mercury	1.00E+00	2.07E-03	2E-03
Manganese	8.80E+01	1.85E+01	2E-01
Nickel	4.00E+01	4.74E-01	1E-02
Lead	8.00E+00	2.28E+01	**3E+00**
Antimony	1.25E+00	1.08E-01	9E-02
Selenium	2.00E-01	4.06E-02	2E-01
Thallium	7.40E-02	4.38E-02	6E-01
Vanadium	2.10E-01	5.67E-01	**3E+00**
Zinc	1.60E+02	2.13E+01	1E-01
Acenaphthene	1.00E+00	1.39E+02	**1E+02**
Naphthalene	1.00E+00	3.28E+01	**3E+01**

Notes:

1-Values with bold and shading indicate an elevated potential for adverse ecological effects.

HQ = COPEC-specific hazard quotient

mg/kg/day = milligrams COPEC per kilogram body weight per day

Table 5-5
Hazard Quotients for Eastern Cottontail (*Sylvilagus floridanus*)
for Exposures at Reservoir No. 2 Burning Ground, Inside the Burn Area,
Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Effect Dose (mg/kg/day)	Exposure Dose Maximum (mg/kg/day)	HQ[1]
2,3,7,8-TCDD TEQ	1.00E-06	2.16E-06	**2E+00**
2,4-Dinitrotoluene	2.00E-01	1.65E+03	**8E+03**
2,6-Dinitrotoluene	2.00E-01	6.53E+01	**3E+02**
1,3,5-Trinitrobenzene	--	3.52E+01	NA
Aluminum	1.93E+00	6.47E+01	**3E+01**
Arsenic	1.25E+00	1.04E-01	8E-02
Barium	5.10E+00	4.99E+01	**1E+01**
Beryllium	6.60E-02	4.87E-03	7E-02
Cadmium	1.00E+00	4.00E-02	4E-02
Cobalt	1.20E+00	4.52E-01	4E-01
Chromium	2.74E+00	1.74E-01	6E-02
Copper	1.17E+01	1.11E+01	1E+00
Iron	2.60E+01	1.40E+02	**5E+00**
Mercury	1.00E+00	1.59E-03	2E-03
Manganese	8.80E+01	5.36E+00	6E-02
Nickel	4.00E+01	4.27E-01	1E-02
Lead	8.00E+00	1.87E+01	**2E+00**
Antimony	1.25E+00	5.58E-02	4E-02
Selenium	2.00E-01	1.24E-02	6E-02
Thallium	7.40E-02	1.22E-02	2E-01
Vanadium	2.10E-01	1.56E-01	7E-01
Zinc	1.60E+02	2.52E+00	2E-02
Acenaphthene	1.00E+00	3.74E-01	4E-01
Naphthalene	1.00E+00	5.55E-01	6E-01

Notes:

1-Values with bold and shading indicate an elevated potential for adverse ecological effects.

HQ = COPEC-specific hazard quotient

mg/kg/day = milligrams COPEC per kilogram body weight per day

Table 5-6
Hazard Quotients for Red-tailed Hawk (*Buteo jamaicensis*)
for Exposures at Reservoir No. 2 Burning Ground, Inside the Burn Area,
Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Effect Dose (mg/kg/day)	Exposure Dose Maximum (mg/kg/day)	HQ[1]
2,3,7,8-TCDD TEQ	1.00E-06	3.57E-07	4E-01
2,4-Dinitrotoluene	2.00E-01	2.42E+01	**1E+02**
2,6-Dinitrotoluene	2.00E-01	8.09E-01	**4E+00**
1,3,5-Trinitrobenzene	--	2.66E-01	NA
Aluminum	1.93E+00	1.65E+00	9E-01
Arsenic	1.25E+00	1.22E-03	1E-03
Barium	5.10E+00	6.42E-01	1E-01
Beryllium	6.60E-02	1.17E-04	2E-03
Cadmium	1.00E+00	8.84E-04	9E-04
Cobalt	1.20E+00	4.54E-03	4E-03
Chromium	2.74E+00	6.51E-04	2E-04
Copper	1.17E+01	7.76E-02	7E-03
Iron	2.60E+01	3.71E+00	1E-01
Mercury	1.00E+00	1.09E-05	1E-05
Manganese	8.80E+01	1.30E-01	1E-03
Nickel	4.00E+01	2.27E-03	6E-05
Lead	8.00E+00	1.15E-01	1E-02
Antimony	1.25E+00	6.56E-04	5E-04
Selenium	2.00E-01	2.83E-04	1E-03
Thallium	7.40E-02	3.11E-04	4E-03
Vanadium	2.10E-01	4.03E-03	2E-02
Zinc	1.60E+02	1.63E-01	1E-03
Acenaphthene	1.00E+00	1.12E+00	**1E+00**
Naphthalene	1.00E+00	2.63E-01	3E-01

Notes:

1-Values with bold and shading indicate an elevated potential for adverse ecological effects.

HQ = COPEC-specific hazard quotient

mg/kg/day = milligrams COPEC per kilogram body weight per day

Table 5-7
Hazard Quotients for Raccoon (*Procyon lotor*)
for Exposures at Reservoir No. 2 Burning Ground, Inside the Burn Area,
Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Effect Dose (mg/kg/day)	Exposure Dose Maximum (mg/kg/day)	HQ[1]
2,3,7,8-TCDD TEQ	1.00E-06	1.09E-05	**1E+01**
2,4-Dinitrotoluene	2.00E-01	2.11E+01	**1E+02**
2,6-Dinitrotoluene	2.00E-01	8.31E-01	**4E+00**
2,4,6-Trinitrotoluene	1.60E+00	1.34E+01	**8E+00**
1,3,5-Trinitrobenzene	--	4.38E-01	NA
Aluminum	1.93E+00	2.23E+00	**1E+00**
Arsenic	1.25E+00	2.83E-03	2E-03
Barium	5.10E+00	9.61E-01	2E-01
Beryllium	6.60E-02	1.59E-04	2E-03
Cadmium	1.00E+00	6.30E-04	6E-04
Cobalt	1.20E+00	7.17E-03	6E-03
Chromium	2.74E+00	5.81E-03	2E-03
Copper	1.17E+01	1.72E-01	1E-02
Iron	2.60E+01	4.98E+00	2E-01
Mercury	1.00E+00	4.31E-05	4E-05
Manganese	8.80E+01	1.36E-01	2E-03
Nickel	4.00E+01	1.19E-02	3E-04
Lead	8.00E+00	4.86E-01	6E-02
Antimony	1.25E+00	1.00E-03	8E-04
Selenium	2.00E-01	3.87E-04	2E-03
Thallium	7.40E-02	4.19E-04	6E-03
Vanadium	2.10E-01	5.43E-03	3E-02
Zinc	1.60E+02	9.04E-02	6E-04
Acenaphthene	1.00E+00	6.62E-03	7E-03
Naphthalene	1.00E+00	8.33E-03	8E-03

Notes:

1-Values with bold and shading indicate an elevated potential for adverse ecological effects.

HQ = COPEC-specific hazard quotient

mg/kg/day = milligrams COPEC per kilogram body weight per day

Table 5-8
Hazard Quotients for Short-tailed Shrew (*Blarina brevicauda*) for Exposures at Reservoir No. 2, Outside the Burn Area, Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Effect Dose (mg/kg/day)	Exposure Dose Maximum (mg/kg/day)	HQ[1]
2,4-Dinitrotoluene	7.00E-01	1.01E+01	**1E+01**
2,6-Dinitrotoluene	7.00E-01	3.14E+00	**4E+00**
1,3,5-Trinitrobenzene	--	1.42E-01	NA
Aluminum	1.10E+02	5.74E+02	**5E+00**
Arsenic	2.46E+00	2.94E-01	1E-01
Barium	2.08E+01	5.40E+00	3E-01
Cadmium	1.45E+00	7.44E-02	5E-02
Cobalt	--	4.63E-01	NA
Chromium	1.00E+00	3.13E-01	3E-01
Copper	4.70E+01	2.11E+00	4E-02
Iron	5.00E+01	1.04E+03	**2E+01**
Mercury	4.50E-01	2.81E-03	6E-03
Manganese	9.77E+02	4.88E+01	5E-02
Nickel	7.74E+01	5.06E-01	7E-03
Lead	3.85E+00	4.78E+00	**1E+00**
Selenium	5.00E-01	4.60E-02	9E-02
Thallium	3.50E-01	6.66E-02	2E-01
Vanadium	1.14E+01	1.36E+00	1E-01
Zinc	1.45E+01	1.84E+01	**1E+00**
Naphthalene	--	7.30E-01	NA

Notes:

1-Values with bold and shading indicate an elevated potential for adverse ecological effects.

HQ = COPEC-specific hazard quotient

mg/kg/day = milligrams COPEC per kilogram body weight per day

Table 5-9
Hazard Quotients for White-tailed Deer (*Odocoileus virginianus*)
for Exposures at Reservoir No. 2 Burning Ground, Outside the Burn Area,
Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Effect Dose (mg/kg/day)	Exposure Dose Maximum (mg/kg/day)	HQ[1]
2,4-Dinitrotoluene	2.00E-01	3.89E-02	2E-01
2,6-Dinitrotoluene	2.00E-01	1.71E-02	9E-02
1,3,5-Trinitrobenzene	--	6.72E-03	NA
Aluminum	1.93E+00	1.90E-01	1E-01
Arsenic	1.25E+00	3.45E-04	3E-04
Barium	5.10E+00	1.27E-02	2E-03
Cadmium	1.00E+00	1.20E-04	1E-04
Cobalt	1.20E+00	2.36E-03	2E-03
Chromium	2.74E+00	3.38E-04	1E-04
Copper	1.17E+01	2.75E-02	2E-03
Iron	2.60E+01	3.03E-01	1E-02
Mercury	1.00E+00	5.01E-06	5E-06
Manganese	8.80E+01	3.60E-02	4E-04
Nickel	4.00E+01	9.49E-04	2E-05
Lead	8.00E+00	1.04E-02	1E-03
Selenium	2.00E-01	2.28E-05	1E-04
Thallium	7.40E-02	2.21E-05	3E-04
Vanadium	2.10E-01	4.32E-04	2E-03
Zinc	1.60E+02	2.48E-03	2E-05
Naphthalene	1.00E+00	4.51E-05	5E-05

Notes:

1-Values with bold and shading indicate an elevated potential for adverse ecological effects.

HQ = COPEC-specific hazard quotient

mg/kg/day = milligrams COPEC per kilogram body weight per day

Table 5-10
Hazard Quotients for Marsh Wren (*Cistothorus palustris*)
for Exposures at Reservoir No. 2 Burning Ground, Outside the Burn Area,
Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Effect Dose (mg/kg/day)	Exposure Dose Maximum (mg/kg/day)	HQ[1]
2,4-Dinitrotoluene	2.00E-01	6.50E+00	**3E+01**
2,6-Dinitrotoluene	2.00E-01	2.00E+00	**1E+01**
1,3,5-Trinitrobenzene	--	8.36E-02	NA
Aluminum	1.93E+00	2.80E+02	**1E+02**
Arsenic	1.25E+00	1.18E-01	9E-02
Barium	5.10E+00	2.64E+00	5E-01
Cadmium	1.00E+00	4.52E-02	5E-02
Cobalt	1.20E+00	2.26E-01	2E-01
Chromium	2.74E+00	5.43E-02	2E-02
Copper	1.17E+01	5.80E-01	5E-02
Iron	2.60E+01	5.10E+02	**2E+01**
Mercury	1.00E+00	7.71E-04	8E-04
Manganese	8.80E+01	2.58E+01	3E-01
Nickel	4.00E+01	1.08E-01	3E-03
Lead	8.00E+00	1.18E+00	1E-01
Selenium	2.00E-01	2.24E-02	1E-01
Thallium	7.40E-02	3.25E-02	4E-01
Vanadium	2.10E-01	6.64E-01	**3E+00**
Zinc	1.60E+02	1.06E+01	7E-02
Naphthalene	1.00E+00	4.80E-01	5E-01

Notes:

1-Values with bold and shading indicate an elevated potential for adverse ecological effects.

HQ = COPEC-specific hazard quotient

mg/kg/day = milligrams COPEC per kilogram body weight per day

Table 5-11
Hazard Quotients for Deer Mouse (*Peromyscus maniculatus*)
for Exposures at Reservoir No. 2 Burning Ground, Outside the Burn Area,
Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Effect Dose (mg/kg/day)	Exposure Dose Maximum (mg/kg/day)	HQ[1]
2,4-Dinitrotoluene	2.00E-01	1.18E+01	**6E+01**
2,6-Dinitrotoluene	2.00E-01	4.54E+00	**2E+01**
1,3,5-Trinitrobenzene	--	1.25E+00	NA
Aluminum	1.93E+00	2.47E+02	**1E+02**
Arsenic	1.25E+00	1.51E-01	1E-01
Barium	5.10E+00	4.24E+00	8E-01
Cadmium	1.00E+00	5.56E-02	6E-02
Cobalt	1.20E+00	5.88E-01	5E-01
Chromium	2.74E+00	1.01E-01	4E-02
Copper	1.17E+01	5.29E+00	5E-01
Iron	2.60E+01	4.43E+02	**2E+01**
Mercury	1.00E+00	1.47E-03	1E-03
Manganese	8.80E+01	2.60E+01	3E-01
Nickel	4.00E+01	2.49E-01	6E-03
Lead	8.00E+00	2.72E+00	3E-01
Selenium	2.00E-01	2.11E-02	1E-01
Thallium	7.40E-02	2.87E-02	4E-01
Vanadium	2.10E-01	5.83E-01	**3E+00**
Zinc	1.60E+02	8.54E+00	5E-02
Naphthalene	1.00E+00	3.75E-01	4E-01

Notes:

1-Values with bold and shading indicate an elevated potential for adverse ecological effects.

HQ = COPEC-specific hazard quotient

mg/kg/day = milligrams COPEC per kilogram body weight per day

Table 5-12
Hazard Quotients for Eastern Cottontail (*Sylvilagus floridanus*)
for Exposures at Reservoir No. 2 Burning Ground, Outside the Burn Area,
Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Effect Dose (mg/kg/day)	Exposure Dose Maximum (mg/kg/day)	HQ[1]
2,4-Dinitrotoluene	2.00E-01	5.11E+00	**3E+01**
2,6-Dinitrotoluene	2.00E-01	2.24E+00	**1E+01**
1,3,5-Trinitrobenzene	--	8.73E-01	NA
Aluminum	1.93E+00	6.86E+01	**4E+01**
Arsenic	1.25E+00	7.88E-02	6E-02
Barium	5.10E+00	2.05E+00	4E-01
Cadmium	1.00E+00	1.73E-02	2E-02
Cobalt	1.20E+00	3.41E-01	3E-01
Chromium	2.74E+00	1.12E-01	4E-02
Copper	1.17E+01	3.92E+00	3E-01
Iron	2.60E+01	1.19E+02	**5E+00**
Mercury	1.00E+00	1.13E-03	1E-03
Manganese	8.80E+01	7.53E+00	9E-02
Nickel	4.00E+01	2.24E-01	6E-03
Lead	8.00E+00	2.23E+00	3E-01
Selenium	2.00E-01	6.48E-03	3E-02
Thallium	7.40E-02	7.97E-03	1E-01
Vanadium	2.10E-01	1.60E-01	8E-01
Zinc	1.60E+02	1.01E+00	6E-03
Naphthalene	1.00E+00	6.34E-03	6E-03

Notes:

1-Values with bold and shading indicate an elevated potential for adverse ecological effects.

HQ = COPEC-specific hazard quotient

mg/kg/day = milligrams COPEC per kilogram body weight per day

Table 5-13
Hazard Quotients for Red-tailed Hawk (*Buteo jamaicensis*)
for Exposures at Reservoir No. 2 Burning Ground, Outside the Burn Area,
Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Effect Dose (mg/kg/day)	Exposure Dose Maximum (mg/kg/day)	HQ[1]
2,4-Dinitrotoluene	2.00E-01	7.51E-02	4E-01
2,6-Dinitrotoluene	2.00E-01	2.78E-02	1E-01
1,3,5-Trinitrobenzene	--	6.60E-03	NA
Aluminum	1.93E+00	1.75E+00	9E-01
Arsenic	1.25E+00	9.28E-04	7E-04
Barium	5.10E+00	2.64E-02	5E-03
Cadmium	1.00E+00	3.82E-04	4E-04
Cobalt	1.20E+00	3.42E-03	3E-03
Chromium	2.74E+00	4.18E-04	2E-04
Copper	1.17E+01	2.74E-02	2E-03
Iron	2.60E+01	3.16E+00	1E-01
Mercury	1.00E+00	7.72E-06	8E-06
Manganese	8.80E+01	1.82E-01	2E-03
Nickel	4.00E+01	1.19E-03	3E-05
Lead	8.00E+00	1.38E-02	2E-03
Selenium	2.00E-01	1.47E-04	7E-04
Thallium	7.40E-02	2.04E-04	3E-03
Vanadium	2.10E-01	4.14E-03	2E-02
Zinc	1.60E+02	6.54E-02	4E-04
Naphthalene	1.00E+00	3.00E-03	3E-03

Notes:

1-Values with bold and shading indicate an elevated potential for adverse ecological effects.

HQ = COPEC-specific hazard quotient

mg/kg/day = milligrams COPEC per kilogram body weight per day

Table 5-14
Hazard Quotients for Racoon (*Procyon lotor*)
for Exposures at Reservoir No. 2 Burning Ground, Outside the Burn Area,
Plum Brook Ordnance Works, Sandusky, Ohio

Contaminant of Potential Ecological Concern (COPEC)	Effect Dose (mg/kg/day)	Exposure Dose Maximum (mg/kg/day)	HQ[1]
2,4-Dinitrotoluene	7.00E-01	2.82E+00	**4E+00**
2,6-Dinitrotoluene	7.00E-01	4.13E-01	6E-01
2,4,6-Trinitrotoluene	7.00E-01	3.17E+03	**5E+03**
1,3,5-Trinitrobenzene	--	3.60E-02	NA
Aluminum	1.10E+02	5.56E+04	**5E+02**
Arsenic	2.46E+00	2.26E-02	9E-03
Barium	2.08E+01	5.06E+00	2E-01
Cadmium	1.45E+00	1.87E-03	1E-03
Cobalt	--	5.37E-02	NA
Chromium	1.00E+00	1.28E-02	1E-02
Copper	4.70E+01	8.58E-01	2E-02
Iron	5.00E+01	1.84E+05	**4E+03**
Mercury	4.50E-01	6.87E-05	2E-04
Manganese	9.77E+02	3.43E+02	4E-01
Nickel	7.74E+01	3.95E-02	5E-04
Lead	3.85E+00	3.20E+00	8E-01
Selenium	5.00E-01	1.08E-03	2E-03
Thallium	3.50E-01	1.75E-03	5E-03
Vanadium	1.14E+01	3.33E-01	3E-02
Zinc	1.45E+01	3.51E+01	**2E+00**

Notes:

1-Values with bold and shading indicate an elevated potential for adverse ecological effects.

HQ = COPEC-specific hazard quotient

mg/kg/day = milligrams COPEC per kilogram body weight per day

APPENDICES

APPENDIX A
ECOLOGICAL SURVEY

DAVEY
RESOURCE GROUP
A Division of The Davey Tree Expert Company

Corporate Headquarters
1500 North Mantua Street
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Kent, OH 44240-5193
330•673•5685
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November 17, 2008

Jon Russ
Jacobs Engineering
1527 Cole Boulevard, Building #2
Golden Colorado 80401

Dear Mr. Russ:

Please find enclosed information for the NASA Plum Brook ecological survey. Included are the plant lists for Acid Area 1 and Reservoir No. 2 Burning Ground based on our site visits on May 14 and October 2, 2008. Also enclosed are vegetation community maps for both sites and vegetation community descriptions. The vegetation community maps are approximate due to the poor quality of the aerial photographs.

If you have any questions or need additional information, please let me know. This should complete my work on this project.

Sincerely,

Todd Crandall
Natural Resource Consulting

NASA Plum Brook
Sandusky, Ohio
Plant Community Description
Acid Area 1 and Reservoir No. 2 Burning Ground
November, 2008

Upland Old Fields. These areas are dominated by grasses and herbs and have been recently disturbed by mowing and/or brush-hogging. Scattered shrubs, small trees, and groups of shrubs also occur here.

Shrub Thickets. Dense areas of shrub thickets occur in both Acid Area 1 and Reservoir No. 2 Burning Ground. *Cornus racemosa* (gray dogwood) dominates most of these areas. *Eleagnus umbellata* (autumn olive) is also common. Small trees and saplings also occur within the shrub thickets.

Successional Woods. Successional woods are comprised of small and moderate sized trees, primarily *Fraxinus pennsylvanica* (green ash), *Acer negundo* (box elder), and *Populus deltoides* (cottonwood). These areas generally have a moderate to dense shrubby understory. The herbaceous layer is dense in most areas. *Carex* spp. (sedges) dominate most of the understory.

Marsh. Small areas of marsh are found within Acid Area 1. These areas are generally dominated by cattails, with other species such as sedges and bulrushes also occurring. All of these areas were either created by, or influenced by, past disturbances.

Scrub/shrub Wetlands. Several areas of scrub/shrub wetlands are found within Acid Area 1. The drainage ditch along the south side of this site is also a scrub/shrub wetland. These areas contain *Cornus racemosa* (gray dogwood) along with herbaceous species such as sedges and horsetails.

NASA Plum Brook
Sandusky, Ohio
Reservoir No. 2 Burning Ground Plant List
May 14 and October 2, 2008

Scientific Name	Common Name
Acer negundo	box elder
Acer rubrum	red maple
Achillea millefolium	yarrow
Agrimonia parviflora	small-flowered groovebur
Alliaria petiolata	garlic mustard
Allium vineale	field garlic
Andropogon virginicus	broom sedge
Apocynum cannabinum	dogbane
Asplenium platyneuron	ebony spleenwort
Aster divaricatus	white wood aster
Aster lateriflorus	calico aster
Aster pilosus	heath aster
Berberis thunbergii	barberry
Botrychium virginianum	grape fern
Brassica nigra	yellow rocket
Carex gracillima	graceful sedge
Carex hirtifolia	sedge
Carex radiata	sedge
Carya ovata	shagbark hickory
Cirsium arvense	creeping thistle
Cornus racemosa	gray dogwood
Crataegus sp.	hawthorn
Cryptotaenia canadensis	honewort
Dactylis glomerata	orchard grass
Daucus carota	Queen Anne's lace
Dryopteris carthusiana	spinulose wood fern
Eleagnus umbellata	autumn olive
Elymus riparius	river bank wild rye
Equisetum arvense	field horsetail
Erigeron philadelphicus	common fleabane
Eupatorium rugosum	white snakeroot
Festuca sp.	fescue
Fragaria virginiana	strawberry
Fraxinus pennsylvanica	green ash
Galium aparine	cleavers
Galium asprellum	rough bedstraw
Galium circaezans	wild licorice
Galium triflorum	sweet bedstraw
Glechoma hederacea	ground ivy
Gleditsia triacanthos	honeylocust
Juglans nigra	black walnut
Leersia virginica	white grass
Lonicera tatarica	Tartarian honeysuckle

Scientific Name	Common Name
Maclura pomifera	osage orange
Medicago lupulina	black medick
Monarda fistulosa	wild bergamot
Morus alba	mulberry
Oxalis stricta	sorrel
Panicum virgatum	switch grass
Parthenocissus quinquefolia	Virginia creeper
Penstemon digitalis	beard tongue
Phleum pratense	timothy
Phryma leptostachya	lopseed
Plantago lanceolata	English plantain
Plantago major	common plantain
Platanus occidentalis	American sycamore
Poa alsodes	blue grass
Polygonatum biflorum	Solomon's seal
Polygonum virginianum	Virginia knotweed
Populus deltoides	cottonwood
Potentilla norvegica	cinquefoil
Prunus avium	pin cherry
Prunus serotina	black cherry
Pyrus coronaria	crabapple
Quercus palustris	pin oak
Ranunculus abortivus	kidney leaved buttercup
Ranunculus recurvatus	cursed crowfoot
Rosa multiflora	multiflora rose
Rosa setigera	prairie rose
Rubus allegheniensis	Allegheny blackberry
Rubus flagellaris	dewberry
Rubus occidentalis	black raspberry
Satureja vulgaris	wild basil
Setaria glauca	yellow bristle grass
Solanum carolinense	horse nettle
Taraxacum officinale	dandelion
Teucrium canadense	germander
Toxicodendron radicans	poison ivy
Trifolium repens	white clover
Ulmus americana	American elm
Verbesina alternifolia	wingstem
Vernonia gigantea	ironweed
Viola papilionacea	blue violet
Vitis aestivalus	summer grape
Vitis riparia	riverbank grape

APPENDIX B
ASSESSMENT RECEPTOR PROFILES

Appendix B

Assessment Receptor Profiles

Eastern Cottontail (*Sylvilagus floridanus*). These medium-size grazing herbivores are found over most of the eastern half of the United States and southern Canada, and have been widely introduced into the western U.S. Environmental Protection Agency ([EPA], 1993) . The eastern cottontail is unique to the genus because of the large variety of habitats that it occupies, including glades and woodlands, deserts, swamps, prairies, hardwood forests, rain forests, and boreal forests (EPA, 1993). Open grassy areas are generally are used for grazing at night, whereas dense, heavy cover typically is used for shelter during the day (EPA, 1993). During the summer seasons these rabbits consume herbaceous plants (e.g. grasses, clover, timothy, and alfalfa), whereas winter diet typically consists of woody vines, shrubs and trees (e.g. birch, maple, and apple) (EPA, 1993). Home range is 3 to 20 acres, with larger ranges in the summer and smaller ranges in the winter (Burt and Grossenheider, 1980). Populations fluctuate from 1 to 4 cottontail per four acres to several per acre in winter conditions (Burt and Grossenheider, 1980). The eastern cottontail breeds from February through September and usually produces 3 to 4 litters per year of 1 to 9 young (usually 4 to 5); however, this rabbit's' death rate vies with its birth rate, and few rabbits live for more than one year (Whitaker, 1995). The average longevity is 1.25 years (EPA, 1993).

References:

Burt, W. H. and R. P. Grossenheider, 1980, "A Field Guide to Mammals," ***Peterson Field Guide Series***, Hougton Mifflin Co., Boston.

U.S. Environmental Protection Agency (EPA), 1993, ***Wildlife Exposure Factors Handbook,*** Office of Health and Environmental Assessment, Office of Research and Development, EPA/600/R93/187a.

Whitaker Jr., J. O., 1995, ***The Audubon Society Field Guide to North American Mammals,*** Alfred A. Knopf, Inc., New York.

Deer Mouse (Peromyscus maniculatus). This medium-sized mouse is found in the eastern United States from the Hudson Bay to Pennsylvania, the southern Appalachians, central Arkansas, and central Texas. In the west it is found from Mexico to the south Yukon and north-west territories (Whitaker, 1995). Deer mice habitat includes nearly every dry land habitat within its range, including forest, grasslands, or a mixture of the two (Burt and Grossenheider, 1980). Nocturnal and active year-round, deer mice construct nests in the ground, trees, stumps, and buildings (Burt and Grossenheider, 1980). Omnivorous, the deer mouse feeds on nuts and seeds (e.g., jewel weed and black cherry pits), fruits, beetles, caterpillars, and other insects. Deer mice may cache their food during the fall and winter in the more northern parts of their range (EPA, 1993). Home range is 0.15 to 3 acres (Burt and Grossenheider, 1980; EPA, 1993). Density of populations is 4 to 12 mice per acre, and average life span is 2 years in the wild (Burt and Grossenheider, 1980). The breeding season is from February to November, depending on latitude. Three to five young are born in each of two to four litters per year (Burt and Grossenheider, 1980). They are greyish to reddish-brown with a white belly, with a distinctly shorthaired, bicolor tail (Whitaker, 1995). Weight range is 14.8 (EPA, 1993) to 33 grams (Whitaker, 1995).

References:

Burt, W. H. and R. P. Grossenheider, 1980, "A Field Guide to Mammals," ***Peterson Field Guide Series***, Hougton Mifflin Co., Boston.

U.S. Environmental Protection Agency (EPA), 1993, ***Wildlife Exposure Factors Handbook***, Office of Health and Environmental Assessment, Office of Research and Development, EPA/600/R93/187a.

Whitaker Jr, J. O, 1995, The ***Audubon Society Field Guide to North American Mammals***, Alfred A. Knopf, Inc., New York.

Mallard Duck (Areas platyrhynchos). The mallard duck is widespread throughout most of the United States and is the most abundant of the United States ducks. It is large, migratory duck with an average body size of 58 centimeters from bill to tail tip. Wintering mallards prefer the natural bottom-land wetlands and rivers where water depths are 20 to 40 centimeters. The primary habitat requirement for nesting is thought to be dense grassy vegetation. Nests are generally located within a few kilometers of water (EPA, 1993).

In winter, mallards feed primarily on seeds, invertebrates, agricultural grains and, to a limited extent, leaves, stems, buds, rootlets, and tubers. In spring, females shift mostly to a diet of invertebrates to support molting and egg laying activities. Ducklings also feed mainly on invertebrates to help support their rapid growth rates. Mallards are serially monogamous and re-mate annually. Each pair of mallards establishes a territory and the drake defends it against other mallards. Average home range size varies, depending upon the type of habitat available. High rates of nest failure require the females to re-nest persistently, with average clutch size decreasing as the breeding season progresses. Annual adult mortality rates vary with year, depending on location, hunting pressure, age, and sex. Females suffer greater natural mortality rates than do males (EPA, 1993).

The typical home range of the mallard is from 540 to 620 hectares (ha) for adult female and male birds, respectively, for wetlands and river habitat in Minnesota (USEPA, 1993). For the current ERA, an average home range of 580 ha was used. The typical migration schedule is from mid-March through mid-May for the spring migration. The fall migration typically starts in mid-October, and peaks in November (USEPA, 1993).

References:

U.S. Environmental Protection Agency (EPA), 1993, ***Wildlife Exposure Factors Handbook***, Office of Health and Environmental Assessment, Office of Research and Development, EPA/600/R93/187a.

Red-Tailed Hawk (*Buteo jamacensis*). This carnivorous hawk is one of the most common and widespread members of the genus Buteo in the continental United States and Canada (Brown and Amadon, 1968). Red-tailed hawks live in a variety of habitats, such as farmlands, woodlands, mountains, and deserts as long as there is open country interspersed with woods, bluffs, or streamside trees. They are primarily carnivorous, feeding on (greater than 85 percent) small rodents, as well as fish. Other prey items include amphibians, reptiles, crayfish, and other birds (Adamcik, et al., 1979; Ehrlich, et al., 1988). Home range has been reported as

approximately 66.8 acres, with a population density of 0.16 pairs per acre (Janes, 1984), although EPA (1993) reports an average territory size of 842 hectares (2,080 acres). Breeding population density is one nest per 0.009 acre or one individual per 0.004 acre. Body weight for male red-tails is 1,028.6 to 1,142.9 grams, and for females 1,371.4 to 1,600 grams (Brown and Amadon, 1968), although EPA (1993) reports an average body weight of 957 grams. They typically mate for life or until one of the pair dies, with pairs clinging to territories year after year (Austing, 1964).

References:

Adamcik, R. S., A. W. Todd, and L. B. Keith, 1979, "Demographic and Dietary Responses of Red-Tailed Hawks During a Snowshoe Hare Fluctuation," ***Canadian Field Naturalis***t, Vol. 93, pp. 16-27.

Austing, G. R., 1964, ***The World of the Red-Tailed Hawk***, J. B. Lippincott Co., Philadelphia.

Brown, L. and D. Amadon, 1968, Eagles*,* ***Hawks, and Falcons of the World***, Vol. 1, McGraw-Hill Book Company, New York.

Ehrlich, P. R., D. S. Dobkin, and D. Wheye, 1988, ***The Birder's Handbook: A field guide to the Natural History of North American Birds***, Simon and Shuster, Inc., New York.

Janes, S . W., 1984, "Influences of Territory Composition and Interspecific Competition on Red-Tailed Hawk Reproductive Success," ***Ecology***, 65:862-870.

U.S. Environmental Protection Agency (EPA), 1993, ***Wildlife Exposure Factors Handbook***, Office of Health and Environmental Assessment, Office of Research and Development, EPA/600/R93/187a.

Raccoon (*Procyon lotor*). Raccoons are native only in the Americas. Their range extends from the southern edge of the southern provinces of Canada and most of the United States, except for portions of the Rocky Mountain States, central Nevada, and Utah (Whitaker, 1995). The raccoon weighs from 3 to 15 kilograms (Merritt, 1987; EPA, 1993) and has a head and body length of 46 to 71 centimeters and a tail length of 20 to 30 centimeters (Burt and Grossenheider, 1980). The raccoon is nocturnal and solitary, except when breeding or caring for its young. During particularly cold spells, the raccoon may sleep for several days at a time but does not hibernate (Whitaker, 1995). The raccoon is found along lakes near wooded areas or rock cliffs (Burt and Grossenheider, 1980), but prefers wooded streams (Whitaker, 1995). The raccoon is highly omnivorous and is an opportunistic feeder, consuming virtually any animal or plant matter that is available (Merritt, 1987; EPA, 1993). Animal matter predominates the diet during the spring and early summer; plant matter predominates during late summer, autumn, and winter (Merritt, 1987; EPA, 1993). The home range of the raccoon extends up to 3 .2 kilometers across, but usually it is less than 1 .6 kilometers. Population densities range from one per acre (highest) to one per 15 acres (considered high) (Burt and Grossenheider, 1980). Captive raccoons live for approximately 14 years (Burt and Grossenheider, 1980). Average body weight is 5 .1 kilograms (EPA, 1993).

References:

Burt, W. H., and R. P. Grossenheider, 1980, "A Field Guide to Mammals," ***Peterson Field Guide Series***, Hougton Mifflin Co., Boston.

Merritt, J. F., 1987, ***Guide to the Mammals of Pennsylvania***, University of Pittsburgh Press, Pennsylvania.

U.S. Environmental Protection Agency (EPA), 1993, ***Wildlife Exposure Factors Handbook***, Volume I of II, Office of Health and Environmental Assessment, Office of Research and Development, EPA/600/R93/187a.

Whitaker Jr., J. O., 1995, ***The Audubon Society Field Guide to North American Mammals,*** Alfred A. Knopf, Inc., New York.

Short-tailed Shrew (*Blarina brevicauda*). This shrew is the largest found in North America. It is solid grey above and below, with a short tail, and weighs between 15 and 29 grams (Whitaker, 1995). Total length of this shrew is 76 to 102 millimeters (Burt and Grossenheider, 1980). The range of this shrew extends from southeastern Canada and the northeastern U.S. to Nebraska, Missouri, Kentucky, and in the mountains to Alabama (Whitaker, 1995). Preferable habitat for the shrew includes forests, grasslands, marshes, and brushy areas. It will make a nest of dry leaves, grass, and hair beneath logs, stumps, rocks, or debris (Burt and Grossenheider, 1980). This underground tunneler may burrow as deep as 6 feet, and has a voracious appetite, eating one half of its own body weight per day of earthworms, other terrestrial vertebrates, and sometimes young mice (Whitaker, 1995). Mean population densities range "from 5.7 in the winter, to 28 per acre in the summer (EPA, 1993). Their home range varies from 0.5 to 1 acre (Burt and Grossenheider, 1980). Longevity is typically around 20 months (EPA, 1993), with five to eight young born to each of two to three litters (Burt and Grossenheider, 1980).

References:

Burt, W. H. and R. P. Grossenheider, 1980, "A Field Guide to Mammals," ***Peterson Field Guide Series***, Hougton Mifflin Co., Boston.

U.S. Environmental Protection Agency (EPA), 1993, ***Wildlife Exposure Factors Handbook***, Office of Health and Environmental Assessment, Office of Research and Development, EPA/600/R93/187a.

Whitaker Jr., J. O., 1995, ***The Audubon Society Field Guide to North American Mammals***, Alfred A. Knopf, Inc, New York.

White-tailed Deer (*Odocoileus virginianus*). The white-tailed deer is a member of the Family Cervidae. They are large, even-toed, hoofed mammals with long legs. Their coat is predominantly light brown or chestnut colored, with the under parts being white. Deer are primarily herbivorous grazers and browsers, constantly moving from one food source to the next. The deer's diet changes seasonally. When available, farm crops such as winter wheat, corn, alfalfa, soy beans, and hay are important components of the species diet. Other top food items include wild crab apples, sumac, grasses, green briar, clover, jewelweed, acorns, and dogwood. In regions where the climate varies from season to season, deer may make annual

migrations of 10 to 20 miles in the search for food. However, in Ohio, deer typically have rather small home ranges (2 to 3 square miles) and are reluctant to leave this range. The average weight for the species is 88 kilograms for males and 61 kilograms for females. Breeding season ranges from November through February, with the young offspring born in May and early June. Virtually all yearling and adult does conceive each year, and in Ohio usually carry twins. Triplets and quadruplets have also been recorded Gottschang (1981).

References:

Gottschang, J . L., 198, ***A Guide to the Mammals of Ohio***, The Ohio State University Press, pp.143-149.

Marsh Wren (*Cistothorus palustris*). The marsh wren is a small bird (4 to 4.5 inches in length) which inhabits freshwater cattail marshes and salt marshes. Nesting pairs are not likely to occupy other habitats and the species avoids the wet meadow and sedge meadow habitats preferred by sedge wrens. Marsh wrens breed throughout most of the northern half of the United States and in coastal areas as far south as Florida. The species eats mostly insects, and occasionally snails and other invertebrates. The average body weight is 0 .01 kilograms, and the average home range for the species is 0.054 hectares. Because the species is polygamous, there may be more females than males inhabiting a breeding marsh. Densities as high as 120 birds per hectare have been recorded (EPA, 1993). Marsh wrens' nests are globular structures placed at heights of 2 to 5 feet in dense vegetation. The males commonly build dummy nests in addition to the one where the eggs will be laid (Peterjohn and Rice, 1991).

References:

U.S. Environmental Protection Agency (EPA), Office of Research and Development, 1993, ***Wildlife Exposure FactorsHandbook***, EPA/600/R-93/187a.

Peterjohn, B. G., and Rice, D. L., 1991, ***The Ohio Breeding Bird Atlas***, The Ohio Department of Natural Resources.

APPENDIX C

APPLICATION OF ESSENTIAL NUTRIENTS IN ECOLOGICAL RISK ASSESSMENT

Appendix C

Application of Essential Nutrients In Ecological Risk Assessment

Introduction

All forms of living matter require inorganic elements, or minerals, for their normal life processes. All animal tissues and feeds contain inorganic or mineral elements in widely varying amounts and proportions. Minerals that are needed in relatively large amounts are referred to as major or macrominerals; those that are needed in very small amounts are referred to as trace minerals or microminerals. These terms represent quantity designations of the amounts required in an animal's diet and their generally low or trace concentrations in tissues. The major minerals are required in concentrations of greater than 100 parts per million (ppm) and are often reported as a percentage of diet, while trace elements are required at less than 100 ppm and are sometimes reported at the parts per billion level. Table C-1 presents 24 elements known to be required by at least some animal species (McDowell, 1992).

Table C-1
General Macro and Microminerals

Major or Macrominerals	Trace or Microminerals		
Calcium (Ca)	Arsenic (As)*	Iodine (I)	Nickel (Ni)*
Chlorine (Cl)	Boron (B)*	Iron (Fe)	Selenium (Se)
Magnesium (Mg)	Chromium (Cr)	Lead (Pb)*	Silicon (Si)*
Phosphorus (P)	Cobalt (Co)	Lithium (Li)*	Tin (Sn)*
Potassium(K)	Copper (Cu)	Manganese (Mn)	Vanadium (V)*
Sodium (Na)	Fluorine (F)	Zinc (Zn)	Molybdenum (Mo)
Sulfur (S)			

* These elements have not been shown to be essential for livestock or humans consuming typical diets.

The listing of some of the trace elements as essential is difficult and sometimes tentative, and rests on experiments with one or more species. In these experiments, diets adequate in all nutrients except the mineral in question produced clinical signs that were prevented or overcome by adding that mineral to the diets (McDowell, 1992).

Unlike other nutrients, mineral elements cannot be synthesized by living organisms. Minerals act as: (1) structural components of body organs and tissues, (2) constituents of body fluids and tissues as electrolytes, and (3) catalysts in enzyme and hormone systems. The most obvious function of mineral elements in the body is to provide structural support (skeleton) for the body. Calcium, phosphorus, magnesium, fluoride, and silicon in bones and teeth all contribute to mechanical stability. Birds use calcium to produce eggshells, phosphorus, sulfur, and silicon are found in muscle proteins. Minerals are interrelated and balanced against each other, and most often cannot be considered as single elements with independent and self-sufficient roles in the organized bodily processes. The definite relationship of cadmium and phosphorus in the formation of bones and teeth and the interrelationships of iron, copper, and cobalt (in vitamin B_{12}) in hemoglobin synthesis and red blood cell formation are examples. Sodium, potassium, calcium, phosphorus, and chlorine serve individually and collectively in the body fluids. A number of trace elements (i.e., copper, zinc, and selenium) in addition to certain vitamins (i.e., A, D, E, B_6, and folacin) and other nutrients, are strongly related to adequate immune response (McDowell, 1992).

Mineral Requirements

A series of "safe" dietary levels of potentially toxic elements has been established on the extent to which other elements that affect their absorption and retention are present (McDowell, 1992). Table C-2 presents some of these "safe" dietary levels or mineral requirements for selected species.

Table C-2
Mineral Requirements for Selected Species

Species	Mineral (mg/kg of feed)									
	Ca	Mg	K	Na	Cu	Fe	Mn	P	Se	Zn
Japanese Quail	25,000	500	4,000	1,500	6	100	70	5,000	0.2	50
Rat	5,000	400	3,600	500	5	35	50	4,000	0.10	0.25
Mouse	4,000	500	2,000	---	4.5	25	44	4,000	---	30
Cat	8,000	400	4,000	500	5	80	5	6,000	0.1	50
Mink	6,000	440	3,000	---	6	80	44	5,500	0.1	66

To determine whether concentrations of these minerals in the environment exceed safe dietary levels, the mineral requirements were converted to dietary doses using the following equation:

$$\text{Dose (mg/kg-day)} = \text{Diet (mg/kg)} \times \text{FI (kg/day)} \times 1 / \text{BW(kg)}$$

where:

Diet (mg/kg) = mineral requirement for each nutrient
FI (kg/day) = food ingestion rate
BW(kg/day) = body weight.

Variables for the species are shown in Table C-3.

Table C-3
Food Ingestion and Body Weights

Species	Food Ingestion (FI) (kg/day)	Body Weight (Kg)
Japanese Quail	0.017 derived from (FI(kg/day) = $0.0582*BW(kg)^{0.651}$[b]	0.15[a]
Rat	0.08[a]	0.35[a]
Mouse	0.0055[a]	0.03[a]
Cat	0.24 derived from (fi(kg/day) = $0.0687*BW(kg)^{0.822}$[b]	4.5 derived from 10 lbs*0.4535923 conversion factor.[c]
Mink	0.137[a]	1.0[a]

[a]Oak Ridge National Laboratory (ORNL), 1996.
[b]U.S. Environmental Protection Agency (EPA), 1993 .
[c]IT Corporation, 1999.

Table C-4 presents the mineral requirements calculated as dietary doses for selected species presented in Table C-3.

Table C-4
Mineral Requirements as a Dietary Dose for Selected Species

Species	Mineral (mg/kg of feed)									
	Ca	Mg	K	Na	Cu	Fe	Mn	P	Se	Zn
Japanese Quail	2,833	56.7	453	170	0.7	11.3	7.9	567	0.02	5.7
Rat	1,143	91.4	823	114	1.1	8	11.4	914	0.02	0.06
Mouse	733	92	367	---	0.8	4.6	8.1	733	---	5.5
Cat	427	21	213	26.7	0.3	4.3	0.3	320	0.01	2.7
Mink	822	60	411	---	0.8	11	6	753	0.01	9

Maximum Tolerance Levels

Information concerning the toxicity or tolerance of minerals is incomplete. According to available information, the toxic level of most major minerals is about 10 times the recommended level for young, growing livestock. The toxic levels of trace minerals appear to be highly variable, ranging between 10 and 1,500 times the recommended level. The National Research Council publishes maximum tolerance levels for domestic animals. The maximum tolerance level is defined as that dietary level that, when fed for a limited period, will not impair animal performance and should not produce unsafe residues in human food derived from animals. The levels listed in Table C-5 were derived from toxicity data on the designated species. Tolerance levels vary with the species, adaptation, duration of receiving the toxicants, age, physical condition of the animal, and many other factors (McDowell, 1992).

Table C-5
Maximum Tolerance Levels for Domestic Animals

Species	Mineral (mg/kg of feed)									
	Ca	Mg	K	Na	Cu	Fe	Mn	P	Se	Zn
Poultry	40,000[b] 12,000[c]	(3,000)	(20,000)	20,000	300	1,000	2,000	8,000	20,000	1,000
Rabbits	20,000	(3,000)	(30,000)	(30,000)	200	(500)	(400)	10,000	(20,000)	(500)

Source: McDowell, 1992.
The levels in parentheses were derived by interspecific species extrapolation.
[a]Ratio of calcium to phosphorus is important.
[b]Laying hen.
[c]Other poultry.

Using the same procedure described in Section H.2.0, the maximum tolerance levels were converted into dietary doses to determine whether concentrations of these minerals in the environment exceed safe dietary levels. Variables for the domestic animals are shown in Table C-6.

Table C-6
Food Ingestion and Body Weights for Domestic Animals

Species	Food Ingestion (FI)(kg/day)	Body Weight (kg)
Poultry	0.08 derived from (FI(kg/day) = 0.0582*BW(kg)$^{0.651a}$	1.6 (mean weight of male and femal chicken)[b]
Rabbits	0.2 derived from (FI(kg/day) = 0.0687*BW(kg)$^{0.822a}$	3.8[b]

a EPA, 1993.
b ORNL, 1996.

Table C-7 presents the calculated dietary doses for selected species presented in Table C-6.

Table C-7
Maximum Tolerance Level as a Dietary Dose for Domestic Animals

Species	Mineral (mg/kg of feed)									
	Ca	Mg	K	Na	Cu	Fe	Mn	P	Se	Zn
Poultry	600	150	1,000	1,000	15	50	100	400	1,000	50
Rabbits	1,053	158	1,579	1,579	11	26	21	526	1,053	26

Data Use

Mineral requirements or maximum tolerance levels will be used in ecological risk assessments, as appropriate.

References

IT, 1999. Best professional judgment for cat's (Felis domesticus) body weight being 10 lbs.

McDowell, L. R., 1992, Minerals in Animal and Human Nutrition, Academic Press, Inc. San Diego.

Oak Ridge National Laboratory (ORNL), 1996, Toxicological Benchmarks for Wildlife: 1996 Revision, B. E. Sample, D. M. Opresko, G. W. Suter 11. ES/ER/TM-86/R3, June 1996.

U.S. Environmental Protection Agency (EPA), 1993, Wildlife Exposure Factors Handbook, EPA/600/R-93/187a, December.

APPENDIX D

RESPONSES TO COMMENTS ON THE FINAL SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

Inter-Office Communication

To:	Paul Jayko, **NWDO-DERR**	Date: 29 May 2009
From:	Janusz Z. Byczkowski, DERR, CO	
Subject:	**Draft Baseline Human Health Risk Assessment, and Draft Screening Ecological Risk Assessment, Reservoir No. 2 Burning Ground, Former Plum Brook Ordnance Works Sandusky, Ohio,** March 2009. Site: US NASA PLUM BROOK, TAYLOR & COLUMBUS Rds., SANDUSKY, OH 44870; ERIE Cnt.; OHID# 322-0552.	

The following memo is regarding the *"**Draft Baseline Human Health Risk Assessment" and "Draft Screening Ecological Risk Assessment", Reservoir No. 2 Burning Ground", Former Plum Brook Ordnance Works Sandusky, Ohio,*** dated March, 2009.

If you have any questions or need further technical support, please call me at: 614-644-3070 or e-mail at jbyczkowski@epa.state.oh.us.

DOCUMENT TITLE: ***Draft Baseline Human Health Risk Assessment, and Draft Screening Ecological Risk Assessment, Res. No. 2 Burning Ground***

SITE: US NASA PLUM BROOK, TAYLOR & COLUMBUS Rds., SANDUSKY, OH 44870; ERIE Cnt.; OHID# 322-0552.

DOCUMENT/DATE: Draft /March 2009

Ohio EPA – Division of Emergency and Remedial Response COMMENTS

REVIEWER: Dr. Janusz Z. Byczkowski, DERR, CO; Tel: 614-644-3070; e-mail: jbyczkowski@epa.state.oh.us.

Review/DATE: 05/29/2009

Comment Number	Sect. Page/ Line#	Cross Ref.	Comment	Recommendation	PRP Response
1.	P. 2-8 P. 2-9 Table 2-1 and SERA Table 2-2		**General Remark:** This Document contains some errors and misrepresentations, and thus, it should be revised. If you have any questions or need further technical support, please give me a call at: 614-644-3070 or e-mail at jbyczkowski@epa.state.oh.us. For example, this Document states: On pages 2-8 and 2-9: "…[…] *Table 2-1 provides the following information for each detected chemical for each medium at 2BG*: *[…] ● Range of detected concentrations ● Range of detection limits ● Arithmetic mean of site concentrations ● 95 percent UCL on arithmetic mean…"* but then, in the heading of Table 2-1: "…| *Range of detection limits*	*Minimum Detected Concentration*	*Maximum Detected Concentration*	*Average* | Comment: Description in the text apparently misrepresents the data listed in the tables.	I suggest a **revision** of both Documents, followed by the quality reading. Also, the specific issues listed below should be addressed. Please **reconcile text with tables** throughout the Document.	Consistency between text and tables in the documents will be reviewed.

Comment Number	Sect. Page/ Line#	Cross Ref.	Comment	Recommendation	PRP Response
			Specifically, "*Average*" does not mean the same as an "*arithmetic mean*". If it indeed was an arithmetic mean, all values in the "*Average*" column, listed as greater than the corresponding "*Maximum Detected Concentrations*" would be implausible and thus, in error. Also, "*95 percent UCL on arithmetic mean*" is not the same as "*Average*". The data and other variables in tables should be defined precisely and labeled exactly what they are, e.g., "The *95% UCL on arithmetic mean*" (instead of "Average"), all units for numerical data should be listed (best in the heading or a footnote) and all the tables should be followed by an adequate description in the text.		
2.	HHRA Table 4-1		**Specific Issues:** In Table 4-1, both "*Reference Doses*" and "*Cancer Slope Factors*" are listed without units. Comment: It looks unprofessional and may be confusing for the reader when numerical values are listed without their units. Especially for the inhalation pathway, it is unclear whether the "Reference Doses" expressed concentrations (e.g., mg/m^3), or converted equivalent external dose rates (e.g., mg/kg per day). Similarly, it is unclear whether "Cancer Slope Factors" for inhalation indeed listed slope factors (SF), or may be, the inhalation unit risks (IUR).	Please revise this table and check all others, providing respective **units for all numerical values** listed.	Tables will be revised to include units for all numerical values.

Comment Number	Sect. Page/ Line#	Cross Ref.	Comment	Recommendation	PRP Response
3.	HHRA S. 2.1.3 P. 2-3, L.# 40 and S. 5.1 P. 5-2 L.# 22 also S. 5.3 P. 5-5 Eq. 5.7		This Document states on P. 2-3: "…*Acceptable exposure levels are generally concentration levels that represent an increased upper bound lifetime risk cancer risk to an individual of 1E-6 to 1E-4 (EPA, 1990), referred to as "risk management range…*" and on page 5-2: "…*ILCR estimates above 1E-4 are considered to be unacceptable. The OEPA (2004b) policy is consistent with the EPA (1990) policy of risk management…*" then, on page 6-1: "…*risk exceeds generally acceptable limits (cancer risk greater than 1E-4…*" <u>Comment</u>: Baseline risk assessment should objectively evaluate risk, without deciding what level is or is not "*acceptable*". Even at this early stage of risk assessment (which is not yet an FS or risk management step), whenever the NCP "range" of risk has been invoked, there should be also a reference to the current OEPA - DERR (2004) risk goal guidance. For consistency, also the target risk level (TR) used in RBRL calculations, e.g., in equation 5.7 (and elsewhere), should be presented as a point value = 1E-5. Listing a couple of values can be misleading, giving an impression that for some chemicals of concern, the target levels may be an order of magnitude higher than for the others. The OEPA guidance is very clear about cancer risk goal for any potential carcinogen (it's 1E-5): "…*The DERR Remedial Response program has*	i) Please delete any reference to "*acceptable risk*" from baseline human health risk assessment, and ii) when referring to 40 CFR Part 300 "risk management range", please refer also to OEPA-DERR (2004); also iii) use **point risk goal of 1E-5**, particularly, in Conclusions and Summaries (e.g. S. 7.3 on pages 7-4 and 7-5).	The text will be revised accordingly per the comment.

Comment Number	Sect. Page/ Line#	Cross Ref.	Comment	Recommendation	PRP Response
			adopted a human health cumulative excess lifetime carcinogenic risk goal of 1E-5 and a cumulative non-cancer hazard goal equal to a hazard index (HI) of 1, for all receptors and land uses. These goals are to be used as both the level of acceptable excess cancer risk or non-cancer hazard and for the development of remediation goals for a site…" **Reference:** **OEPA – DERR (2004)** Human Health Cumulative Carcinogenic Risk and Non-carcinogenic Hazard Goals for DERR Remedial Response and Office of Federal Facility Oversight. Technical Decision Compendium, 28 April 2004. Available on-line: http://www.epa.state.oh.us/derr/rules/riskgoal.pdf		
4.	HHRA S. 2.1.5, L.# 18		This Document states in Section 2.1.5: *"…Each groundwater BSC is either the MDC or the calculated 95 percent upper tolerance limit of the background groundwater data set.* […] *BSCs for soil were reported as the 95 percent upper tolerance limit for lognormal data sets or the 95th percentile for datasets with nonparametric distribution…"* and then: "…*Background screening was not used to eliminate COPCs*…" Comment: The described methodology does not follow the screening process recommended either by U.S. EPA (1989), or OEPA-DERR (2004). OEPA – DERR does not recommend the usage of the Upper Tolerance Limit (*UTL*) as the background screening criterion. Instead, the upper cutoff value should be used to estimate the background	Please follow methodology described by U.S. EPA (1989) in RAGS part A. For each chemical that may be screened out based on background, please calculate the background level equal to the **upper cutoff value**, according to OEPA – DERR (2004a). In the BHHRA document, please list a single, unadjusted, representative background level for each chemical, in each medium, within the same geological formation as the on-site area of concern.	It is true, there is no recent background data taken specifically for 2BG. However, there is a metals background data set from 2001, from background locations as agreed upon by the PBOW Team, including USACE and OEPA, that would suffice as the background data set for all PBOW FUDS AOCs to be investigated, including Acid Area 1. During the development of the appropriate background statistic to compare to for PBOW FUDS AOCs, the PBOW Team reviewed many statistics, including arithmetic mean, median, UCLs and UTLs. The OEPA risk assessors Bonnie Buthker, Laurie Moore with the rest of the PBOW team deemed the 95% UTL or the maximum detected background metal

Comment Number	Sect. Page/ Line#	Cross Ref.	Comment	Recommendation	PRP Response
			concentration level and to compare it to the samples, taken from the area of concern within the same geological formation, on a point by point basis. For guidance on acceptable background calculation methodology, please see the OEPA – DERR (2004 and 2004a). **References:** **U.S. EPA (1989)** Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part A), Interim Final, EPA/540/1-89/002, December 1989; page 5-21. On-line: http://www.epa.gov/oswer/riskassessment/ragsa/index.htm **OEPA - DERR (2004)**: TECHNICAL DECISION COMPENDIUM Remedial Response Program: Methodology for Evaluating Site-specific Background Concentrations of Chemicals. On-line: http://www.epa.state.oh.us/derr/rules/Methodology.pdf **OEPA - DERR (2004a)**: Background Calculation Methodology. DERR-00-RR-039P, 30 June 2004, Final. On-line: http://www.epa.state.oh.us/derr/rules/RR-039_public.pdf		concentration, which ever is less, as the appropriate statistic to use during background screening of AOCs' metals, and as documented in the May 2000 PBOW Team Meeting Minutes as consensus for using this method.
5.	HHRA S. 2.3 P. 2-9 and P.2-10 L.# 13 L.# 25 L.# 35 and		In several paragraphs, this Document states: "…*Specific compounds exceeding the USEPA Region 9 Residential PRGs (EPA, 2004a) are identified in Table 2-1*…" Comment: Actually, in the table 2-1 the values listed (RBCs) are equal to 1/10 of PRGs for non-carcinogens	Please explain in the text derivation of the RBCs used, and please **provide in Table 2-1 the missing information** according to U.S. EPA (2001) RAGS part D.	During the 26 June 2008 PBOW Team Meeting, USACE presented to the team the discussion of and recommendation to use the Regional Screening Levels (RSLs) adopted all three EPA regions which had screening levels previously, and being EPA Region 3, Region 6 and Region 9. The PBOW Team decision was to

Comment Number	Sect. Page/ Line#	Cross Ref.	Comment	Recommendation	PRP Response
	L# 6 L.# 11 L.# 14 Table 2-1		(including lead) and 100% PRGs for potential carcinogens. Please note that in the Table 2-1, some reporting limits (or range of detection limits) are missing. Also, the rational for COPC selection or rejection has not been included. This information could be displayed in the appropriately indexed "*Standard Table*" for occurrence, distribution and selection of chemicals of potential concern (see: Table 2.1) according to U.S. EPA (2001) RAGS part D. **Reference:** **U.S. EPA (2001)** Risk Assessment Guidance for Superfund (RAGS): Volume I - Human Health Evaluation Manual (Part D, Standardized Planning, Reporting and Review of Superfund Risk Assessments), Final, December 2001. On-line: http://www.epa.gov/oswer/riskassessment/ragsd/index.htm		discuss RSLs with Bonnie Buthker, DOD Program Manager at OEPA and use RSLs for any new starts after being given the "go ahead" by Bonnie Buthker. On 18 March 2009, Bonnie Buthker stated that Brian Tucker of OEPA has directed her to direct USACE FUDs risk assessors to use the RSLs, and no longer the obsolete Region 9 PRGs. According to the 26 June 2008 PBOW Team agreement, when Bonnie Buthker gave the "go ahead" to use RSLs, any new starts there after should use the RSLs. The Acid Area 1 Risk Assessment Work Plans are dated April 2009 which is after 18 March 2009, and will incorporate the RSLs, not the obsolete EPA Region 9 PRGs from 2004. The rationale and process for selection or rejection of a COPC is specifically addressed in the Work Plan for 2BG.
6.	S. 3.2.2 P. 3-13 L.# 25 and S. 8.0 P. 8-2 to 8-5		This Document states: "…*Evaluation Manual (HHEM) (EPA, 1991b) was used in the BHHRA. This model was selected based on correspondence between OEPA (2004c) and the USACE*…" Comment: The *OEPA (2004c)* is not listed in the References section 8.0. The references are not well organized alphabetically.	Please **revise and organize References, section 8.0** and perform quality reading to reconcile text with the section 8.0.	The text and references will be revisited for completeness per the comment.

Comment Number	Sect. Page/ Line#	Cross Ref.	Comment	Recommendation	PRP Response
			While the U.S. Army Core of Engineers is referred to in this Document as the "USACE", the U.S. Environmental Protection Agency is only referred to as "EPA" and in the text it may be confused with the Ohio EPA.		
7.	S. 5.4 P. 5-7 L.# 1		This Document states: "…*COCs are defined as the chemicals that contribute significantly to an ILCR exceeding 1E-4*…" but then, e.g., on page 5-8: "…*COCs* […as] *exceeding the PRGs*…" <u>Comment:</u> This definition of COC is contradicting some other statements in this Document and is in disagreement with the OEPA (2004) [see above, comment # 3].	Please use **1E-5** in defining both human health cumulative excess lifetime carcinogenic risk goal and a level of concern from aggregate exposures.	See response to comment no. 3
Draft Screening Level Ecological Risk Assessment					
8.	SLERA S.7 P. 7-4		This Document states: "*U.S. Environmental Protection Agency (EPA*)…" and then: "*EPA*…" <u>Comment</u>: See above, comment # 6.	Please **revise and organize References, section 7.0** and perform quality reading to reconcile text with the section 7.0.	See response to comment no. 6
9.	SLERA Figure 2-2		This document states: "…*Injestion*…" <u>Comment:</u> It should be "Ingestion".	Please correct **typos** (and perform quality reading).	Change will be made as noted.
10.	SLERA S. 2.1.1 P. 2-3 L# 7		This document states: "…*Jacobs personnel completed a checklist similar to EPA's checklist for ecologicalaAssessment/ sampling (EPA, 1997)*…"	Please complete a checklist recommended by **OEPA-DERR (2008)**.	The text will be removed indicating the completion of the ecological checklist. The checklists were reviewed prior to completion of the ecological site surveys to ensure the

Comment Number	Sect. Page/ Line#	Cross Ref.	Comment	Recommendation	PRP Response
			Comment: The ecological risk assessment guidance by OEPA-DERR, updated in 2008, provides the recommended generic ecological scoping checklist list in the Appendix B. **Reference:** **OEPA-DERR (2008)** Ecological Risk Assessment Guidance Document. Available on-line at: http://www.epa.state.oh.us/derr/rules/RR-031.pdf		surveys were adequate. The results of the ecological surveys are presented in the Appendices.
11	SERA S. 2.2.5 P. 2-12 L# 13		This document states: "…*BSCs for soil were reported as 95 percent upper tolerance limit (UTL) for lognormal data sets or the 95th percentile for datasets with nonparametric distribution*…" Comment: According to OEPA – DERR (2004), background concentration levels are to be calculated as the upper cutoff value of the data set defined as the upper quartile + 1.5 X (interquartile range). **Reference:** **OEPA - DERR (2004):** TECHNICAL DECISION COMPENDIUM Remedial Response Program: Background Calculation. On-line: http://www.epa.state.oh.us/derr/rules/RR-039_public.pdf	Please use **background definition** as described in OEPA – DERR (2004).	See response to comment no. 4
12	SERA S. 2.2.6 P. 2-12 L# 31 and P. 2-13		This document states: "*The following RBSEVs or RBSEV hierarchy, as noted, were used for the ecological evaluation*…" Comment: The hierarchy listed does not follow the OEPA-DERR recommendations.	Please use **screening hierarchy** for soil and sediment in accordance with OEPA (2008).	The hierarchy used is consistent with the approach specified in the Work Plan. The Ohio EPA sediment values were reviewed and used as part of this process.

Comment Number	Sect. Page/ Line#	Cross Ref.	Comment	Recommendation	PRP Response
			For soil, please add at the top of the list "U.S. EPA ECO-SSLs". For sediment risk-based screening, please use the following hierarchy, after comparing to OEPA Ohio-specific SRVs (Attachment H, p. 3-28. On-line: http://www.epa.state.oh.us/derr/rules/RR-031.pdf): 1) Consensus-based TEC values; The TEC values are located in: Development and Evaluation of Consensus-based Sediment Quality Guidelines for Freshwater Ecosystems, D.D. MacDonald, C.G. Ingersoll, and T.A. Berger, Arch. Environ. Contam. Toxicol. 39, 20-31 (2000). 2) Ecological Screening Levels, U.S. EPA, Region 5, 2003. http://www.epa.gov/reg5rcra/ca/edql.htm . **References:** **U.S. EPA ECO-SSLs**) U.S. EPA Ecological Screening Levels (Eco-SSL). On-line: http://www.epa.gov/ecotox/ecossl/ **OEPA-DERR (2008)** ECOLOGICAL RISK ASSESSMENT Guidance Document. On-line: http://www.epa.state.oh.us/derr/rules/RR-031.pdf		
13	SERA S. 3.1 P. 3-4 L# 38		This document states: "...*the drainage ditches associated with 2BG are ephemeral and were dry at the time of sampling*..." Comment: In the case of ephemeral runoff/surface water, the sampling should be performed during the wet season.	Please do additional **sampling,** or at least perform a predictive **modeling** of surface water.	The drainage ditches were dry at the time of sampling and sediment samples do not indicate the presence of contaminants at levels of concern.