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February 25, 2011

U.S. Army Engineer District, Nashville
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Submittal of the Final Baseline Human Health Risk Assessment and Screening Level Ecological Risk Assessment Locomotive Building Area (Garage Maintenance Area) Former Plum Brook Ordnance Works, Sandusky, Ohio Contract No. W912QR-08-D-0013: Shaw Project Number 133767

Dear Ms. McClanahan:

In accordance with the requirements of Delivery Order No. DX06 of Contract No. W912QR-08-D-0013 Shaw is pleased to submit the final Baseline Human Health Risk Assessment and the final Screening Level Ecological Risk Assessment for the Locomotive Building Area (Garage Maintenance Area) at the Former Plum Brook Ordnance Works (PBOW) located in Sandusky, Ohio. These reports were prepared consistent with those prepared for other PBOW sites, the agreements among the PBOW project delivery team members, and specifically the respective Locomotive Building Area Baseline Human Health Risk Assessment and Screening Level Ecological Risk Assessment work plans. These reports also incorporate responses to reviewer comments on the draft reports.

Enclosed for your records are four copies of these reports. Copies have also been sent to those on the distribution list as indicated. As requested, the document was sent to the Center of Expertise and the Restoration Advisory Board Co-Chair in electronic format only.

Should you have any questions or require additional information regarding this submittal, please do not hesitate to contact me at (865) 694-7496.

Sincerely,

Steven T. Downey, PE, PMP
Project Manager

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Screening Level Ecological Risk Assessment
Garage Maintenance Area
(Locomotive Building Area)

Plum Brook Ordnance Works,

Sandusky, Ohio

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Final

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List of Acronyms

ARP	assessment receptor profile
BAF	bioaccumulation factor
BCF	bioconcentration factor
bgs	below ground surface
BERA	baseline ecological risk assessment
BSC	background screening concentration
COPEC	chemical of potential ecological concern
CT	central tendency
DNAP	Ohio Division of Natural Areas and Preserves
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
ESBSNP	Erie Sand Barrens State Nature Preserve
ESCM	ecological site conceptual model
ESV	ecological screening value
GSA	General Services Administration
HQ	hazard quotient
IAEA	International Atomic Energy Agency
IT	IT Corporation
K_{ow}	octanol-water partition coefficient
LBA	Locomotive Building Area
LOAEL	lowest-observed-adverse-effect level
MDC	maximum detected concentration
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MSL	mean sea level
NASA	National Aeronautics and Space Administration
NOAEL	no-observed-adverse-effect level
NTU	nephelometric turbidity units
NWI	National Wetlands Inventory
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
PBOW	Plum Brook Ordnance Works
RME	reasonable maximum exposure
Shaw	Shaw Environmental, Inc.

List of Acronyms *(Continued)*

SLERA	screening level ecological risk assessment
TNT	trinitrotoluene
TNTA	TNT Area A
TNTB	TNT Area B
TNTC	TNT Area C
TRV	toxicity reference value
UCL	upper confidence limit
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Services
WRS	Wilcoxon Rank Sum

Executive Summary

A screening level ecological risk assessment was performed to provide an estimate of current and future ecological risk associated with potential hazardous substance releases within the Locomotive Building Area site at Plum Brook Ordnance Works in Sandusky, Ohio. The results of the screening level ecological risk assessment contribute to the overall characterization of the site and serve as part of the baseline used to develop, evaluate, and select appropriate remedial alternatives, if necessary. The primary objective of the assessment was to determine the potential for unacceptable risks to ecological receptors as a result of exposure to chemicals detected at the site. This objective was met by characterizing the ecological communities in the vicinity of the site, determining the particular hazardous substances being released from the site, identifying pathways for receptor exposure, and estimating the magnitude and likelihood of potential risk to identified receptors. The assessment addresses the potential for adverse effects to the vegetation, wildlife, aquatic life, and endangered and threatened species.

Vegetative communities at the site were classified during two site reconnaissance trips. The site consists of a mixture of mowed fields, upland old fields, and shrub thicket. An unnamed ditch separates the Locomotive Building Area from the Railcar Washing Area. No wetlands were formally identified at the site. Vegetative stress attributable to chemicals was not observed at the site. No threatened or endangered species were documented at the site. Based on the site reconnaissance information, there was no indication that ecological threats exist at the site, as there was no definitive absence of biota or animal life in areas expected to support these ecological components.

The maximum detected concentrations of chemicals detected in sampled media were compared with risk-based screening ecotoxicity values during an initial screening step. Chemicals that exceeded the screening values, or for which no screening values were available, and that did not meet additional screening criteria (e.g., comparison with background data, nutrient status, frequency of detection, etc.) were retained as chemicals of potential ecological concern (COPEC) and assessed further. Ten COPECs were selected for soil, 11 were selected for surface water, and 4 were identified for sediment. Ninety-five percent upper confidence limits were calculated for these chemicals and used as their exposure point concentrations during the subsequent stages of the risk assessment.

Eight representative receptor species that are expected or possible at the site were selected as indicator species for the potential effects of the chemicals of potential ecological concern. The

eight species selected included the deer mouse, short-tailed shrew, Eastern cottontail rabbit, marsh wren, white-tailed deer, raccoon, red-tailed hawk, and muskrat. The raccoon and muskrat were selected as aquatic receptors.

The assessment endpoints for the site were the protection of long-term survival and reproductive capabilities for terrestrial invertebrates, herbivorous mammals, omnivorous mammals, insectivorous mammals and birds, carnivorous birds, benthic invertebrates, omnivorous aquatic mammals, and omnivorous aquatic birds. Measurement assessment endpoints, or measurable responses to stressors, included lowest-observed-adverse-effect levels and no-observed-adverse-effect levels, collectively termed toxicity endpoint values.

Measurable responses to stressors, collectively termed toxicity reference values, 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 toxicity reference values 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 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 adverse effects to ecological receptors resulting from exposure to environmental stressors present at the site. Qualitative and semiquantitative approaches were taken to estimate the likelihood of adverse effects occurring as a result of exposure of the selected site receptors to chemicals.

For the semiquantitative predictive assessment, toxicity reference values and exposure rates were calculated and were used to generate hazard quotients (HQ) by dividing the receptor exposure rate for each chemical by the calculated reference toxicity values. 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 soil, terrestrial invertebrates and plants may have slightly elevated hazard based upon the exceedance of ecological benchmarks. However, only 10 site-related chemicals exceeded benchmarks, and the concentrations were not highly elevated. Given the conservative nature of benchmark values, it is unlikely that these communities are adversely impacted at the site.

Benthic invertebrates and plants may have slightly elevated hazard based upon the exceedance of ecological benchmarks. However, due to the limited aquatic habitat present near the site and the limited number of exceedances, it is unlikely that these communities are significantly impacted. Ecological risk from soil, surface water, and sediment was primarily evaluated using food chain models for the selected terrestrial assessment receptors (i.e., deer mouse, short-tailed shrew, Eastern cottontail rabbit, marsh wren, white-tailed deer, raccoon, red-tailed hawk, and muskrat). Only aluminum (deer mouse and short-tailed shrew) and selenium (muskrat) resulted in HQ values greater than 1. All HQs were below 5. A review of the data indicated that aluminum in surface water and selenium in sediment are not significantly elevated, and may be naturally occurring. Therefore, the potential for adverse ecological impacts is considered to be minimal at this site.

Based on the findings of the screening level ecological risk assessment, the potential for adverse effects to populations of ecological receptors exposed to chemicals in soil, surface water, and sediment is expected to be very low. No chemicals at the Locomotive Building Area are recommended for further evaluation for ecological purposes alone.

1.0 Introduction

This screening level ecological risk assessment (SLERA) evaluates the potential for adverse effects posed to ecological receptors from potential releases at the Locomotive Building Area (LBA) at the former Plum Brook Ordnance Works (PBOW). The approaches used to evaluate the potential for ecological risk are described in the LBA SLERA Work Plan (Shaw, 2010a). This SLERA is consistent with the ecological risk assessment process described in U.S. Environmental Protection Agency (EPA) guidance (e.g., EPA [1997]), with Ohio Environmental Protection Agency (OEPA) Division of Emergency and Remedial Response (OEPA, 2008) guidance, and with the procedures previously established in previous ecological risk assessments performed at PBOW (e.g., IT Corporation [IT], 2001a; Shaw, 2010b), with some adjustments to accommodate current practices in the field of ecological risk assessment.

This work is being conducted by Shaw Environmental, Inc. (Shaw) for the U.S. Army Corps of Engineers (USACE) under the Defense Environmental Restoration Program - Formerly Used Defense Sites and managed by the USACE Huntington District, with technical oversight provided by the USACE Nashville District.

1.1 Facility Description and Location

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 areas surrounding PBOW are mostly agricultural and residential. 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. Hunting is allowed by permit on portions of PBOW during the annual deer hunting season.

1.2 Facility History and Background

The PBOW facility was constructed on property comprising 9,009 acres in early 1941 as a manufacturing plant for 2,4,6-trinitrotoluene (TNT), 2,4-dinitrotoluene, and pentolite (USACE, 1995). Production of explosives at PBOW began in December 1941 and continued until 1945. It is estimated that more than 1 billion pounds of nitroaromatic explosives were manufactured during the 4-year operating period. The three explosive manufacturing areas were designated TNT Area A (TNTA), TNT Area B (TNTB), and TNT Area C (TNTC). Twelve process lines

were used in the manufacture of TNT, including four lines at TNTA, three lines at TNTB, and five lines at TNTC.

After plant operations ceased, the manufacturing process lines were decontaminated by the War Department in late 1945. During decontamination, all structures, equipment, and manufacturing debris were either removed and salvaged or removed and burned. After decontamination, 3,280 acres of the property was initially transferred to the Ordnance Department, then to the War Assets Administration after it was certified by the U.S. Army to be decontaminated. In 1949, PBOW was transferred to the General Services Administration (GSA). This transfer did not include the Plum Brook depot areas, which consist of approximately 2,800 acres. The Department of the Army required the 3,280 acres in 1954 and performed remedial efforts from the mid-1950s until 1963. In 1955, the Army completed further decontamination of manufacturing process lines. This effort included removal of contaminated surface and subsurface soil around the building and wooden and ceramic waste disposal lines containing TNT. Thousands of pounds of TNT were discovered in catch basins; this TNT was removed and burned at the burning grounds.

Two property use agreements were entered into by the Army and the National Advisory Committee of Aeronautics, the predecessor of the National Aeronautics and Space Administration (NASA), in 1956 and 1958, respectively. Accountability and custody were transferred to NASA on March 15, 1963 for the entire portion of the former PBOW property (6,030 acres) that had been had been under the accountability and custody of the Department of the Army. NASA performed further decontamination efforts during 1964. The NASA decontamination process included removing contaminated surface soil above the drain tiles, flumes, etc.; destruction of all buildings by fire; and removal of all soil, debris, sumps, and above-grade portions of concrete foundations. Portions of the concrete foundations located below grade were left buried, and some that had been previously slightly above grade were likewise buried. All materials, including the soil in those areas, were flashed. The area was then rough-graded. The decontamination process was also to have included the burning of nitroaromatic-filled flumes that were excavated (Dames & Moore, Inc., 1997).

NASA has operated and maintained the former PBOW property since 1963, and the facility is currently the NASA Glenn Research Center, Plum Brook Station. NASA operates the property as a space research facility in support of their John Glenn Research Center at Lewis Field, Cleveland, Ohio. Most of the aerospace testing facilities built in the 1960s at the facility are currently on standby or inactive status. On April 18, 1978, NASA declared approximately 2,152 acres of PBOW as excess. The Perkins Township Board of Education acquired 46 acres of the

excess acreage and uses this area as a bus transportation area. The GSA retains ownership of the remaining excess acreage and currently has a use agreement with the Ohio National Guard for 604 acres of this land. The details of land transactions are listed in the site management plan (USACE, 1995).

1.3 Locomotive Building Area Description and History

The LBA was part of the Garage Maintenance Area. As noted above, PBOW was built in early 1941 and manufactured 2,4,6-TNT, dinitrotoluene, and pentolite until 1945. The Garage Maintenance Area included three buildings used for the maintenance of various vehicles and equipment used on site during facility operation. The easternmost of these is Building 718, referred to herein as the Locomotive Shop, which was used specifically for locomotive maintenance. The LBA includes the Locomotive Shop and the nearby Rail Car Washing Area. The LBA is located in the central portion of the PBOW facility (Figure 1-2). The Locomotive Shop is located north of Maintenance Road. The former Rail Car Washing Area is located approximately 260 feet east of the Locomotive Shop (Figure 1-2).

The Locomotive Shop was used for the maintenance of equipment, vehicles, and rail way cars. A work pit built to allow maintenance personnel to work below the locomotives is the primary area of concern in this building. The pit measures 60 feet long; 3 feet, 8 inches wide; and 5 feet deep (USACE, 2000). The pit is located beneath the northern set of railroad tracks that run through the Locomotive Shop. This work pit is labeled “Maintenance Pit” in the depiction on Figure 1-2. NASA has backfilled this pit with loose stone and currently uses this building as a storage garage. The pit was used to work on the rail way cars and locomotives during the operation of PBOW. When the maintenance pit was operational, the waste effluent from the pit was sent into the sewer system via a sump pump. The sump measures 9 feet, 2 inches deep and 2 feet, 6 inches in diameter and is located just inside the south side of the building.

The Rail Car Washing Area is located approximately 260 feet east of the Locomotive Shop, across Maintenance Road from Ash Pit No. 1 (Figure 1-2). During the operation of PBOW, the Rail Car Washing Area consisted of tracks which carried locomotives over a pit. It was used as a locomotive car cleaning operation that involved an acid; thus, it is also referred to as the acid area in the limited site inspection report (USACE, 2000). The Rail Car Washing Area surrounded the terminus of the southern track in the pair of railroad tracks that exited the Locomotive Shop from the eastern end of the building. A third track, known as the “Z” track, oriented east to west just north of the Locomotive Shop, also ran to the Rail Car Washing Area (USACE, 2000). During 2008 and 2009 site visits by USACE and Shaw personnel, it was observed that the Locomotive Shop is used for equipment storage (e.g., backhoe tractor) and possibly

maintenance. It is also noted that an approximately 30-foot-long addition was built onto the eastern end of the Locomotive Shop at some point after the PBOW operational period. It was apparent that this addition was post-operational based on a comparison of current site observations versus historical photographs and historical use (including the fact that the presence of this addition would not have allowed access to the Rail Car Washing Area through the Locomotive Shop).

The location of the former Rail Car Washing Area pit is not apparent from visual survey. As shown on Figure 1-2, there are no buildings at the Rail Car Washing Area, and none are known to have been present historically. The area is not located near any easily recognizable man-made structure other than the Locomotive Shop. Three rubble piles were observed within the Rail Car Washing Area; these piles contain railroad ties and railroad ballast rock.

1.4 Scope and Objectives

The objective of this SLERA is to provide an estimate of the potential for adverse ecological effects associated with contamination resulting from former PBOW activities at the LBA. The results of the SLERA will contribute to the overall characterization of the site and may be used to determine the need for additional investigations or to develop, evaluate, and select appropriate remedial alternatives. Guidance documents used to perform the SLERA include the general guidelines of the *Tri-Service Procedural Guidelines for Ecological Risk Assessments* (Wentsel, et al., 1996), as well as the *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (EPA, 1997), *Region 5 Biological Technical Assistance Group (BTAG) Ecological Risk Assessment Guidance Bulletin No. 1* (EPA, 1996), and *Guidance for Conducting Ecological Risk Assessments* (OEPA, 2008). The SLERA fits into Steps 1 and 2 of the ecological risk assessment guidance for Superfund process (EPA, 1997), and Level I through a maximum of Level III evaluation using the OEPA (2008) process.

The goal of the SLERA is to evaluate the potential for adverse ecological effects to ecological receptors from site-related contaminants at the LBA. This objective is met by characterizing the ecological communities in the vicinity of the site, determining the particular contaminants present, identifying pathways for receptor exposure, and estimating the magnitude of the likelihood of potential adverse effects to identified receptors. The SLERA addresses the potential for adverse effects to the vegetation, wildlife, aquatic life (e.g., sediment-dwelling organisms), threatened and endangered species, and wetlands or other sensitive habitats associated with the site.

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

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

2.0 Problem Formulation

The screening assessment null hypotheses are stated as follows:

- Potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of viable habitat for potential ecological receptors.
- Potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of potential ecological receptors.
- Potential for adverse ecological effects to ecological entities at the site is minimal or nonexistent due to the lack of potential exposure pathways.
- 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 null hypotheses are accepted, a predictive assessment is not triggered. All four null hypotheses must be rejected for a predictive assessment to be triggered. The first three null hypotheses are tested with the results of the ecological site description, the pre-assessment reconnaissance, the documentation of potential receptors of special concern and critical habitats, and the determination of significant ecological threats (Section 2.1). The fourth null hypothesis is tested with the results of COPEC selection (Section 2.2).

If a predictive assessment is triggered, terrestrial and aquatic ecological conceptual site models are developed, as appropriate, and additional problem formulation tasks are performed as described in Sections 2.3 through 2.5.

2.1 Ecological Site Description

This ecological site description includes a general discussion of site background and the area of concern, surface water resources, wetlands, and vegetative communities; a species inventory; and a discussion on threatened and endangered species. Ecological characterization of the study area was based on a compilation of existing ecological information and site reconnaissance activities. A photographic record was made during the site reconnaissance (Figure 2-1). Information was obtained on the presence of state- and federally listed, threatened, and endangered species; species of special concern; and wildlife and fisheries resources. A botanist searched for threatened and endangered plant species during the reconnaissance visits. A checklist of biological species present at the site was developed using existing site investigation reports, environmental data sources mentioned previously, and information gathered during the site

reconnaissance. Information on unique and special-concern habitats, preserves, wildlife refuge parks, and natural areas within the general vicinity was also obtained.

2.1.1 General Site Background

PBOW, approximately 6,400 acres in size, 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 above mean sea level at the southwest edge of the site to 625 feet above mean sea level in the northern portion of the property at Bogart Road, resulting in an average slope of approximately 0.3 percent. The Lake Plains region itself is over 69 percent cropland, 2.7 percent pasture land, and 10.5 percent forest (Ohio Department of Natural Resources [ODNR], 1985). However, since the U.S. Army acquired the site in 1941 and removed the land from agricultural production, undeveloped portions of the former PBOW have become second generation forest and open fields. This has resulted in PBOW becoming an island of forest and open fields within a sea of agricultural land in north-central Ohio.

The LBA is approximately 4 acres in size, with minimal topography. Surface drainage is generally to the unnamed ditch separating the Locomotive Shop from the Rail Car Washing Area. Multiple site reconnaissance visits were performed by Shaw ecologists in the spring and fall of 2009. A photographic record of the site was prepared and is presented on Figure 2-1. Prior to arrival at the site, Shaw personnel obtained relevant information on the site, including topographic, township, county, or other appropriate maps; and determined the location of potential ecological units such as streams, creeks, ponds, grasslands, forest, and wetlands on or near the site. Additionally, the 1994 biological inventory of PBOW (NASA, 1995), which identifies and shows the locations of threatened and endangered species at PBOW, was reviewed. Shaw personnel completed a checklist similar to EPA’s checklist for ecological assessment/sampling (EPA, 1997); also, information from this checklist was used to complete Chapter 2.0. 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. Shaw personnel also used the reconnaissance to search for any indication of potential effects from contaminant release.

2.1.2 Surface Water

Due to the minimal topography at this site, surface water tends to pool in localized shallow depressions. The area as a whole drains to the unnamed ditch that is located between the Locomotive Shop and the Railcar Washing Area (Photos 4 and 8, Figure 2-1). This ditch is approximately 10 feet wide at the top, narrowing slightly towards the bottom of the ditch. When the ditch was observed during ecological site reconnaissance visits, less than 2 feet of water was present and no flow was observed.

2.1.3 Wetlands

According to the National Wetland Inventory (NWI) Maps for the area (U.S. Fish and Wildlife Services, 2010), there are no designated wetlands at the LBA site. It should be noted that the accuracy of NWI maps is limited, especially in relatively flat landscapes (such as PBOW) because minor depressions often contain isolated wetlands not easily identified through aerial photograph interpretation (the process used by the U.S. Fish and Wildlife Service in preparing NWI maps).

2.1.4 Vegetative Communities

Vegetative communities at the site were classified during the site reconnaissance trips and are documented in the photographic log (Figure 2-1) and vegetation community diagram (Figure 2-2). A list of the plant species identified at the site is presented in Table 2-1. The LBA contains primarily upland old field and shrub thickets. Small disturbed areas occur around the Locomotive Shop and driveway (Photos 5 and 7, Figure 2-1). A channelized ditch flows through this site (Photos 4 and 8, Figure 2-1). There is limited semiaquatic vegetation around the edges of the ditch. Small areas within the shrub thicket in the vicinity of the historical Railcar Wash Area have been cleared and disturbed for the installation of monitoring wells (Photos 9 and 10, Figure 2-1). The majority of the area adjacent to the Locomotive Shop is mowed grass and upland field (Photos 1, 2, 3, 5, and 6, Figure 2-1), and the area where the Railcar Wash Area was located consists primarily of upland old field/shrub thicket habitat. Denser shrub thickets are located adjacent to the unnamed ditch and in the southeast of the historical location of the Railcar Wash Area (Photos 3, 4, 9, and 10, Figure 2-1).

During the site reconnaissance, the study area was examined for vegetative stress, which included looking for plants displaying stunted growth, poor foliage growth, tissue discoloration, and a loss of leaf coverage. Vegetative stress attributable to chemical contamination was not observed at the LBA, although a few locations had been cleared of vegetation around monitoring

well locations to improve access to the wells (Photos 1 and 9, Figure 2-1). Based on site reconnaissance information, the LBA is a partially managed area characterized by disturbed and successional vegetation in the areas that are not regularly mowed. The shrub thicket areas adjacent to the unnamed ditch and in the southeastern portion of the Rail Car Wash Area represent the areas of densest (and least disturbed) vegetation cover.

2.1.5 Species Inventory

Based on information from ODNR (1995) and collected during the site reconnaissance, species lists were prepared for plants, mammals, birds, reptiles, amphibians, and fish (Tables 2-1 through 2-6). Unless noted on the tables, the species listed in Tables 2-1 through 2-6 apply to the former PBOW as a whole and are not necessarily specific to the LBA.

A total of 102 plant species were documented at the LBA during the spring and fall vegetation survey (Table 2-1). This comprises approximately 24 percent of the total number of species documented at PBOW either during the 1994 biological inventory (ODNR, 1995) or during vegetation surveys at other sites at the former PBOW (Appendix A).

Signs of 4 of the 43 species of mammals that may be found in the region based on species range maps were observed at the LBA during site visits (Table 2-2), including opossum, cottontail rabbit, raccoon, and white-tailed deer. It is likely that other species are present but were not observed due to the short duration of the field visits.

A total of 130 species of birds are likely to be found in the region based on species range maps and field observations, and 105 species have been recorded at the former PBOW by the ODNR during their multiyear studies (Table 2-3). PBOW lies within a major migratory corridor that is used by birds travelling between their southern wintering grounds to their breeding grounds in Canada. Of the species recorded by the ODNR, 49 are neotropical migrants and would not be expected to nest at the former PBOW. Fifteen bird species were documented at the LBA during the site visits performed by Shaw, 13 of which were identified as being present during the breeding season (Table 2-3).

Of the 14 species of reptiles that may be found in the region based on species range maps, 10 (71 percent) have been observed at the former PBOW, including turtles and snakes (ODNR, 1995; Table 2-4). No reptiles were observed during the LBA site reconnaissance.

Ten species of amphibians are likely to be found in the region based on species range maps, nine of which (90 percent) have been observed at the former PBOW (ODNR, 1995; Table 2-5),

including salamanders, toads, and frogs. No amphibians were observed during the LBA site reconnaissance.

According to ODNR (1995), a combination of electroshocking 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 (Table 2-6). Although no fish were visually observed in the unnamed ditch at the LBA during the site reconnaissance, some of the smaller fish species are expected to be present.

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, 2010), there are records of State of Ohio threatened or endangered species within a 2-mile radius of the site. No federally listed species were identified. The state-listed species include the following:

- Bushy aster (*Symphyotrichum dumosum*) - endangered
- Canada St. John's wort (*Hypericum canadense*) – endangered
- Flat-leaved rush (*Juncus platyphyllus*) – endangered
- Rough rattlesnake-root (*Prenanthes aspera*) – endangered
- Ashy sunflower (*Helianthus mollis*) – threatened
- Dwarf bulrush (*Lipocarpha micrantha*) – threatened
- Field sedge (*Carex conoidea*) – threatened
- Greene's rush (*Juncus greenei*) – threatened
- Slender spike-rush (*Eleocharis tenuis*) – threatened
- Southern hairy panic grass (*Panicum meridionale*) – threatened
- Thin-leaved sedge (*Carex cephaloidea*) – threatened
- Tufted fescue sedge (*Carex brevior*) – threatened
- Twisted yellow-eye-grass (*Xyris torta*) – threatened
- Upland sandpiper (*Bartramia longicauda*) – threatened.

In addition, based on information contained in ODNR (1995), several species of threatened or endangered plants, potentially threatened plants, and threatened or endangered birds have been recorded at PBOW, as follows (current status as of August 2010, if different, is listed in parentheses):

- Grove sandwort (*Arenaria lateriflora*) – threatened (not listed)
- 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 (not listed)
- Virginia meadow beauty (*Rhexia virginica*) - potentially threatened
- Tall nut rush (*Scleria triglomerata*) - potentially threatened

- Lance-leaved violet (*Viola lanceolata*) - potentially threatened
- Cattle egret (*Bublucus ibis*) - endangered
- Black-crowned night heron (*Nycticorax nycticorax*) - threatened
- Trumpeter swan (*Cygnus buccinator*) - endangered
- Indiana bat (*Mytolis sodalis*) - endangered.

The site reconnaissance included detailed searches performed by a qualified botanist subcontractor during the June and September 2009 site visits. Based on the results of the site reconnaissance, no threatened or endangered plant species were found at the LBA.

None of the threatened or endangered bird species are expected to be at the site. The cattle egret, trumpeter swan, and upland sandpiper are all considered rare visitors or migrants at the former PBOW (ODNR, 1995), and have not been documented nesting in the vicinity of the site. Upland sandpipers have been documented approximately 4,500 feet to the southeast of the LBA (Woischke, 2010); however, breeding populations of this species are no longer present in this area (PBOW, 2010). The black-crowned night heron, an Ohio threatened species, is a regular visitor at ponds, streams, and ditches within the former PBOW, but it does not nest at the former PBOW (ODNR, 1995; Woischke, 2010). The species is typically found near water and wetlands. Since the early 1980s, there has been a nesting colony of approximately 100 pairs located on an island in Sandusky Bay, approximately 10 miles north northwest of the study area (Peterjohn and Rice, 1991).

The Indiana bat has not been documented at the site and is generally not expected at PBOW because its preferred habitat (e.g., caves along streams or trees with exfoliated bark) is not present at the LBA. Trees with exfoliated bark, such as shagbark or shellbark hickory, are rare or not present at the site, respectively, thereby providing little bat roosting habitat (Appendix A).

With the exception of the Erie Sand Barrens State Nature Preserve (ESBSNP), there are no existing or proposed state nature preserves or scenic rivers near the site. ODNR is unaware of any unique ecological sites, geological features, breeding or nonbreeding animal concentrations, champion trees, or state parks, forests, or wildlife areas within a 2-mile radius of the site (Woischke, 2010). The ESBSNP is located to the west-southwest of PBOW, approximately 0.5 mile from Patrol Road. The 32-acre preserve is a remnant sand beach of Lake Warren, the fifth ancestral Lake Erie, that supports many threatened and endangered plant species such as field sedge, Least St. John’s wort, dwarf bullrush, twisted yellow-eyed-grass, flat-leaved rush, bushy aster, and Virginia meadow beauty. Many of the preserve’s rare plant species thrive in open windswept conditions such as those found on the sand barrens. The DNAP actively manages the

preserve to ensure that the open wind-swept areas remain and do not become overgrown with woody vegetation.

2.1.7 Pre-Assessment Reconnaissance

Shaw ecological scientists performed site visits to the LBA on April 27, June 2, and September 9, 2009. The primary purpose of the April trip was to perform a habitat assessment and fauna inventory at the site, and it was intentionally performed during the period when birds are migrating north to their breeding grounds to ensure that transient species utilizing the site were identified. The primary purposes of the June and September site visits were to perform a summer and fall walkover to identify plant species (including threatened and endangered species). The June visit was also used as a follow-up to the April fauna visit. During early June, breeding birds are vocalizing as they establish and defend territories, while non-breeding birds have continued their migration to their breeding grounds further north and moved out of the area. Therefore, bird species identified during the June site visit were assumed be using the site for breeding. The list of plant species observed during the two site walks is presented in Table 2-1. The mammal and bird species observed at the LBA are indicated in Tables 2-2 and 2-3.

Information obtained during the reconnaissance trips was used to select representative receptors, refine exposure scenarios for the risk assessment, and identify protected species or habitats of special concern in the study area. Reconnaissance personnel completed a checklist similar to that on EPA's checklist for ecological assessment/sampling (EPA, 1997) and OEPA's ecological risk assessment guidance (OEPA, 2008). The locations 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. Reconnaissance personnel used the site visit to evaluate the site for more subtle clues of potential effects from contaminant release.

The methods used to characterize natural resources focused on aquatic and terrestrial resources at the site and within the immediate vicinity. General habitat maps showing the types and extent of vegetation communities present within the immediate vicinity of the site were prepared based on information collected during the site reconnaissance.

2.2 Selection of Chemicals of Potential Ecological Concern

A list of the LBA media samples used for the SLERA is presented in Table 2-7. Sample locations are presented on Figure 2-3. From the chemical results of samples on this list, a COPEC selection process was performed to develop a subset of chemicals detected at the site that are not naturally occurring or are associated with non-site-related sources. These chemicals

are also present at sufficient frequencies, concentrations, and spatial areas to pose a potential risk to ecological receptors. Examples of screening criteria that were used include the following: analytical detection limit, frequency of detection less than 5 percent, comparability with background, status as a nutrient, and comparison with risk-based screening ecotoxicity values. This selection process is described in more detail in Section 2.2.3.

2.2.1 Data Organization

Chemical analytical data, as well as all previous and ongoing investigations, were reviewed and evaluated for quality, usefulness, and uncertainty. Data identified as being of acceptable quality for use in the SLERA were summarized in a manner that presents the pertinent information to be applied in the SLERA. Any data rejected during the data evaluation as a result of the data evaluation ("R"-qualified data) were identified along with the rejection rationale. All data used in the SLERA were validated.

The data for each chemical were sorted by medium. For ecological impacts, soil from 0 to 6 feet below ground surface (bgs) was considered. The 0 to 6 feet depth interval was selected for three primary reasons: (1) to maintain consistency with other PBOW ecological risk assessments (e.g., IT [2001a]); (2) to include potential exposure to ecological receptors that may be exposed to deeper soil; and (3) to increase the size of the total soil data base by including samples collected from up to 6 feet bgs. Therefore, COPEC selection was performed for the 0 to 6 feet interval. Chemicals not detected at least once in a medium were not included in the risk assessment. Available background data were determined for each medium. Potential sources of background information include data from previous and current investigations, as well as monitoring wells in areas unaffected by site activities.

The analytical data included 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.
- R - Quality control indicates that the data are unusable (chemical may or may not be present).
- B - Concentration of chemical in sample is not sufficiently higher than concentration in the blank (using the "5-times, 10-times" rule).

"J"-qualified data are used in the risk assessment; "R"- and "B"-qualified data are not. The handling of "U"-qualified data (nondetects) is described in the following sections.

2.2.2 Descriptive Statistical Calculations

Because of the uncertainty associated with characterizing contamination in environmental media, both the mean and the 95 percent upper confidence limit (UCL) of the mean are usually estimated for chemicals of interest. The EPA ProUCL software (Version 4.00.05 [EPA, 2010]) was used to estimate UCLs for the data sets of all environmental media represented by at least five samples. If the data set consisted of fewer than five data points, the maximum detected concentration (MDC) was selected as the exposure point concentration (EPC). One-half the reporting limit was used as the ProUCL input concentration for nondetects. Nondetect sample results with aberrantly high detection limits due to matrix interferences or other sample-specific causes are included in the initial ProUCL calculations. This is a conservative approach, as EPA (1989) recommends that nondetected results with aberrantly high detection limits be removed from the data set so that the calculation of the UCL is not unduly skewed by a nondetect. Because the latest version of ProUCL (EPA, 2010) includes mathematical manipulations under the default “with NDs” mode that are more robust than previous versions, single elevated detection limits are less likely to skew the UCL estimates than in the past. If it is observed that an elevated nondetect value or values skew a UCL estimate such that the hazard estimate is substantially affected, the ProUCL model is rerun without the elevated nondetect value and the hazards are recalculated, and the eliminated data are discussed in the uncertainty section. The re-evaluation of elevated nondetects was not performed in the LBA SLERA.

ProUCL generates a variety of UCL estimates for each data set. Generally, the results of one or two (sometimes more) of the UCL estimates are recommended. This recommendation is based on a variety of factors, including the distribution (i.e., normal, lognormal, gamma, or not discernable) that provides the best fit, number of nondetects, size of the data set, and skewness. If the recommended value(s) generated by the default mode equal or exceed the MDC, ProUCL is rerun under the full data set mode, which assumes that the COPEC is present in nondetect samples at one-half the reporting limit. Occasionally, ProUCL will recommend the 97.5 or 99 percent UCL on the arithmetic mean estimated by the Chebyshev method. In these cases, the 95 percent UCL estimated by the Chebyshev method was selected as the EPC because this is more consistent with the intent of the reasonable maximum exposure paradigm as defined by EPA (1989; 2002).

Analytical data from field duplicates were joined with parent sample results to yield one result for use in the generation of mean and UCL concentrations, as follows:

- The average of field duplicate and parent sample was used if both were positive detections, or if both were nondetects.
- The detected value was used if one sample was a positive detection and the other was a nondetect.

The UCL generated by the ProUCL protocol described in the preceding paragraphs or the MDC, whichever is lower, is selected as the EPC and is understood to represent a conservative estimate of average for use in the risk assessment. Unusually high detected values were retained in the calculation of the UCL concentration. Inclusion of these high values increases the statistical variability and the overall conservativeness of the risk estimate.

2.2.3 COPEC Selection Criteria

The criteria used to identify COPECs in the SLERA are described in the following sections.

2.2.3.1 Comparison to Ecological Screening Values

MDCs of chemicals detected in various media were compared with ecological screening values (ESV) for ecological endpoints following recommendations received from OEPA and as discussed in EPA *Region 5 Biological Technical Assistance Group (BTAG) Ecological Risk Assessment Bulletin No. 1* (EPA, 1996). Chemicals that exceed the ESVs, or for which no ESVs are available, were retained as COPECs if other COPEC selection criteria were also met. The following ESVs, or ESV hierarchy (as noted), were used for the ecological evaluation:

- ***Soil.*** Soil screening values were selected using the following hierarchy: (1) EPA ecological soil screening levels (EPA, 2008), (2) *Preliminary Remediation Goals for Ecological Endpoints* (Efroymson, et al., 1997a), (3) EPA Region 5 ecological screening levels (EPA, 2003), (4) *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process* (Efroymson, et al., 1997b), and (5) *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Terrestrial Plants* (Efroymson, et al., 1997c). It should be noted that effects on heterotrophic processes may not be relevant to ecological receptors of concern at the site.
- ***Surface Water.*** The lowest surface water screening value was selected from the following three sources: (1) OEPA Water Quality Criteria (OAC Chapter 3745-1) for the protection of aquatic life, (2) *Preliminary Remediation Goals for Ecological Endpoints* (Efroymson, et al., 1997a), and (3) EPA Region 5 ecological screening levels (EPA, 2003). Because OEPA water quality criteria do not consider food-chain effects, a hierarchy could potentially eliminate important surface water COPECs.

- ***Sediment.*** Sediment screening values were selected using the following hierarchy: (1) Consensus-based threshold effect concentration values (MacDonald, et al., 2000), (2) EPA Region 5 ecological screening levels (EPA, 2003), (4) *Preliminary Remediation Goals for Ecological Endpoints* (Efroymson, et al., 1997a), and (5) *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario* (Ontario Ministry of the Environment and Energy, 1993).

The development of the ESVs used for the former PBOW SLERAs is presented in Appendix B.

2.2.3.2 Frequency of Detection

Chemicals that are detected infrequently may be artifacts in the data that may not reflect site-related activity or disposal practices. These chemicals are not evaluated further in the risk evaluation. Generally, chemicals that are detected only at low concentrations in less than 5 percent of the samples from a given medium are dropped from further consideration, unless their presence is expected based on historical information about the site. Chemicals detected infrequently at elevated concentrations as compared with applicable risk-based thresholds may identify the existence of "hot spots" and have been retained in the evaluation, unless other information exists to suggest that their presence is unlikely to be related to site activities.

2.2.3.3 Background Evaluation

Chemical concentrations were compared to site-specific background concentrations (see next paragraph for details) as an indication of whether a chemical is present from site-related activity or as natural background. This comparison is generally valid for inorganic chemicals but not for organic chemicals, because inorganic chemicals are naturally occurring and most organic chemicals are not. Statistical techniques are used as tools to aid the exercise of professional judgment in resolving site-related issues for metals, because metals are naturally present in most environmental media. The statistical techniques generally involve comparing the site data with background data. Background data are only available for soil at PBOW. Background soil values were also used to compare to concentrations in sediment from samples collected from the unnamed ditch, as the bottom of the ditch is most likely composed of native soil, and accumulates sediment as a result of overland runoff from adjacent soils. Background data do not exist for surface water; therefore, a statistical background evaluation for this medium cannot be performed.

The first statistical technique used for the background screen is the comparison of the MDC of the site data set to the PBOW background screening concentration (BSC). The background data set and derivation of soil BSCs for all PBOW soil investigations are described in IT (1998). The

background soil samples were collected from near the property boundary, away from any potential source areas. BSCs were calculated for use at PBOW based on concentrations found in these background soil samples. Each BSC is either the MDC of the concentrations found in these background soil samples or the calculated 95th percent upper tolerance limit of the background data set, whichever value is lower (Shaw, 2005). The upper tolerance limit is the concentration, with a probability of 0.95 (or a confidence of 95 percent), that would capture (or cover) 95 percent of background samples if a larger number of samples were collected. Chemicals with MDCs less than their respective BSCs are eliminated from further consideration. If the MDC exceeds the BSC, the chemical may be retained as a COPEC, or a different statistical analysis may be performed to determine if the background data and the site data are drawn from the same population. The Wilcoxon Rank Sum (WRS) test is used for this purpose.

The WRS test (also known as the Mann-Whitney U test) is described in Appendix M of Shaw (2005). WRS testing is performed for inorganic chemicals in soil whose MDCs exceed their respective BSCs, and when the site and background data sets each contain less than 50 percent nondetects. The WRS test is not performed on data sets containing 50 percent or more nondetects because the medians of such data sets are unknown and the test lacks sufficient power to yield reliable results. Likewise, the WRS test is not performed on data sets of size $n < 5$; in such cases, the test lacks sufficient power to identify differences between the two samples. Site data sets are interpreted as being significantly different from PBOW background if the associated p-level is less than 0.05. WRS statistical output and box and whisker plots of the various inorganic COPEC data sets are appended to the SLERA for each inorganic data set evaluated against the site background data set. Analytes shown by the WRS results to exceed background (or for which the WRS testing was not run) are assumed to be site related and retained as COPECs, unless a qualitative chemical-specific explanation is presented in the uncertainties analysis as to why the analyte should not be regarded as site related. Analytes shown by the WRS results to be drawn from the same population as the background samples are assumed to be naturally occurring and are not retained as COPECs. WRS results were used to evaluate aluminum, chromium, lead, and vanadium in soil and manganese in sediment. Cadmium was also a candidate for WRS analysis, but no WRS test could be performed for this metal because all background samples were nondetect. Concentrations of aluminum, chromium, lead, and vanadium in soil were not statistically different from background concentrations; therefore, these three chemicals are considered to be naturally occurring. Concentrations of manganese in sediment were determined to be significantly greater than background soil concentrations, and this chemical was retained for further evaluation. Supporting information for the WRS tests, including box-and-whisker plots, are presented in Appendix C.

Chemicals that fail the background evaluation are assumed to be site-related, and are not eliminated at this point of the screening process.

2.2.3.4 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 to be 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.

2.2.4 Summary of COPEC Selection

The results of the COPEC screening are presented in Tables 2-8 through 2-10 for soil, surface water, and sediment. The tables present the following information for each medium:

- Chemical name
- Frequency of detection
- Range of detected concentrations
- Range of detection limits
- Arithmetic mean (average) of site concentrations
- Distribution type
- UCL of the mean of the concentration (only for chemicals selected as COPECs)
- Appropriate ESV
- BSC
- COPEC selection conclusion: NO (with rationale for exclusion), or YES (selected).

The selected EPC is also presented for each chemical identified as a COPEC. For soil, two EPC results are presented, a total soil EPC for concentrations in the 0-6 feet bgs depth range and a surface soil EPC for concentrations in the 0-2 feet bgs depth range. These two sets of EPCs are used to evaluate various ecological receptors that may be exposed to different soil depths associated with their various life history characteristics (see Section 3.1).

Footnotes in the tables provide the rationale for selecting or rejecting a chemical as a COPEC. In some situations, it is appropriate to reinstate as COPECs chemicals that have been eliminated using one or more of the screening criteria. Examples of these exceptions include potential breakdown products, chemicals known to have been used on site historically, chemicals with detection limits greater than the ESV, and chemicals with high bioconcentration and/or bioaccumulation factors. A qualitative evaluation of the COPEC tables for soil, surface water,

and sediment was performed; based on this evaluation, no additional COPECs are recommended for reinstatement.

Ten COPECs were selected for total soil (Table 2-8), 11 were selected for surface water (Table 2-9), and 5 were selected for sediment (Table 2-10). As discussed at the beginning of Section 2.0, the SLERA null hypotheses are that potential for adverse ecological effects are minimal or nonexistent due to the lack of viable habitat, potential ecological receptors, potential exposure pathways, and/or potential chemical stressors. Given the selection of COPECs in multiple media, and the finding that viable habitat, potential receptors, and potential exposure pathways exist at the site, none of the null hypotheses are accepted, and a predictive assessment is triggered. Chemicals not eliminated using the screening procedures previously presented are considered COPECs and are quantitatively evaluated in the predictive SLERA.

2.3 Ecological Endpoint (Assessment and Measurement) Identification

The first step in the predictive SLERA is the identification of assessment and measurement endpoints. 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 (e.g., the Comprehensive Environmental Response, Compensation, and Liability Act, National Environmental Policy Act). Other legislation includes the Endangered Species Act 16 U.S.C. 1531-1544 (1993, as amended) and the Migratory Bird Treaty Act 16 U.S.C. 703-711 (1993, as amended). To determine whether these protection goals are met at the site, assessment and measurement endpoints have been 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, nondomesticated receptors. This is accomplished by selecting measurement endpoints (discussed below) that are related to parameters most likely to result in population-level effects (e.g., survival, growth, or reproduction) and consideration of lowest-observed-adverse-effect levels (LOAEL) in addition to no-observed-adverse-effect level (NOAEL) endpoints (see Chapter 4.0). In the SLERA process, risks to individual receptors are assessed only if they are protected under the Endangered Species Act, are species that are candidates for protection, or are species of special concern.

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) definability in clear, operational terms (Suter, 1993). Selected assessment endpoints 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.

Measurement endpoints for this SLERA are based on toxicity values from the available literature and not statistical or arithmetic summaries of actual field or laboratory observations or measurements. When possible, receptors and endpoints have been 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 have been 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.

2.3.1 Assessment Endpoints

The assessment endpoints for the LBA 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, benthic invertebrates, omnivorous aquatic mammals, and omnivorous aquatic birds.” The corresponding null hypothesis for each of the assessment endpoints is stated as “the presence of site contaminants within soil, surface water, sediment, vegetation, and prey will have no effect on the survival or reproductive capabilities of terrestrial invertebrates, herbivorous mammals, omnivorous mammals, insectivorous mammals and birds, carnivorous birds, benthic invertebrates, omnivorous aquatic mammals, and omnivorous aquatic birds.”

Assessment receptor species were selected based on the likelihood of finding the species at the LBA. Historical information, the site reconnaissance (performed April 27, June 2, and September 9, 2009), and the availability of toxicological data were used to select terrestrial and aquatic assessment receptor species. These receptors species are depicted in food web models (Figures 2-4 and 2-5). 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 of organisms, 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 species names for organisms at the base of the food web (e.g., species names of terrestrial invertebrates). Thus, generic terrestrial invertebrates, benthic invertebrates, and aquatic invertebrates 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 (Chapter 3.0). Brief life history descriptions for the selected receptor species are provided in Appendix D.

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. COPECs can adsorb to the sediment and detritus particles through abiotic processes. When these particles settle and become part of the benthic substrate, they may also become a source of COPECs to benthic communities. Various species of aquatic biota fulfill the role of aquatic herbivores (feeding on aquatic plants and suspended detritus) and predatory invertebrates (feeding on benthic invertebrate species). The combination of COPEC bioconcentration from water, ingestion of contaminated prey, and restricted ranges for aquatic organisms provides good conditions for significant bioaccumulation of COPECs. In terrestrial species, bioconcentration occurs in plants and invertebrates, and higher food chain receptors bioaccumulate COPECs through the ingestion of food items.

2.3.2 Measurement Endpoints

Measurement endpoints are frequently 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 parameters in toxicity tests; individual abundance; and species diversity (EPA, 1997).

For assessments, measurable responses to stressors may include LOAELs, NOAELs, lethal concentration to 50 percent of the test population, lethal dose to 50 percent of the test population, or effective concentration for 20 percent of the test population, collectively termed toxicity reference values (TRV) (see Section 4.1 for further explanation).

2.4 Selection of Assessment Receptors

In order to focus the exposure characterization portion of the SLERA on species or components that are the most likely to be affected and on those that, if affected, are most likely to result in significant impacts to the on-site ecosystem, the selection of assessment receptors focuses on species, groups of species, or functional groups that are directly related to the assessment endpoints previously identified (Section 2.3.1).

Site biota were organized into major functional groups. 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, including vertebrates (water fowl and fish), aquatic invertebrates, and wetland/terrestrial mammals. Species presence and relative abundance were partly determined during the site reconnaissance.

Primary criteria for selecting appropriate assessment receptors include, but are 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 chemicals.
- 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 by a governmental organization, or the receptor consists of critical habitat for rare, threatened, or endangered species.

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. Assessment receptors are representative species that are modeled for exposure to contaminants via multiple exposure routes. Organisms at the base of the food chain (i.e., plants, invertebrates, etc.) are not evaluated for food chain effects because direct exposure is the primary exposure route of concern for these organisms, and direct exposure effects are evaluated by the ecological benchmark comparison during the initial COPEC screening process. Therefore, these types of organisms are not selected as assessment receptors.

2.4.1 Terrestrial Receptors

Seven representative terrestrial receptor species that are expected or possible in the area of the LBA (based on the ecological description of the site presented in Section 2.1) 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, and include herbivores, omnivores, and carnivores. 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 terrestrial 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).

A terrestrial food web is presented on Figure 2-4. Many of the species evaluated, particularly the deer mouse, cottontail rabbit, short-tailed shrew, marsh wren, and muskrat, have limited home ranges which make them particularly vulnerable to exposure from site contaminants. All of the selected terrestrial receptor species have a potential 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. 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 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. Estimated hazards to the selected terrestrial indicator receptors are considered protective of organisms with larger home ranges and/or migratory organisms. Area use factors were set to 100 percent for the mouse, shrew, rabbit, wren, and muskrat due to their relatively small home ranges (Section 3.1). However, for the deer, hawk, and raccoon, the area use factor was set at 0.003, 0.002, and 0.01 (or 0.3, 0.2, and 1 percent), respectively, based on these species' relatively large home ranges (518, 842, and 156 hectares, or 1,280, 2,081, and 385 acres, respectively), compared with the size of the site (approximately 4 acres [Figure 1-2]).

Results of the assessment receptor selection process are presented in detailed biological and ecological descriptions called assessment receptor profiles (ARP). The biologically relevant criteria used to select the seven terrestrial assessment receptors are also discussed and summarized in the ARP (Appendix D).

2.4.2 Aquatic Receptors

The only aquatic habitat at the site is the unnamed ditch which is a tributary to Plum Brook and which separates the Locomotive Shop from the Rail Car Wash Area. During site observations, the water in this ditch appeared to be approximately 1 to 2 feet deep. Flow was not observed. Exposure to aquatic organisms within the ditch is assumed to occur via direct exposure to contaminants in the water column and via ingestion of benthic invertebrates as well as prey exposed to contaminants in surface water and sediment. Potential uptake through the aquatic food chain is evaluated for the raccoon (also considered as a terrestrial receptor) and muskrat (*Ondatra zibethicus*) (medium-sized aquatic herbivorous mammal). An avian aquatic omnivore such as the mallard (*Anas platyrhynchos*) is not evaluated because open water that can be used by mallards and other "dabblers" to forage for vegetation and other food sources is not present at the site.

Aquatic organisms represent some of the prey base for aquatic receptors (represented by the raccoon and muskrat). An aquatic food web is presented on Figure 2-5. The raccoon has been documented at the site (Section 2.1), has a potential high abundance and wide distribution at the site, and sufficient toxicological information is available in the literature for comparative and interpretive purposes. The muskrat is also likely to be found at PBOW (see Table 2-2). Although the unnamed ditch may be too small a water body to support muskrat populations, this receptor is conservatively included to represent mammalian aquatic herbivores. Both the raccoon and muskrat have readily available exposure data, as summarized in the *Wildlife Exposure Factors Handbook* (EPA, 1993).

Results of the assessment receptor selection process, including a summary of the relevant biological criteria used to select the aquatic assessment receptors, are presented in the ARPs (Appendix D).

2.5 Ecological Site Conceptual Model

Pictorial representations of the evaluated food webs are presented on Figures 2-4 and 2-5. The accompanying text presented in Section 3.1 is intended to clarify the ecological site conceptual models (ESCM). The ESCMs trace the contaminant pathways through both abiotic components and biotic food web components of the environment. The ESCMs present all potentially complete exposure pathways. The ESCMs have been 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

An estimate of the nature, extent, and magnitude of potential exposure of assessment receptors to COPECs that are present at or migrating from the site is presented in this section, considering both current and reasonably plausible future use of the site. Exposure characterization is critical in further evaluating the risk of chemicals identified as COPECs during the screening process (Section 2.2). The exposure assessment has been conducted by linking the magnitude (concentration) and distribution (locations) of the contaminants detected in the media sampled during the investigation, evaluating pathways by which chemicals may be transported through the environment, and determining the points at which organisms found in the study area may contact contaminants.

3.1 Exposure Analysis

An exposure analysis was performed that combines the spatial and temporal distribution of the ecological receptors with those of the COPECs to evaluate exposure. The exposure analysis focuses on the bioavailable chemicals and the means by which the ecological receptors are exposed (e.g., exposure pathways). The focus of the analysis is dependent on the assessment receptors being evaluated as well as the assessment and measurement endpoints.

Exposure pathways consist of four primary components: source and mechanism of contaminant release, transport 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 have been addressed within this SLERA. If any of these components is not complete, then contaminants in the affected media do not constitute an environmental risk at the site. The major fate and transport properties associated with typical site contaminants are described in subsequent sections. These properties directly affect a contaminant's behavior in each of the exposure pathway components.

Ecological routes of exposure for biota may be direct (bioconcentration) or through the food web via the consumption of contaminated organisms (biomagnification). Direct exposure routes include dermal contact, absorption, inhalation, and ingestion. 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. Given the scarcity of available data for wildlife dermal and inhalation exposure pathways, potential risk from these pathways is not estimated in this

SLERA. In addition, these pathways are generally considered to be incidental for most species, with the possible exceptions of burrowing animals and dust-bathing birds.

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.

Bioavailability is an important contaminant characteristic that influences the degree of chemical-receptor interaction. The bioavailability of a chemical refers to the degree to which a receptor is able to absorb a chemical from the environmental medium. A chemical's bioavailability is a function of several physical and chemical factors such as grain size, organic carbon content, water hardness, and pH. Unless site-specific data are available, bioavailability is conservatively assumed to be 100 percent.

Daily doses of COPECs for vertebrate receptors were calculated using standard exposure algorithms. These algorithms incorporate species-specific natural history parameters (i.e., feeding rates, water ingestion rates, dietary composition, etc.) and also use site-specific area use factors, as follows:

$$Total\ Daily\ Dose = \left(\frac{\left(\left[Soil_j * IR_{soil} \right] + \left[Water_j * IR_{water} \right] + \left[\sum_{i=1}^{N} B_{ji} * P_i * IR_{food} \right] \right)}{Body\ Weight} \right) * AUF \qquad \text{Eq. 3.1}$$

where:

$Soil_j$	=	Concentration of COPEC "j" in soil
$Water_j$	=	Concentration of COPEC "j" in surface water
B_{ji}	=	Concentration of COPEC "j" in food type "i"
IR_{soil}	=	Soil ingestion rate
IR_{water}	=	Surface water ingestion rate
IR_{food}	=	Food ingestion rate
P_i	=	Proportion of food $type_i$ in receptor diet
AUF	=	Area use factor (equal to area of exposure unit/home range of receptor
Body Weight	=	Body weight of receptor.

Sediment may replace soil in Equation 3.1 for aquatic or semiaquatic receptors.

The first step in estimating exposure rates for terrestrial wildlife involves the calculation of feeding and drinking rates for site receptors. EPA (1993) includes a variety of exposure

information for a number of avian, herptile, and mammalian species. Information regarding feeding and drinking rates and dietary composition are available for many species or may be estimated using allometric equations (Nagy, 1987). Data on incidental ingestion of soil have also been gathered and are incorporated for the receptor species. Literature values for animal-specific sediment ingestion are used if available. However, such values generally are not available in the literature. Where sediment ingestion rates could not be found, the animal-specific incidental soil ingestion rate is used for sediment ingestion as well, if the receptor's life history profile suggests a significant aquatic component (e.g., raccoons' use of surface water in foraging activities). This information is summarized in Table 3-1.

To estimate dose associated with ingested food items, concentrations of COPECs in the vegetation or prey in the species' diet is estimated using bioaccumulation factors (BAF) (sometimes referred to as bioconcentration factors [BCF]). BAFs are based on regression models or scalar variables that reflect the potential for the COPECs to be present in food items at concentrations different from (usually greater than) the ambient environment. Differences in concentration are due to chemical-specific properties of the COPEC that affect its tendency to bioaccumulate in tissue, balanced by the innate ability of the species to regulate body burden levels of the chemical via metabolic and excretory processes.

Selection of appropriate BAFs is a critical component to food chain modeling. General approaches for BAF selection have been discussed in Sample and Suter (1994), EPA (1999a), U.S. Army Environmental Center (2005), and EPA (2008). An approach that is consistent with these sources was followed in the selection of BAFs for PBOW. The general hierarchy for selection of BAFs based on types of sources, is as follows:

1. Use of regression equations derived from paired field- or laboratory-based measurements

2. Ratio-derived BAFs developed based on paired data of tissue concentrations compared to media concentrations where the BAF is equal to the tissue concentration divided by the concentration in the abiotic medium.

3. Modeled equilibrium partitioning-derived BAFs based on physical or chemical characteristics

4. Assumptions based on values common to chemical class.

Both U.S. Army Environmental Center (2005) and EPA (1999a) support the use of ratio BAFs in preference to equilibrium partitioning-based BAFs, which are typically calculated based on

factors such as log octanol-water partition coefficient (K_{ow}) values, fraction of organic carbon in soil, or percent of lipids in invertebrates.

Other general recommendations provided in EPA (2008) were also followed, including the following:

- For selection of ratio-based BAFs, median values are selected over maximum or other high-end BAFs.
- BAFs for polynuclear aromatic hydrocarbon (PAH) accumulation into mammalian prey are assumed to equal zero due to the high metabolic breakdown of PAHs in mammals.

Regression equations used to calculate prey tissue concentrations of a specific chemical typically take the following general equation form:

$$\text{Ln}\ (C_{food}) = \text{slope value x ln}\ (C_{abiotic_media}) + \text{intercept value} \qquad \text{Eq. 3.2}$$

where:

C_{food}	=	Concentration of chemical in food type
$C_{abiotic_media}$	=	Concentration of chemical in abiotic media.

Ratio BAFs can be generally presented as follows:

$$C_{food} = \text{BAF x}\ (C_{abiotic_media}) \qquad \text{Eq. 3.3}$$

where:

C_{food}	=	Concentration of chemical in food type
$C_{abiotic_media}$	=	Concentration of chemical in abiotic media
BAF	=	Bioaccumulation factor.

BAFs calculated based on equilibrium partitioning typically use a physical constant of a chemical to generate a BAF. A generalized form for this calculation would be as follows:

$$\text{Log (BAF)} = \text{slope value x Log}\ (K_{ow}) + \text{intercept value} \qquad \text{Eq. 4}$$

where:

Log (BAF)	=	Log of the BAF for chemical in food type
K_{ow}	=	Octanol-water partition coefficient.

BAFs calculated based on equilibrium partitioning are applied in the same fashion as ratio-based BAFs to generate a tissue concentration value. Any K_{ow} values needed for BAFs based on equilibrium partitioning are obtained using the K_{ow} WIN application in EPA's EPI Suite software (http://www.epa.gov/oppt/exposure/pubs/episuite.htm).

Finally, where ratio-based BAFs are missing and where no equilibrium partitioning method has been developed for calculating BAFs, other methods, such as using BAFs for chemicals in the same class as surrogates, may be presented for establishing ratio-based BAFs.

Site-specific soil-to-earthworm and sediment-to-benthic invertebrate BAFs were developed for the Red Water Ponds site at PBOW. These BAFs were developed as part of a Phase II baseline ecological risk assessment (IT, 2001b) based on 28-day bioaccumulation studies performed using the earthworm species *Eisenia foetida* and the invertebrate species *Lumbriculus variegates.* BAFs were calculated after comparing tissue concentrations with concentrations detected in soil or sediment samples collected from the PBOW Red Water Pond areas. For the current SLERA, these PBOW-specific BAFs were used for the LBA food chain models as well, when available. Both reasonable maximum exposure (RME) and central tendency (CT) BAFs were estimated in the Red Water Ponds risk assessment. The RME BAFs were based on all tissue concentration results, even if blank related, and the CT BAFs were based on blank-corrected tissue results. Although EPA recommends that median values are selected over maximum or other high-end BAFs, the RME sediment-to-aquatic invertebrate and soil-to-worm BAFs were conservatively selected over the CT BAFs as the selected BAFs for the LBA SLERA, when available. The Red Water Ponds baseline ecological risk assessment also developed CT and RME BAFs for surface water-to-fish for two different PBOW sites, the West Area Red Water Ponds and Pentolite Road (IT, 2001b). These values were also adopted for use in the LBA SLERA. When two surface water-to-fish values were available for a given chemical from the two areas, the average of the RME values was used as the BAF for the LBA SLERA.

The hierarchies used to select BAFs specific to the various types of biota are presented below. Chemical-specific BAFs (or the regression equation used to calculate COPEC concentrations) for COPECs selected using the respective hierarchies are presented in Tables 3-2 through 3-6.

Table 3-2 presents the soil-to-plants BAFs for COPECs at the LBA. Soil-to-plants BAFs are also used to evaluate sediment-to-plant uptake at PBOW. Soil-to-plants BAFs are selected using the following specific hierarchy of sources:

1. EPA (2008) selected regressions
2. Efroymson, et al. (2001) regressions
3. EPA (2008) recommended non-regression BAFs
4. International Atomic Energy Agency (IAEA) (1994) BAFs
5. Baes, et al. (1984) BAFs (these values were often updated in the more recent IAEA [1994] publication).

Table 3-3 presents the soil-to-invertebrates (earthworms) BAFs for COPECs at the LBA. Soil-to-invertebrates BAFs are selected using the following hierarchy of sources:

1. PBOW site-specific BAFs (IT, 2001b)
2. EPA (2008) selected regressions
3. Sample, et al. (1998a) regressions
4. Sample, et al. (1998a) median BAFs
5. Equilibrium BAF calculation method in EPA (2008) based on Jager (1998).

Table 3-4 presents the soil-to-mammals BAFs for COPECs at the LBA. Soil-to-mammals BAFs are selected using the following hierarchy or sources:

1. EPA (2008) or Sample (1998b) selected regressions
2. EPA (2008) referenced BAFs (Note: per EPA [2008], a BAF of zero is used for all PAHs, TNT, and RDX.)
3. Sample, et al. (1998b) median BAFs
4. IAEA (1994) BAFs
5. Baes, et al. (1984) BAFs (these values were often updated in the newer IAEA [1994] publication)
6. EPA (1999b) maximum calculated BAFs/BCFs for feeding guilds.

Table 3-5 presents the sediment-to-aquatic invertebrates BAFs for COPECs at the LBA. Sediment-to-aquatic invertebrates BAFs are selected using the following hierarchy of sources:

1. PBOW site-specific BAFs (IT, 2001b)
2. Ratio BAFs from Bechtel Jacobs Company, LLC (1998)
3. Ratio BAFs from EPA (1999b)
4. Ratio BAFs from other literature sources
5. Conservative default based on median BAF for PCBs from Bechtel-Jacobs Corporation, LLC (1998).

Table 3-6 presents the surface water-to-fish BAFs for COPECs at the LBA. Surface water-to-fish BAFs are selected using the following hierarchy:

1. PBOW site-specific BAFs (IT, 2001b)
2. EPA (1999b) ratio BAFs
3. EPA (1989) ratio BAFs

4. Risk Assessment Information System database (Oak Ridge National Laboratory, 2008)
5. Equilibrium partitioning equation (Bintein and Devillers, 1993).

It should be noted that the BAFs presented in EPA (1989; 1999b) are given in units of milligrams per kilogram (mg/kg) (wet) per milligrams per liter (mg/L). These BAFs were adjusted to BAFs with dry weight units of mg/kg (dry) per mg/L by dividing by the proportion of solids of a fish (20 percent, as detailed in Table C-5 [EPA, 2000]).

Ingestion rates for receptor species are typically developed as a quantity of wet weight material ingested. Soil analytical data results are typically reported on a dry weight basis. Literature-derived BAFs are often a mixture of dry weight to wet weight, and dry weight to dry weight values. To avoid underestimating or overestimating food concentrations based on confusion over dry weight versus wet weight, final food concentrations are adjusted in the SLERA to report concentrations on a dry weight basis. Although it was not necessary to convert food intake rates from wet weight to dry weight in this SLERA, the moisture contents of the invertebrate and vegetative material in the receptor species' diets from the EPA's *Wildlife Exposure Factors Handbook* (EPA, 1993) can be used for this conversion, as follows:

- Earthworms - 84 percent
- Fruit - 77 percent
- Roots/young grass - 82 percent
- Seeds - 9.3 percent
- Fruit/young grass - 78 percent.

Exposure to four categories of environmental media are addressed in the 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 animals, exposure to soil from a depth of 0 to 1 foot bgs (extended to 0 to 2 feet bgs for this SLERA, due to the inclusion of samples LBA0012, which was collected from 0.9 to 1.9 feet bgs, and PBOW99-DP002-0002, which was collected from 0 to 2 feet bgs in the surface soil database) was considered, as this soil depth would represent the depth of regular exposure. For burrowing animals such as the shrew, exposure to soil from a depth of 0 to 6 feet bgs was considered. It is noted that although the shrew itself may not actually burrow to a depth of 6 feet, there may be other burrowing mammals that do burrow this deep. For plants and herbivores that feed on deep-rooted plants (e.g., the white-tailed deer, which is assumed to ingest leaves of trees translocating COPECs from subsoils), exposure to soil from a depth of 0 to 6 feet bgs (or the water table surface) was also evaluated because most

feeder roots are located within this depth. Thus, the shrew and the white-tailed deer (Figure 2-4), were evaluated for exposure to deeper (0-6 feet bgs) soil. All other receptors exposed to soil were evaluated for exposure to concentrations in surface (0-2 feet bgs) soil.

Environmental conditions such as 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. Generally, neutral to alkaline soils (soil pH of 6.5 or greater) restrict the absorption of toxic metals, making pathway completion to plants difficult.

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 over-ground transport from the LBA area and contaminated surface water, groundwater, and soil. The release mechanisms include surface water runoff, groundwater discharge, and airborne deposition. Potential receptors of 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 (e.g., polychlorinated biphenyls 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 transport medium for COPECs. Potential sources for contaminated surface water include over-ground transport from the LBA area, contaminated soil/sediment and groundwater, and deposition of airborne contaminants. The release mechanisms include surface 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 constitutes a potential indirect exposure pathway for faunal receptors. 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 leaching of contaminants in soil.

Groundwater itself is not an exposure point in ecological risk assessments, although contaminant transport along the shallow groundwater pathway may be considered an exposure route to wildlife where the groundwater discharges to surface water. This pathway is of importance to aquatic receptors if groundwater is found to be discharging to surface water. Because this scenario is unlikely at the LBA, groundwater was not directly evaluated in this SLERA. However, surface water samples were collected from the unnamed ditch during the wet season in May 2009, which is when groundwater discharge to the ditch is most likely. Thus, the surface water evaluation considers potential impact from contaminants that may be present in groundwater, under exposure conditions in an aquatic habitat.

3.2 Exposure Characterization Summary

The estimated chemical intakes for each exposed receptor group under each exposure pathway and scenario are presented in the risk characterization spreadsheets in Appendix E. These intake estimates are combined with the COPEC toxicity values, discussed in the following section, to derive estimates and characterize potential ecological risk. The uncertainties associated with the estimation of chemical intake are discussed in Section 5.2.

4.0 Ecological Effects Characterization

The ecological effects characterization primarily describes the development of TRVs. TRVs provide a reference point for the comparison of toxicological effects upon exposure to a contaminant and are compared against calculated receptor doses. TRVs are not used for evaluating plants or invertebrates, which are evaluated in terms of potential hazards at a community scale rather than a species scale.

Development of Toxicity Reference Values. TRVs focusing on the growth, survival, and reproduction of species and/or populations have been developed for the LBA SLERA. Empirical data are available for the specific receptor-endpoint combinations in some instances. Data on surrogate species and/or on endpoints other than the NOAEL and LOAEL were considered as necessary. The NOAEL is a dose of each COPEC that produced no known adverse effects in the test species. The NOAEL was judged to be an appropriate toxicological endpoint since it would provide the greatest degree of protection to the receptor species. In addition, the LOAEL was used as a point of comparison for risk management decisions. In instances where data are unavailable for a site-associated COPEC, toxicological information for surrogate chemicals or groups of chemical were used. Safety factors were used to adjust for these differences and extrapolate risks to the site's receptors at the NOAEL and/or LOAEL endpoint. This process is described in the following paragraphs.

Toxicity information pertinent to identified receptors has been gathered for those analytes identified as COPECs. Because the measurement endpoint ranges from the NOAEL to the LOAEL, preference has been given to chronic studies noting concentrations at which no adverse effects were observed and those for which the lowest concentrations associated with adverse effects were observed. Where data are unavailable for the exposure of a receptor to a COPEC, data for a surrogate chemical or group of chemicals were considered for use in the SLERA.

Whenever possible, studies that use the site-specific target wildlife receptors were utilized. When studies for these species were not available, alternative species studies were used. TRVs are not applied across classes under any circumstances (e.g., a TRV for a bird species may not be used to estimate hazard for a mammal species). In instances where TRVs for multiple avian or mammalian species are supported, the TRV for the most similar species to the measurement receptor based on feeding strategy and physiological attributes were used in the SLERA. For example, avian TRVs based on both quail and kestrel test species data are available for lead,

which was identified as a COPEC in surface water. The quail TRV was used in the food chain model to evaluate the marsh wren measurement receptor because both the quail and the wren have an insectivorous component to their diet, whereas the kestrel TRV was used for the red-tailed hawk due to closer taxonomic similarity and foraging patterns (i.e., carnivores). The following TRVs had values for multiple test species available, which were applied to the various measurement receptors according to the table below:

COPEC	TRV Test Species	Measurement Receptor
Lead	Quail	Marsh Wren
Lead	Kestrel	Red-Tailed Hawk
Selenium	Duck	Marsh Wren
Selenium	Owl	Red-Tailed Hawk

Using the relevant toxicity information, TRVs were calculated for each of the COPECs. TRVs represent NOAELs and LOAELs with the safety factors presented in Wentsel, et al. (1996), applied to toxicity information that was derived from studies other than no-effects or lowest-effects studies (Figure 4-1).

Because NOAELs and LOAELs for the selected wildlife receptor species are based on data from test species that are usually different from the species of concern, previous ecological risk assessment often applied a mathematical adjustment to the TRVs using a power function of the ratio of species body weights (e.g., Sample, et al., 1996). This practice is often referred to as allometric scaling. Alternately, uncertainty factors have also been used to adjust the TRVs when the toxicity values were based on a different species from the evaluated receptor to account for the potential differences in species' chemical sensitivities. However, in recent years, these practices have been discouraged by most scientific and regulatory groups. Recent reviews of these practices (EPA, 2008; Allard, et al., 2009) have concluded that the use of allometric scaling of TRVs does not reflect a sound application of toxicological or ecological risk practices because supporting data for this practice are limited, and the ratio relationships used for the mathematical conversions were developed based on acute (rather than chronic) toxicity data. Allard, et al. (2009), also concluded that uncertainty factors based on an arbitrary multiplier should not be used without a scientific basis for their application. Therefore, the use of toxicity data without adjustments as reported in the literature is regarded as the most technically sound approach and is adopted for this SLERA. The TRVs used for this SLERA are summarized in Tables 4-1 and 4-2 for mammals and birds, respectively.

5.0 Risk Characterization

The risk characterization phase integrates information on exposure, exposure-effects relationships, and defined or presumed target populations. The result is a determination of the likelihood, severity, and characteristics of adverse effects to environmental stressors present at a site. Qualitative and semiquantitative approaches were used to estimate the likelihood of adverse effects occurring as a result of exposure of the selected site receptors to COPECs. Because potential adverse affects to terrestrial and aquatic plants and invertebrates have been qualitatively assessed during the initial COPEC screening step, the risk characterization focuses on potential impacts to assessment receptors (Section 2.3).

For the semiquantitative predictive assessment, TRVs and exposure rates were calculated and used to generate hazard quotients (HQ) (Wentsel, et al., 1996). HQs are calculated by summing intake doses across all exposure pathways for each chemical for a given receptor and dividing by the TRV. HQs for those chemicals that have a similar mode of toxicological action are typically summed to account for cumulative effects. In this SLERA, the four dinitrotoluenes were identified as potentially having similar mechanisms of toxicity and were summed. HQs are a means of estimating the potential for adverse effects to organisms at a contaminated site and for assessing the potential that toxicological effects will occur among site receptors.

5.1 Hazard Estimation for Terrestrial and Aquatic Wildlife

The hazard estimation was performed through a series of quantitative HQ calculations that compare receptor-specific exposure doses with TRVs. The HQs are compared 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 environmental effects, HQs from 10 up to but less than 100 represent a significant potential that effects could result from greater exposure, and HQs greater than 100 represent the highest potential for expected effects (Wentsel, et al., 1996). It should be noted that OEPA considers HQs greater than 1 to be potentially significant. It should also be noted that HQs are not measures of risk, are not population-based statistics, and are not linearly scaled statistics. Therefore an HQ above 1, even exceedingly so, does not definitively indicate that there is even one individual expressing the toxicological effect associated with a given chemical to which it was exposed (Tannenbaum, 2005; Bartell, 1996).

Table 5-1 summarizes the NOAEL and LOAEL-based HQs for the eight evaluated assessment receptors. Only aluminum (deer mouse, short-tailed shrew) and selenium (muskrat) had HQs

greater than 1, when rounded, for any receptor species. Aluminum was identified as a COPEC only in surface water (Table 2-9), and selenium was identified as a COPEC in both surface water and sediment (Tables 2-9 and 2-10). No NOAEL-based HQs exceeded 2, and no LOAEL-based HQs exceeded 1. Therefore, aluminum and selenium are considered to have a low potential for adverse effects.

The EPC for aluminum in surface water is skewed high due to the contribution from sample location LBA-SW06, which had a concentration of 23,800 µg/L. This was an order of magnitude greater than the next highest concentration of 2,520 µg/L detected at LBA-SW05. LBA-SW06 was characterized by very high turbidity (294.7 nephelometric turbidity units [NTU] compared with a range of 0.8-36 NTUs for other sample locations). Therefore, total recoverable aluminum in this water sample is likely associated with suspended clay particles originating from soil runoff and sediment from the base of the ditch. Aluminum was determined to be background-related in both soil and sediment (Tables 2-8 and 2-10). Therefore, aluminum in surface water is likely associated with suspended particles originating from naturally occurring mineral deposits.

Nearly 100 percent of the muskrat HQ of 2.09 for selenium was associated with ingestion of aquatic plants, which is an indirect pathway for selenium in sediment. Concentrations of selenium in sediment ranged from 1.7 to 3 mg/kg (Table 2-10), which approximate the soil BSC of 2 mg/kg. All detections of selenium in sediment were “J”-qualified. “J”-qualified data indicate that confidence in the presence of the chemical is high, but there is some uncertainty regarding the exact concentration. Because selenium in sediment only marginally exceeded the soil BSC based on “J”-qualified data, and because only the NOAEL-based HQ for selenium exceeded 1, adverse effects associated with selenium in sediment are unlikely, and this metal is not recommended for further evaluation.

TRVs were not identified for dibenzofuran or 1,2,4-trimethylbenzene for either mammals or birds. Both chemicals were selected as COPECs in soil because they lacked screening values (Table 2-8). Dibenzofuran was detected in 1 out of 18 samples at an estimated (“J”-qualified) concentration of 0.461 mg/kg. 1,2,4-Trimethylbenzene was detected in 2 out of 18 samples at estimated concentrations of 0.00171 and 0.00178 mg/kg. Although the lack of toxicity data represents an uncertainty in the SLERA, the presence of trace concentrations of these two chemicals in such a low number of samples is unlikely to impact ecological receptors at the site.

5.2 Uncertainty Analysis

A number of factors contribute to the overall variability and uncertainty inherent in ecological risk assessments. Variability is due primarily to measurement error and natural variability of

chemical concentrations in environmental media. Laboratory media analyses, sampling design/methods, 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 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, methods of direct field or laboratory observation, measurement, and/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 describes many of the major assumptions made for the SLERA. When discernible, the direction of bias caused by each assumption (i.e., whether the uncertainty results in an overestimate or underestimate of risk) is provided as well. Where possible, a description of recommendations for minimizing the identified uncertainties if the SLERA progresses to higher level assessment phases is also presented.

The most important uncertainties associated with this SLERA are discussed in the following paragraphs.

Assumptions of Bioavailability. The assumption that COPECs are 100 percent bioavailable likely overestimates the potential for adverse effects. The duration that has lapsed since the contaminant release affects bioavailability as the contaminant becomes sequestered 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 likely overestimates potential risks. As discussed previously, 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 overestimate or underestimate the potential for adverse effects. The method of administration of the contaminant in the laboratory is typically different than that experienced in the wild by the receptors. Also, laboratories typically use "naïve" organisms in their toxicity testing, which are likely to be much more sensitive to toxicants than organisms living in the wild or at the site, which have likely developed resistances or have otherwise adapted to ambient concentrations of chemicals in their environment.

Use of the HQ Method to Estimate Risks to Populations or Communities. The calculation of HQs also introduces uncertainty. The following limitations associated with HQs (Tannenbaum, et al., 2003) are noted:

- HQs are not measures of risk.
- HQs are not population-based.
- HQs are not linearly scaled.
- HQs are often produced that are unrealistically high and toxicologically impossible (e.g., estimated HQs greater than 1,000, although HQs generated for the LBA SLERA do not appear to fall into this category).
- Trace soil concentrations of inorganic chemicals (including concentrations well below background levels) can lead to HQ threshold exceedances.

Therefore, it should be understood that HQs greater than 1 do not mean that adverse ecological effects are occurring or may occur in the future.

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 the LBA, however, was designed to optimize efficiency of the sampling effort and reduce uncertainty by providing coverage of the affected area using historical data and site knowledge to focus on the most likely contaminated areas. This approach 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 considered sufficient to conclude that the potential for adverse impacts associated with chemicals present at the site is very low.

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:

- ***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 SLERA. Some organic chemicals, such as PAHs, may be considered to be anthropogenic background. The inclusion of ambient anthropogenic compounds in the SLERA may impart a conservative bias towards the risk assessment. Soil background values were compared with concentrations of metals detected in LBA sediment in this SLERA. The use of soil background values for comparison to concentrations detected in sediment results in some added uncertainty to the SLERA. Naturally occurring levels of metals can differ in soil and sediment because the presence of metals in the sediment matrix can be affected by factors such as pH of the sediment and overlying water, oxidation/reduction conditions, sediment texture, presence/absence of organic matter, dissolved oxygen levels, etc. Although the concentrations of naturally occurring metals in soil and sediment may differ somewhat, soil background values can provide a reasonable point of reference for determining concentrations in sediment that may be associated with contamination and that warrant further consideration. Because concentrations in "true" background sediment may be higher or lower than their equivalent BSCs in soil, the direction of bias is unknown.

- ***Estimated EPCs are uncertain.*** For statistical purposes, if a constituent is positively identified at a site and has at least a single detection, all the samples with nondetects are assumed to have a value equal to half the reporting limit and are included in the data set, although identified for the ProUCL software (EPA, 2010) as nondetects. However, typical laboratory methods are able to detect concentrations of a chemical well below the reporting limit, or even half the reporting limit. Therefore, although the exact concentration of a nondetect chemical is unknown, the use of half the reporting limit as a surrogate concentration likely overestimates the actual concentration and introduces a conservative bias into the risk assessment. Computed 95 percent UCL 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. For some 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 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 95 percent UCL can be

greater than the MDC. In such situations, the MDC is chosen as the EPC. High confidence limits or use of the MDC likely introduces a conservative bias into the risk assessment.

- Biased soil sampling is a common practice at contaminated sites to identify nature and extent of contamination and to reduce the potential for Type I errors when performing environmental investigations (i.e., concluding that a site is clean when it really is not). The biased sampling approach likely overestimates average chemical concentrations resulting in greater chemical concentrations, and predicted risk. The LBA sampling strategy was not strongly biased, however, and this uncertainty is considered minor for this particular SLERA.
- The selected SW-846 laboratory analytical methods 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.

In summary, the use of the 95 percent UCL as the EPC is likely to underestimate the EPC in 5 percent of the cases and overestimate exposure in 95 percent of cases, imparting an overall conservative bias to the risk assessment. Biased soil sampling may add to the conservativeness of the EPC.

6.0 Risk Summary and Conclusions

Chemicals detected in soil, surface water, and sediment were screened against conservative benchmark values and other criteria to identify COPECs in media present at the LBA. Ten chemicals in soil, 11 chemicals in surface water, and 5 chemicals in sediment were identified as COPECs for further evaluation. A food chain model was used to evaluate the potential hazard associated with exposure to these chemicals by representative measurement receptors. Only aluminum (deer mouse and short-tailed shrew) and selenium (muskrat) resulted in HQ values greater than 1. All HQs were below 5, and all HQs exceeding 1 were based on NOAELs; no LOAEL-based HQ exceeded 1 for any receptor. Aluminum was a COPEC in surface water, and selenium was a COPEC in surface water and sediment, although only selenium in sediment (not surface water) contributed significantly to the HQ of 2 for the muskrat.

Neither aluminum nor selenium is considered to be a final COPEC requiring further investigation because HQ values using conservative input values did not exceed 10 when rounded. Also, a review of the data indicated that elevated aluminum in surface water appears to be associated with high suspended solids/turbidity in a single sample. Because aluminum was determined to be naturally occurring in soil and sediment, the aluminum in the turbid water sample is likely background-related. Similarly, selenium in sediment was detected at “J”-qualified concentrations that approximated soil background levels, and is also likely naturally occurring.

Concern regarding exposure to chemicals at the LBA is unwarranted for most species because considerations such as the home range size and density characteristics of various ecological species of concern make it unlikely that multiple individuals of a given species (i.e., local populations) would be exposed to media at the 4-acre LBA site on a regular basis. In other words, the small size of the site precludes the possibility of population-level impacts at the LBA, regardless of whether contamination is present. However, hazard estimates were generated for a number of measurement receptors under the conservative assumption that impacts to populations are plausible. The results of this exercise revealed that the potential for adverse ecological impacts is considered to be minimal at his site because 1) the only HQ exceedances that were calculated using conservative assumptions marginally exceeded the target value of 1, which suggests that the HQs calculated using more precise and realistic assumptions would fall below 1; and 2) because the chemicals associated with these exceedances are likely background-related, the potential for adverse ecological impacts is considered to be minimal at this site. Therefore, no chemicals are recommended for further ecological investigation at the LBA.

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TABLES

Table 2-1

Plant Species Observed at the Locomotive Building Area
Plum Brook Ordnance Works, Sandusky, Ohio

Scientific Name	Common Name
Vegetation observed during June 2, 2009 site walk	
Acer negundo	box-elder
Achillea millefolium	yarrow
Agropyron repens	quack grass
Agrostis alba	redtop
Alisma plantago-aquatica	water plantain
Alliaria petiolata	garlic mustard
Ambrosia artemesiifolia	annual ragweed
Arctium minus	lesser burdock
Asclepias syriaca	common milkweed
Asparagus officinalis	asparagus
Brassica nigra	mustard
Bromus inermis	smooth brome
Capsella bursa-pastoris	shepherd's purse
Carduus nutans	nodding musk thistle
Carex amphibola var. turgida	eastern narrowleaf sedge
Carex blanda	eastern woodland sedge
Carex granularis	limestone meadow sedge
Carex scoparia	broom sedge
Carex vulpinoidea	fox sedge
Cirsium arvense	creeping thistle
Cornus drummondii	rough dogwood
Coronilla varia	crownvetch
Dactylis glomerata	orchard grass
Daucus carota	Queen Anne's lace
Eleagnus angustifolia	autumn olive
Equisetum arvense	field horsetail
Erigeron philadelphicus	fleabane
Festuca sp.	fescue
Fraxinus pennsylvanica	green ash
Galium aparine	cleavers
Galium asprellum	rough bedstraw
Gleditsia triacanthos	honeylocust
Hackelia virginiana	Virginia stickseed
Juncus effusus	soft rush
Lemna minor	lesser duckweed
Lonicera tatarica	Tartarian honeysuckle
Medicago lupulina	black medick
Melilotus officinalis	yellow sweet clover
Monarda sp.	bee balm
Oxalis stricta	sorrel
Panicum clandestinum	deer tongue grass
Parthenocissus quinquefolia	Virginia knotweed
Penstemon digitalis	false foxglove
Phragmites australis	common reed

Table 2-1

Plant Species Observed at the Locomotive Building Area
Plum Brook Ordnance Works, Sandusky, Ohio

Scientific Name	Common Name
Phytolacca americana	pokeweed
Plantago lanceolata	English plantain
Plantago major	common plantain
Poa pratensis	Kentucky bluegrass
Podophyllum peltatum	mayapple
Polygonum pennsyvlanicum	Pennsylvania smartweed
Populus deltoides	cottonwood
Quercus palustris	pin oak
Ranunculus sceleratus	cursed crowfoot
Rosa multiflora	multiflora rose
Rubus allegheniensis	Allegheny blackberry
Rubus flagellaris	dewberry
Rubus occidentalis	black raspberry
Rumex acetosella	sheep sorrel
Salix exigua	narrowleaf willow
Sambucus canadensis	common elder
Scripus atrovirens	green bulrush
Solidago canadensis	Canada goldenrod
Spenopholis intermedia	slender wedgescale
Taraxacum officinale	dandelion
Teucrium canadense	germander
Toxicodendron radicans	poison ivy
Trifolium pratense	red clover
Trifolium repens	white clover
Urtica dioicia	stinging nettle
Verbascum thapsus	woolly mullein
Vitis aestivalus	summer grape
Vitis riparia	riverbank grape

Table 2-1

Plant Species Observed at the Locomotive Building Area
Plum Brook Ordnance Works, Sandusky, Ohio

Scientific Name	Common Name
Vegetation observed during September 9, 2009 site walk	
Acer negundo	box-elder
Achillea millefolium	yarrow
Agropyron repens	quack grass
Agrostis alba	redtop
Alliaria petiolata	garlic mustard
Ambrosia artemesiifolia	annual ragweed
Andropogon gerardii	big bluestem
Apocynum cannabinum	dogbane
Arctium minus	lesser burdock
Asclepias syriaca	common milkweed
Asparagus officinalis	asparagus
Aster lateriflorus	Calico aster
Aster novae-angliae	New England aster
Bidens frondosa	devil's beggar ticks
Brassica nigra	mustard
Bromus inermis	smooth brome
Capsella bursa-pastoris	Shepherd's purse
Carduus nutans	nodding musk thistle
Carex amphibola var. turgida	Eastern narrowleaf sedge
Carex blanda	Eastern woodland sedge
Carex scoparia	broom sedge
Carex vulpinoidea	fox sedge
Chenopodium album	lamb's quarters
Cirsium arvense	creeping thistle
Conyza canadensis	horseweed
Cornus drummondii	rough dogwood
Coronilla varia	crownvetch
Cyperus erythrorhizos	red-root flatsedge
Cyperus strigosus	straw-colored flatsedge
Dactylis glomerata	orchard grass
Daucus carota	Queen Anne's lace
Dichanthelium dichotomum	cypress panic grass
Digitaria ischaemum	smooth crabgrass
Dipsacus sylvestris	teasel
Eleagnus angustifolia	autumn olive
Epilobium coloratum	purple-leaved willow herb
Equisetum arvense	field horsetail
Erechtites hieraciifolia	fireweed
Erigeron philadelphicus	fleabane
Eupatorium rugosum	snakeroot
Euphorbia maculata	spurge
Euthamia graminifolia	fragrant flat-topped goldenrod
Festuca sp.	fescue

Table 2-1

Plant Species Observed at the Locomotive Building Area
Plum Brook Ordnance Works, Sandusky, Ohio

Scientific Name	Common Name
Fraxinus pennsylvanica	green ash
Galium aparine	cleavers
Galium asprellum	rough bedstraw
Gleditsia triacanthos	honeylocust
Gnathalium obtusifolium	catfoot
Hackelia virginiana	Virginia stickseed
Hypericum perforatum	common St. John's wort
Ipomoea purpurea	common morning glory
Juncus effusus	soft rush
Lemna minor	lesser duckweed
Lepidium campestre	field peppergrass
Lonicera tatarica	Tartarian honeysuckle
Lycopus americanus	American bugleweed
Medicago lupulina	black medick
Melilotus officinalis	yellow sweet clover
Monarda sp.	bee balm
Nepeta cataria	catnip
Oxalis stricta	sorrel
Panicum capillare	witchgrass
Panicum clandestinum	deer tongue grass
Panicum virgatum	switchgrass
Parthenocissus quinquefolia	Virginia knotweed
Penstemon digitalis	false foxglove
Phleum pratense	timothy
Phragmites australis	common reed
Phytolacca americana	pokeweed
Plantago lanceolata	English plantain
Plantago major	common plantain
Poa pratensis	Kentucky bluegrass
Polygonum pennsyvlanicum	Pennsylvania smartweed
Polygonum virginianum	Virginia knotweed
Populus deltoides	cottonwood
Potamogeton pectinatus	Sago pondweed
Quercus palustris	pin oak
Rosa multiflora	multiflora rose
Rosa setigera	prairie rose
Rubus allegheniensis	Allegheny blackberry
Rubus flagellaris	dewberry
Rubus occidentalis	black raspberry
Rumex acetosella	sheep sorrel
Rumex crispus	curly dock
Salix exigua	narrowleaf willow
Sambucus canadensis	common elder
Scirpus atrovirens	green bulrush

Table 2-1

Plant Species Observed at the Locomotive Building Area
Plum Brook Ordnance Works, Sandusky, Ohio

Scientific Name	Common Name
Setaria faberi	foxtail
Setaria glauca	yellow foxtail
Solanum nigrum	black nightshade
Solidago canadensis	Canada goldenrod
Spenopholis intermedia	slender wedgescale
Taraxacum officinale	dandelion
Teucrium canadense	Germander
Toxicodendron radicans	poison ivy
Trifolium pratense	red clover
Trifolium repens	white clover
Urtica dioicia	stinging nettle
Verbascum blattaria	moth mullein
Verbascum thapsus	woolly mullein
Verbena hastata	blue vervain
Verbena urticifolia	white vervain
Vitis aestivalus	summer grape
Vitis riparia	riverbank grape

Table 2-2

Mammals Observed On Site and Likely to be Found in Erie County, Ohio Plum Brook Ordnance Works, Sandusky, Ohio

Family Name	Scientific Name	Common Name	Observed On Site [a]
Didelphidae	*Didelphis virginiana*	Virginia opossum	X
Talpidae	*Condylura cristata*	star-nosed mole (**T**)	
	Parascalops breweri	hairy-tailed mole	
	Scalopus aquaticus	Eastern mole	
Verspertilionidae	*Myotis keenii*	Keen's bat	
	M. lucifugus	little brown bat	
	M. sodalis	Indiana bat **(E*)**	
	Eptesicus fuscus	big brown bat	
	Lasionycteris noctivagans	silver-haired bat	
	Lasiurus borealis	red bat	
	L. cinereus	hoary bat	
	Nycticeius humeralis	evening bat	
	Pipistrellus subflavus	Eastern pipistrelle	
Leporidae	*Sylvilagus floridanus*	cottontail rabbit	X
Sciuridae	*Glaucomys volans*	Southern flying squirrel	
	Marmota monax	woodchuck	
	Sciurus carolinensis	gray squirrel	
	S. niger	fox squirrel	
	Spermophilus tridecemlineatus	thirteen-lined ground squirrel	
	Tamias striatus	Eastern chipmunk	
	Tamiasciurus hudsonicus	red squirrel	
	Blarina brevicauda	short-tailed shrew	
	Cryptotis parva	least shrew	
	Sorex cinereus	masked shrew	

Table 2-2

Mammals Observed On Site and Likely to be Found in Erie County, Ohio Plum Brook Ordnance Works, Sandusky, Ohio

Family Name	Scientific Name	Common Name	Observed On Site [a]
Castoridae	*Castor canadensis*	beaver	
Cricetidae	*Microtus pennsylvanicus*	meadow vole	
	Mus musculus	house mouse	
	Ondatra zibethicus	muskrat	
	Peromyscus leucopus	white-footed mouse	
	P. maniculatus	deer mouse	
	Rattus norvegicus	Norway rat	
	Synaptomys cooperi	Southern bog lemming	
	Zapus hudsonius	meadow jumping mouse	
Procyonidae	*Procyon lotor*	raccoon	X
Mustelidae	*Mephitis mephitis*	striped skunk	
	Mustela frenata	long-tailed weasel	
	M. nivalis	least weasel	
	M. vison	mink	
	Taxidea taxus	Badger (**T**)	
Canidae	*Canis latrans*	coyote	
	Urocyon cinereoargenteus	gray fox	
	Vulpes vulpes	red fox	
Cervidae	*Odocoileus virginianus*	white-tailed deer	X

Mammals likely to be found in Erie County based on information presented in
Gottschang, J. L., 1981, *A Guide to the Mammals of Ohio*, Ohio State University Press, 176 pages.
T = Ohio threatened species.
E* = Federally endangered species.

[a] Shaw Site Reconnaissance, April 27, June 2, and September 9, 2009.

Table 2-3

Birds Observed On Site and/or Likely to be Breeding
In Erie County, Ohio
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Ardeidae	*Ardea herodias*	great blue heron	(1) Regular visitor at ponds, streams, and ditches.
	Bublucus ibis	cattle egret (**E**)	(1) Rare visitor in short grass areas
	Butorides striatus	green heron	(1) Confirmed breeder, rare at ponds, streams.
	Casmerodius albus	great egret	(1) Regular visitor at ponds, streams, and ditches.
	Nycticorax nycticorax	black-crowned night heron (**T**)	(1) Regular visitor at ponds, streams, and ditches.
Anserinae	*Branta canadensis*	Canada goose	(1) Confirmed breeder; uncommon around ponds.
Anatinae	*Aix sponsa*	Wood duck	(1) Confirmed breeder, uncommon around ponds.
	Anas discors	blue-winged teal	Confirmed and/or probable breeder in county.
	A. platyrhynchos	mallard	(1) Confirmed breeder, uncommon at ponds, streams.
	A. rubripes	American black duck	(1) Possible breeder, rare at ponds, streams, ditches.
Merginae	*Lophodytes cucullatus*	hooded merganser	Confirmed and/or probable breeder in county.
Accipitrinae	*Accipiter striatus*	sharp-shinned hawk	Confirmed and/or probable breeder in county.
Buteoninae	*Buteo jamaicensis*	red-tailed hawk	Confirmed and/or probable breeder in county.
	B. lineatus	red-shouldered hawk	Confirmed and/or probable breeder in county.
	B. platypterus	broad-winged hawk	Confirmed and/or probable breeder in county.
	Haliaeetus leucocephalus	bald eagle (**T**)	Confirmed and/or probable breeder in county.
Anatidae	*Cygnus buccinator*	Trumpeter swan (**E**)	(1) Rare migrant seen flying toward lake.
Falconinae	*Falco sparverius*	American kestrel	Confirmed and/or probable breeder in county.
Phasianidae	*Colinus virginianus*	Northern bobwhite quail	Confirmed and/or probable breeder in county.
	Phasianus colchicus	ring-necked pheasant	Confirmed and/or probable breeder in county.
Rallidae	*Gallinula chloropus*	common moorhen	Confirmed and/or probable breeder in county.
	Porzana carolina	Sora	Confirmed and/or probable breeder in county.

Table 2-3

Birds Observed On Site and/or Likely to be Breeding
In Erie County, Ohio
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Cathartidae	*Cathartes aura*	turkey vulture	(2) Possible breeder in county.
Charadriidae	*Charadrius vociferus*	killdeer	Confirmed and/or probable breeder in county.
Scolopacidae	*Actitis macularia*	spotted sandpiper	Confirmed and/or probable breeder in county.
	Bartramia longicauda	upland sandpiper (**T**)	(1) Confirmed breeder, rare in grassy areas.
	Gallinago gallinago	common snipe	Confirmed and/or probable breeder in county.
	Scolopax minor	American woodcock	(1) Confirmed breeder, uncommon in moist woodlots.
Larinae	*Larus argentatus*	herring gull	(1) Regular visitor.
	L. delawarensis	ring-billed gull	(1) Regular visitor.
Columbidae	*Columba livia*	rock dove	(1) Confirmed breeder, very common.
	Zenaida macroura	mourning dove	(1) (2*) Confirmed breeder, very common.
Cuculidae	*Coccyzus americanus*	yellow-billed cuckoo	(1) Confirmed breeder, uncommon in woodlots, shrubs.
	C. erythropthalmus	black-billed cuckoo	(1) Probable breeder, rare in woodlots & shruby areas.
Tytonidae	*Bubo virginianus*	great horned owl	(1) Confirmed breeder, uncommon in woodlots.
	Otus asio	Eastern screech-owl	(1) Confirmed breeder, common in woodlots, shrubs.
	Strix varia	barred owl	Confirmed and/or probable breeder in county.
Caprimulgidae	*Chordeiles minor*	common nighthawk	(1) Possible breeder, rare.
Apodidae	*Chaetura pelagica*	chimney swift	(1) Confirmed breeder, uncommon.
Trochilidae	*Archilochus colubris*	ruby-throated hummingbird	(1) Confirmed breeder, uncommon in woodlots, shrubs.
Alcedinidae	*Ceryle alcyon*	belted kingfisher	(1) Confirmed breeder, rare around ponds, streams.
Picidae	*Colaptes auratus*	Northern flicker	(1) (2) Confirmed breeder, common in woodlots.
	Dryocopus pileatus	pileated woodpecker	Confirmed and/or probable breeder in county.
	Melanerpes carolinus	red-bellied woodpecker	(1) Confirmed breeder, common in mature woods.

Table 2-3

Birds Observed On Site and/or Likely to be Breeding
In Erie County, Ohio
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
	M. erythrocephalus	red-headed woodpecker	(1) Confirmed breeder, uncommon in mature woods.
	Picoides pubescens	downy woodpecker	(1) Confirmed breeder, common in woodlots.
	P. villosus	*hairy woodpecker*	(1) Confirmed breeder, uncommon in large woodlots.
Tyrannidae	*Contopus virens*	Eastern wood-pewee	(1) Confirmed breeder, very common in large woodlots.
	Empidonax alnorum	alder flycatcher	(1) Possible breeder, rare in shrubby wet areas.
	E. minimus	least flycatcher (**T**)	(1) Probable breeder, rare in shrubby areas.
	E. traillii	willow flycatcher	(1) (2*) Confirmed breeder, very common in shrubby areas.
	E. virescens	Acadian flycatcher	(1) Confirmed breeder, uncommon in mature woodlots.
	Myiarchus crinitus	great crested flycatcher	(1) Confirmed breeder, common in large woodlots.
	Sayornis phoebe	Eastern phoebe	(1) Confirmed breeder, common near stream bridges.
	Tyrannus tyrannus	Eastern kingbird	(1) Confirmed breeder, very common - open shrub area.
Alaudidae	*Eremophila alpestris*	horned lark	(1) Probable breeder, rare in grassland, cultiv. fields.
Hirundinidae	*Hirundo pyrrhonota*	cliff swallow	Confirmed and/or probable breeder in county.
	H. rustica	barn swallow	(1) Confirmed breeder, very common near vacant bldgs.
	Progne subis	purple martin	(1) Probable breeder, rare.
	Riparia riparia	bank swallow	(1) Rare migrant or visitor.
	Stelgidopteryx seripennis	Northern rough-winged swallow	(1) Confirmed breeder, rare along streams, ditches.
	Tachycineta bicolor	tree swallow	(1) (2*) Confirmed breeder, rare around ponds.
Corvidae	*Corvus brachyrhynchos*	American crow	(1) Confirmed breeder, very common in woodlots.
	Cyanocitta cristata	blue jay	(1) Confirmed breeder, abundant in woods.

Table 2-3

Birds Observed On Site and/or Likely to be Breeding
In Erie County, Ohio
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Paridae	*Parus atricapillus*	black-capped chickadee	(1) Confirmed breeder, common in woodlots.
	P. bicolor	tufted titmouse	(1) Confirmed breeder, common in woodlots.
Sittidae	*Sitta carolinensis*	white-breasted nuthatch	(1) Confirmed breeder, uncommon in woodlots.
Troglodytidae	*Cistothorus palustris*	marsh wren	(1) Possible breeder, rare in wetlands with cattails.
	C. platensis	sedge wren	(1) Confirmed breeder, common in old grassy fields.
	Thryothorus ludovicianus	Carolina wren	(1) Probable breeder, rare in shrubby areas & woodlots.
	Troglodytes aedon	house wren	(1) Confirmed breeder, abundant in shrubby areas.
	T. troglodytes	winter wren	(1) Rare migrant.
Mimidae	*Dumetella carolinensis*	gray catbird	(1)(2*) Confirmed breeder, abundant in shrubby areas.
	Mimus polyglottos	Northern mockingbird	(1) Confirmed breeder, rare in shrubby areas.
	Toxostoma rufum	brown thrasher	(1) (2*) Confirmed breeder, common in shrubby areas.
Turdidae	*Catharus fuscescens*	veery	(1) Confirmed breeder, uncommon in large woodlots.
	Hylocichla mustelina	wood thrush	(1) Confirmed breeder, very common in large woodlots.
	Sialia sialis	Eastern bluebird	(1) Confirmed breeder, common in openfields & edges.
	Turdus migratorius	American robin	(1)(2*) Confirmed breeder, abundant everywhere.
Sylviidae	*Polioptila caerulea*	blue-gray gnatcatcher	(1) Confirmed breeder, uncommon in woodlots.
	Regulus calendula	ruby-crowned kinglet	(1) Rare migrant.
Bombycillidae	*Bombycilla cedrorum*	cedar waxwing	(1) Confirmed breeder, very common everywhere.
Sturnidae	*Sturnus vulgaris*	European starling	(1) Confirmed breeder, abundant everywhere.

Table 2-3

Birds Observed On Site and/or Likely to be Breeding
In Erie County, Ohio
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Vireonidae	*Vireo bellii*	Bell's vireo	Confirmed and/or probable breeder in county.
	V. flavifrons	yellow-throated vireo	(1) Confirmed breeder, uncommon in mature woodlots.
	V. gilvus	warbling vireo	(1) Confirmed breeder, common in large woodlots.
	V. griseus	white-eyed vireo	(1) Confirmed breeder, uncommon in shrubby areas.
	V. olivaceus	red-eyed vireo	(1) Confirmed breeder, very common in woodlots.
Parulidae	*Dendroica cerulea*	cerulean warbler	(1) Possible breeder, rare in mature woodlots.
	D. dominica	yellow-throated warbler	(1) Confirmed and/or probable breeder in county.
	D. pensylvanica	chestnut-sided warbler	(1) Probable breeder, uncommon in shrubby areas.
	D. petechia	yellow warbler	(1) (2*) Confirmed breeder, abundant in shrubby areas.
	D. virens	*black-throated green warbler*	(1) Possible breeder, rare in mature woodlots.
	Geothylpis trichas	common yellowthroat	(1) Confirmed breeder, abundant in shrub areas, fields.
	Icteria virens	yellow-breasted chat	(1) Confirmed breeder, uncommon in shrubby areas.
	Mniotilta varia	black and white warbler	(1) Possible breeder, rare in mature woodlots.
	Oporornis formosus	Kentucky warbler	(1) Possible breeder, rare in mature woodlots.
	Protonotaria citrea	prothonotary warbler	Confirmed and/or probable breeder in county.
	Seiurus aurocapillus	overbird	(1) Probable breeder, rare in mature woodlots.
	S. motacilla	Louisiana waterthrush	Confirmed and/or probable breeder in county.
	Setophaga ruticilla	American redstart	(1) Probable breeder, rare in shrubby areas & woodlots.
	Vermivora leucobronchialis	Brewster's warbler	(1) Possible breeder, rare in shrubby areas and edges.
	V. pinus	blue-winged warbler	(1) Confirmed breeder, common in shrubby areas.
	Wilsonia citrina	hooded warbler	Confirmed and/or probable breeder in county.

Table 2-3

Birds Observed On Site and/or Likely to be Breeding
In Erie County, Ohio
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
Icteridae	*Agelaius phoeniceus*	red-winged blackbird	(1) (2*) Confirmed breeder, abund. in grasslands, streams.
	Dolichonyx oryzivorus	bobolink	(1) Confirmed breeder, uncommon in grasslands.
	Icterus galbula	Northern oriole	(1) Confirmed breeder, uncommon in open woods.
	I. spurius	orchard oriole	(1) Confirmed breeder, common in open woods & edges.
	Molothrus ater	brown-headed cowbird	(1) Confirmed breeder, abundant everywhere.
	Quiscalus quiscula	common grackle	(1) Confirmed breeder, abundant everywhere.
	Sturnella magna	Eastern meadowlark	(1) Confirmed breeder, common in grasslands.
Ploceidae	*Passer domesticus*	house sparrow	(1) Confirmed breeder, uncommon near buildings.
Thraupidae	*Piranga olivacea*	scarlet tanager	(1) Possible breeder, rare on open woods.
	P. ruba ruba	summer tanager	(1) Confirmed breeder, common in mature woodlots.
Fringillidae	*Ammodramus henslowii*	Henslow's sparrow	(1) Probable breeder, rare in old fields.
	A. savannarum	grasshopper sparrow	(1) Confirmed breeder, common in grasslands.
	Cardinalis cardinalis	Northern cardinal	(1)(2*) Confirmed breeder, abundant everywhere.
	Carduelis tristis	American goldfinch	(1) (2*) Confirmed breeder, abundant in shrubby areas.
	Carpodacus mexicanus	house finch	(1) Confirmed breeder, uncommon around buildings.
	Melospiza georgiana	swamp sparrow	(1) Confirmed breeder, rare in wet fields and ditches.
	M. melodia	song sparrow	(1) (2*) Confirmed breeder, abundant everywhere.
	Passerculus sandwichensis	Savannah sparrow	(1) Confirmed breeder, common in grasslands.
	Passerina cyanea	indigo bunting	(1) (2*) Confirmed breeder, abundant everywhere.
	Pheucticus ludovicianus	rose-breasted grosbeak	(1) Confirmed breeder, common in woodlots & edges.

Table 2-3

Birds Observed On Site and/or Likely to be Breeding
In Erie County, Ohio
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name[a]	Scientific Name[b]	Common Name[c]	Status and Frequency
	Pipilo erythrophthalmus	Eastern towhee	(1) Confirmed breeder, very common in woodlots, edges.
	Pooecetes gramineus	vesper sparrow	(1) Confirmed breeder, uncommon in grassland & fields.
	Spiza amercana	dickcissel	Confirmed and/or probable breeder in county.
	Spizella passerina	chipping sparrow	(1) Confirmed breeder, common in open woods & lawns.
	S. pusilla	field sparrow	(1) (2*) Confirmed breeder, abundant in grasslands, shrubs.
	Zonotrichia albicollis	white-throated sparrow	(1) Late migrant, rare.

[a] Family names from Peterson, R. T., 1947, *A Field Guide to the Birds*, Sponsored by the National Audubon Society, Houghton Mifflin Company, Boston, Massachusetts.

[b] Peterjohn, B. G. and D. L. Rice, 1991, *Ohio Breeding Bird Atlas*, The Ohio Department of Natural Resources, Division of Natural Areas and Preserves, Columbus, Ohio, 416 pages.

[c] E = Ohio Endangered species; T = Ohio Threatened species.

Observation References:

(1) *Biological Inventory of Plum Brook Station* (Ohio Department of Natural Resources, 1994).

(2) Observed during Shaw Site Reconnaissance on April 27, June 2, and/or September 9, 2009. An asterisk (*) indicates the species was detected during the June site visit and is likely using the site for breeding.

Table 2-4

Reptiles Observed On Site and Likely to be Found iin Eric County, Ohio
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name	Scientific Name	Common Name	Observed On Site
Chelydridae	*Chelydra serpentina*	snapping turtle	(1)
Kinosternidae	*Sternotherus odoratus*	musk turtle	
Emydidae	*Chrysemys picta*	painted turtle	(1)
	Emys blandingii	Blanding's turtle	(1)
	Terrapene carolina	box turtle	(1)
Colubridae	*Elaphe vulpina*	fox snake	(1)
	Heterodon platyrhinos	hog-nosed snake	
	Nerodia septemvittata	queen snake	
	N. sipedon sipedon	water snake	(1)
	Opheodrys vernalis	green snake	(1)
	Storeria dekayi	Dekay's brown snake	(1)
	Thamnophis butleri	Butler's garter snake	(1)
	T. sauritus	ribbon snake	
	T. sirtalis	common garter snake	(1)

References:

Conant, R. and J. T. Collins, 1991, *Reptiles and Amphibians, Eastern/Central North America*, Peterson Field Guide, Third Edition, Houghton Mifflin Company, Boston.

Pfingsten, R. A. and F. L. Downs (eds.), 1989, *Salamanders of Ohio*, Ohio Biological Survey Bulletin, New Series, Vol. 7, No. 2, 315 pages, 29 pls.

Wright, A. H. and A. A. Wright, 1957, *Handbook of Snakes of the United States and Canada*, Volumes I and II, Comstock Publishing Associates, Ithaca and London, 1105 pages.

Reference for on-site observation:

(1) *Biological Inventory of Plum Brook Station* (Ohio Department of Natural Resources, 1995).

Table 2-5

Amphibians Observed On Site and Likely to be Found in Eric County, Ohio
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name	Scientific Name	Common Name	Observed On Site
Ambystomatidae	*Ambystoma texanum*	smallmouth salamander	(1)
	Plethodon cinereus	redback salamander	(1)
Bufonidae	*Bufo americanus*	American toad	(1)
Hylidae	*Acris gryllus*	cricket frog	(1)
	Hyla versicolor	gray treefrog	(1)
	Pseudacris crucifer	spring peeper	(1)
	P. triseriata	chorus frog	(1)
Ranidae	*Rana catesbeiana*	bullfrog	(1)
	R. clamitans	green frog	(1)
	R. pipiens	Northern leopard frog	(1)

References:

Conant, R. and J. T. Collins, 1991, *Reptiles and Amphibians, Eastern/Central North America* , Peterson Field Guide, Third Edition, Houghton Mifflin Company, Boston.

Pfingsten, R. A. and F. L. Downs (eds.), 1989, *Salamanders of Ohio* , Ohio Biological Survey Bulletin, New Series, Vol. 7, No. 2, 315 pages, 29 pls.

Reference for on-site observation:

(1) *Biological Inventory of Plum Brook Station* (Ohio Department of Natural Resources, 1995).

Table 2-6

Fish Species Observed at Plum Brook Ordnance Works
Plum Brook Ordnance Works, Sandusky, Ohio

Family Name	Scientific Name	Common Name	Observed On Site	Habitat[a]
Catostomidae	*Catostomus commersoni*	white sucker	(1)	lotic
Centrarchidae	*Lepomis cyanellus*	green sunfish	(1)	lentic, lotic
	Lepomis species	green sunfish hybrid	(1)	lentic
	L. gibbosus	pumpkinseed sunfish	(1)	lentic
	L. macrochirus	bluegill	(1)	lentic
	Micropterus salmoides	largemouth bass	(1)	lentic
Cyprinidae	*Campostoma anomalum*	central stoneroller	(1)	lotic
	Carassius auratus	goldfish	(1)	lentic
	Luxilus chrysocephalus	striped shiner	(1)	lotic
	Pimephales notatus	bluntnose minnow	(1)	lotic
	P. promelas	fathead minnow	(1)	lotic
	Semotilus atromaculatus	creek chub	(1)	lotic
Gasterosteidae	*Culaea inconstans*	brook stickleback	(1)	lotic
Ichtaluridae	*Ameiurus melas*	black bullhead	(1)	lentic

[a] lotic - Flowing water such as brooks, ditches, and creeks.
lentic - Still waters such as ponds and lakes.

Reference for on-site observation:
(1) *Biological Inventory of Plum Brook Station* (Ohio Department of Natural Resources, 1994).

Table 2-7

Summary of Samples Evaluated in the Ecological Risk Assessment
Locomotive Building Area
Plum Brook Ordnance Works, Sandusky, Ohio

Location	Sample Number	Sample Purpose	Sample Date	Depth (ft)	Analyses
Soil Samples					
PBOW99-DP001	PBOW99-DP001-0004	REG	11-Jun-99	2 - 4	Metals, PCB, SVOC
PBOW99-DP001	PBOW99-DP001-0008AA	REG	11-Jun-99	4 - 6	Metals
PBOW99-DP002	PBOW99-DP002-0002	REG	11-Jun-99	0 - 2	Metals, PCB, SVOC
PBOW99-DP002	PBOW99-DP002-0004	REG	11-Jun-99	2 - 4	Metals, PCB, SVOC
PBOW99-DP002	PBOW99-DP002-0006	REG	11-Jun-99	4 - 6	Metals
PBOW99-DP003	PBOW99-DP003-0004	REG	11-Jun-99	2 - 4	Metals, PCB, SVOC
PBOW99-DP003	PBOW99-DP003-0006	REG	11-Jun-99	4 - 6	Metals
PBOW99-DP004	PBOW99-DP004-0006	FD	11-Jun-99	4 - 6	Metals
PBOW99-SB001	PBOW99-SB001-001	REG	9-Jun-99	0 - 0.5	Metals, PCB, SVOC
PBOW99-SB001	PBOW99-SB001-003	REG	9-Jun-99	1 - 3	Metals, PCB, SVOC
PBOW99-SB001	PBOW99-SB001-0005	REG	9-Jun-99	3 - 5	Metals, PCB, SVOC
LBA-SB01	LBA0001	REG	20-Jan-09	0 - 1	Exp, Metals, PCB, SVOC, VOC
LBA-SB02	LBA0004	REG	19-Jan-09	0 - 1	Exp, Gen Chem, Metals, PCB, SVOC, VOC
LBA-SB03	LBA0007	REG	20-Jan-09	0 - 1	Exp, Metals, PCB, SVOC, VOC
LBA-SB03	LBA0008	FD	20-Jan-09	0 - 1	Exp, Metals, PCB, SVOC, VOC
LBA-SB05	LBA0015	REG	19-Jan-09	0 - 1	Exp, Metals, PCB, SVOC, VOC
LBA-SB06	LBA0018	REG	20-Jan-09	0 - 1	Exp, Metals, PCB, SVOC, VOC
LBA-SB10	LBA0026	REG	19-Jan-09	0 - 1	Exp, Metals, PCB, SVOC, VOC
LBA-SB10	LBA0027	FD	19-Jan-09	0 - 1	Exp, Metals, PCB, SVOC, VOC
LBA-SB11	LBA0031	REG	19-Jan-09	0 - 1	Exp, Metals, PCB, SVOC, VOC
LBA-SB12	LBA0034	REG	19-Jan-09	0 - 1	Exp, Metals, PCB, SVOC, VOC
LBA-SB04	LBA0012	REG	19-Jan-09	0.9 - 1.9	Exp, Metals, PCB, SVOC, VOC
LBA-SB03	LBA0010	REG	20-Jan-09	2.5 - 3.2	Exp, Metals, PCB, SVOC, VOC
LBA-SB01	LBA0002	REG	20-Jan-09	3 - 5	Exp, Metals, PCB, SVOC, VOC
LBA-SB02	LBA0005	REG	19-Jan-09	3 - 5	Exp, Metals, PCB, SVOC, VOC
LBA-SB05	LBA0016	REG	20-Jan-09	3 - 5	Exp, Metals, PCB, SVOC, VOC
LBA-SB06	LBA0019	REG	20-Jan-09	3 - 5	Exp, Metals, PCB, SVOC, VOC
LBA-SB10	LBA0029	REG	19-Jan-09	3 - 4.4	Exp, Metals, PCB, SVOC, VOC
LBA-SB12	LBA0035	REG	19-Jan-09	3 - 3.9	Exp, Metals, PCB, SVOC, VOC
LBA-SB04	LBA0013	REG	19-Jan-09	3.9 - 5.9	Exp, Metals, PCB, SVOC, VOC
LBA-SB11	LBA0032	REG	19-Jan-09	3.9 - 5.9	Exp, Metals, PCB, SVOC, VOC
Sediment Samples					
LBA-SD01	LBA1000	REG	20-May-09	0 - 0.5	Exp, Metals, PCB, SVOC, VOC
LBA-SD02	LBA1001	REG	21-May-09	0 - 0.5	Exp, Metals, PCB, SVOC, VOC
LBA-SD03	LBA1002	REG	21-May-09	0 - 0.5	Exp, Metals, PCB, SVOC, VOC
LBA-SD04	LBA1003	REG	21-May-09	0 - 0.5	Exp, Metals, PCB, SVOC, VOC
LBA-SD05	LBA1004	REG	22-May-09	0 - 0.5	Exp, Metals, PCB, SVOC, VOC
LBA-SD06	LBA1005	REG	22-May-09	0 - 0.5	Exp, Metals, PCB, SVOC, VOC
LBA-SD06	LBA1006	FD	22-May-09	0 - 0.5	Exp, Metals, PCB, SVOC, VOC
Surface Water Samples					
LBA-SW01	LBA2000	REG	20-May-09	NA	Exp, Metals, PCB, SVOC, VOC
LBA-SW02	LBA2001	REG	21-May-09	NA	Exp, Metals, PCB, SVOC, VOC
LBA-SW03	LBA2002	REG	21-May-09	NA	Exp, Metals, PCB, SVOC, VOC
LBA-SW03	LBA2003	FD	21-May-09	NA	Exp, Metals, PCB, SVOC, VOC
LBA-SW04	LBA2005	REG	21-May-09	NA	Exp, Metals, PCB, SVOC, VOC
LBA-SW05	LBA2006	REG	22-May-09	NA	Exp, Metals, PCB, SVOC, VOC
LBA-SW06	LBA2007	REG	22-May-09	NA	Exp, Metals, PCB, SVOC, VOC
LBA-SW07	LBA2008	REG	22-May-09	NA	Exp, Metals, PCB, SVOC, VOC

FD - Field duplicate.
Exp - Explosives.
Gen Chem - General chemistry parameters.
NA - Not applicable.
Pest - Organochlorine Pesticide.
PCB - Polychlorinated biphenyl.
SVOC - Semivolatile organic compound.
VOC - Volatile organic compound.

Table 2-8

Statistical Summary and COPEC Selection of Chemicals Detected in Total Soil (0 to 6 feet bgs)
Locomotive Building Area, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Detection Frequency	Percent Detection	Range of Values, mg/kg: Detected Concentrations Minimum	VQ	Maximum	VQ	Reporting Limits Minimum	Maximum	Mean (mg/kg)	BSC [a] (mg/kg)	ESV [b] (mg/kg)	COPEC? [c,d]	Distribution [e]	95% UCL [e] (mg/kg)	EPC [f] (mg/kg)	UCL 0-2' soil depth [g] (mg/kg)	MDC 0-2' soil depth [g] (mg/kg)	EPC 0-2' soil depth [g] (mg/kg)
Inorganics																		
Aluminum	28 / 28	100	4.40E+03		1.72E+04		1.81E+00	3.00E+01	8.25E+03	1.55E+04	pH Dependent	N (d)			---			---
Antimony	14 / 28	50	2.50E-01	J	1.30E+00		4.51E-01	1.50E+00	4.96E-01	9.30E+00	0.27	N (b)			---			---
Arsenic	27 / 28	96	4.40E+00		1.77E+01		9.02E-01	1.50E+00	8.23E+00	3.65E+01	18	N (a)			---			---
Barium	28 / 28	100	1.63E+01		4.25E+02		1.85E-01	3.00E+01	8.88E+01	8.26E+02	330	N (b)			---			---
Beryllium	19 / 28	68	6.60E-01		9.26E+00	J	1.81E-01	7.50E-01	4.41E+00	1.00E+00	21	N (a)			---			---
Cadmium	15 / 28	54	2.53E-01	J	6.99E-01		2.10E-01	5.26E-01	3.18E-01		0.36	Y	Normal	4.12E-01	4.12E-01	5.24E-01	6.99E-01	5.24E-01
Calcium	28 / 28	100	1.18E+03		7.40E+04		4.51E+00	7.50E+02	8.41E+03	5.23E+04	Nutrient	N (c)			---			---
Chromium	28 / 28	100	1.04E+01		5.10E+01		4.51E-01	7.50E-01	1.61E+01	2.90E+01	26	N (d)			---			---
Cobalt	24 / 28	86	3.52E+00		5.38E+01	J	3.61E-01	7.50E+00	1.23E+01	1.16E+02	13	N (b)			---			---
Copper	28 / 28	100	6.54E+00		3.01E+01		4.51E-01	3.70E+00	1.59E+01	5.62E+01	28	N (b)			---			---
Iron	28 / 28	100	1.19E+04		4.64E+04		3.63E+00	1.50E+01	2.22E+04	2.34E+05	pH Dependent	N (b)			---			---
Lead	28 / 28	100	5.29E+00		2.22E+02		3.20E-01	5.26E-01	2.24E+01	4.86E+01	11	N (d)			---			---
Magnesium	28 / 28	100	7.96E+02	J	1.68E+04	J	1.81E+00	7.50E+02	3.18E+03	1.04E+04	Nutrient	N (c)			---			---
Manganese	28 / 28	100	1.15E+02		3.00E+03		1.81E-01	2.20E+00	6.42E+02	3.51E+03	220	N (b)			---			---
Mercury	18 / 28	64	1.18E-02	J	5.50E-02	U	2.11E-02	1.50E-01	4.01E-02	8.50E-02	0.00051	N (b)			---			---
Nickel	28 / 28	100	9.01E+00	J	5.03E+01		2.71E-01	6.00E+00	2.44E+01	5.51E+01	38	N (b)			---			---
Potassium	28 / 28	100	1.88E+02		2.26E+03		2.26E+01	7.50E+02	7.38E+02	3.39E+03	Nutrient	N (c)			---			---
Selenium	1 / 28	4	5.16E-01	J	5.16E-01	J	5.30E-01	1.05E+00	4.19E-01	2.00E+00	0.52	N (a)			---			---
Sodium	18 / 28	64	1.88E+01		1.13E+02		9.02E+00	7.50E+02	1.37E+02		Nutrient	N (c)			---			---
Thallium	8 / 28	29	2.94E-01	J	6.54E-01		4.45E-01	1.50E+00	4.18E-01	1.30E+00	1	N (a)			---			---
Vanadium	28 / 28	100	1.88E+01		4.99E+01		1.81E-01	7.50E+00	2.60E+01	4.09E+01	7.8	N (d)			---			---
Zinc	28 / 28	100	2.60E+01		2.73E+02		2.10E+00	3.00E+00	7.44E+01	3.22E+02	46	N (b)			---			---
Polychlorinated biphenyls (PCB)																		
Aroclor 1221	1 / 25	4	1.90E-01		1.90E-01		3.50E-02	4.90E-02	2.69E-02		0.371	N (a)			---			---
Aroclor 1260	4 / 25	16	6.10E-02	J	1.90E-01		3.50E-02	4.90E-02	3.33E-02		0.371	N (a)			---			---
Nitroaromatics																		
Amino-2,6-dinitrotoluene, 4-	3 / 18	17	3.24E-01		5.30E-01		2.88E-01	3.00E-01	2.00E-01		0.0328	Y	Nonparametric	3.79E-01	3.79E-01	5.27E-01	5.27E-01	5.27E-01
Amino-4,6-dinitrotoluene, 2-	3 / 18	17	1.63E-01	J	4.38E-01		2.88E-01	3.00E-01	1.73E-01		0.0328	Y	Normal	2.42E-01	2.42E-01	2.97E-01	2.94E-01	2.94E-01
Dinitrotoluene, 2,4-	5 / 18	28	1.53E-01	J	1.13E+00		2.88E-01	3.00E-01	2.71E-01		1.28	N (a)			---			---
Semivolatile Organic Compounds																		---
Acenaphthylene	2 / 25	8	7.06E-02	J	2.24E-01	J	3.50E-01	2.06E+00	2.42E-01		29	N (a)			---			---
Anthracene	2 / 25	8	8.11E-02	J	3.81E-01	J	3.50E-01	2.06E+00	2.48E-01		29	N (a)			---			---
Benzo(a)anthracene	3 / 25	12	4.26E-02	J	6.52E-01	J	3.50E-01	2.06E+00	2.56E-01		1.1	N (a)			---			---
Benzo(a)pyrene	2 / 25	8	1.21E-01	JJ	3.95E-01	J	3.50E-01	2.06E+00	2.51E-01		1.1	N (a)			---			---
Benzo(b)fluoranthene	2 / 25	8	1.92E-01	JJ	8.78E-01	J	3.50E-01	2.06E+00	2.73E-01		1.1	N (a)			---			---
Benzo(ghi)perylene	1 / 25	4	1.06E-01	J	1.06E-01	J	3.50E-01	2.06E+00	2.75E-01		1.1	N (a)			---			---
Chrysene	3 / 25	12	3.95E-02	J	7.84E-01	J	3.50E-01	2.06E+00	2.62E-01		1.1	N (a)			---			---
Dibenzofuran	2 / 25	8	4.61E-01	J	1.40E+00	J	3.50E-01	2.06E+00	2.93E-01		NSV	Y	Nonparametric	5.88E-01	5.88E-01	7.55E-01	1.40E+00	7.55E-01
Di-n-butyl phthalate	1 / 25	4	5.90E-02	J	5.90E-02	J	3.50E-01	2.06E+00	2.74E-01		200	N (a)			---			---
Dinitrotoluene, 2,4-	8 / 25	32	2.30E-01	J	4.00E+00		3.50E-01	2.06E+00	5.40E-01		1.28	Y	Gamma	8.19E-01	8.19E-01	1.44E+00	4.00E+00	1.44E+00
Dinitrotoluene, 2,6-	3 / 25	12	1.29E-01	J	3.89E-01	J	3.50E-01	2.06E+00	2.84E-01		0.0328	Y	Normal	2.67E-01	2.67E-01	8.16E-01	2.04E-01	2.04E-01
Fluoranthene	5 / 25	20	4.01E-02	J	1.26E+00	J	3.50E-01	2.06E+00	2.74E-01		1.1	Y	Gamma	2.93E-01	2.93E-01	4.69E-01	1.26E+00	4.69E-01
Indeno(1,2,3-cd)pyrene	1 / 25	4	1.30E-01	J	1.30E-01	J	3.50E-01	2.06E+00	2.76E-01		1.1	N (a)			---			---
Methylnaphthalene, 2-	2 / 25	8	1.66E+00	J	5.60E+00		3.50E-01	2.06E+00	5.09E-01		3.24	Y	Nonparametric	2.19E+00	2.19E+00	2.89E+00	5.60E+00	2.89E+00
Naphthalene	2 / 25	8	1.02E+00	J	3.40E+00		3.50E-01	2.06E+00	3.96E-01		29	N (a)			---			---
Phenanthrene	3 / 25	12	1.17E-01	JJ	1.50E+00		3.50E-01	2.06E+00	3.09E-01		29	N (a)			---			---
Pyrene	3 / 25	12	6.27E-02	J	1.13E+00	J	3.50E-01	2.06E+00	2.79E-01		1.1	Y	Normal	3.27E-01	3.27E-01	4.79E-01	1.13E+00	4.79E-01
Volatile Organic Compounds																		
Acetone	14 / 14	100	2.19E-02	J	2.65E-01	J	1.46E-02	5.92E-02	9.52E-02		2.5	N (a)			---			---
Benzene	3 / 18	17	2.17E-03	J	3.81E-03	J	9.04E-03	2.15E-02	4.82E-03		0.255	N (a)			---			---
Butanone, 2-	7 / 7	100	8.27E-03	J	1.36E-02	J	5.28E-02	5.92E-02	1.08E-02		89.6	N (a)			---			---
Carbon disulfide	1 / 18	6	4.95E-03	JJ	4.95E-03	JJ	9.04E-03	2.15E-02	5.72E-03		0.0941	N (a)			---			---
Dichloroethane, 1,1-	3 / 18	17	3.23E-03	J	2.54E-02	J	9.04E-03	2.15E-02	6.29E-03		20.1	N (a)			---			---
Dichloroethene, 1,1-	2 / 18	11	2.54E-03	J	3.01E-03	J	9.04E-03	2.15E-02	5.04E-03		8.28	N (a)			---			---
Dichloroethene, cis-1,2-	1 / 18	6	3.20E-03	J	3.20E-03	J	9.04E-03	2.15E-02	5.32E-03		0.784	N (a)			---			---
Naphthalene-voc	2 / 18	11	1.51E-03	J	3.46E-03	J	9.04E-03	2.15E-02	5.01E-03		29	N (a)			---			---
Toluene	4 / 18	22	1.04E-03	J	5.99E-03	J	9.04E-03	2.15E-02	4.91E-03		200	N (a)			---			---
Trichloroethane, 1,1,1-	6 / 18	33	1.39E-03	J	1.21E+00	J	9.04E-03	4.95E-01	1.39E-01		29.8	N (a)			---			---
Trichloroethene	3 / 18	17	2.63E-03	J	6.24E-02	J	9.04E-03	2.15E-02	1.07E-02		12.4	N (a)			---			---
Trimethylbenzene, 1,2,4-	2 / 18	11	1.71E-03	J	1.78E-03	J	9.04E-03	2.15E-02	5.11E-03		NSV	Y	Nonparametric	1.81E-03	1.78E-03	ND	ND	NA

BSC - Background screening criterion
COPEC - Chemical of Potential Ecological Concern

Table 2-8

Statistical Summary and COPEC Selection of Chemicals Detected in Total Soil (0 to 6 feet bgs)
Locomotive Building Area, Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Detection Frequency	Percent Detection	Range of Values, mg/kg: Detected Concentrations Minimum	VQ	Maximum	VQ	Reporting Limits Minimum Maximum	Mean (mg/kg)	BSC [a] (mg/kg)	ESV [b] (mg/kg)	COPEC? [c,d]	Distribution [e]	95% UCL [e] (mg/kg)	EPC [f] (mg/kg)	UCL 0-2' soil depth [g] (mg/kg)	MDC 0-2' soil depth [g] (mg/kg)	EPC 0-2' soil depth [g] (mg/kg)

EPC - Exposure point concentration
ESV - Ecological screening value
J - The compound/analyte was positively identified; the reported result is the estimated concentration of the compound/analyte detected in the sample analyzed
mg/kg - milligrams per kilogram
NA - Not applicable
ND - Not detected; chemical was only detected at deeper soil depth ranges.
NSV - No screening value
UCL - Upper confidence limit
VQ - Validation qualifier

[a] IT Corporation (IT), 1998, ***Site Investigation of Acid Areas*** , Plum Brook Ordnance Works, Sandusky, Ohio, August.
[b] ESVs and their sources are in Appendix B.
[c] N = Chemical is not chosen as a COPEC:
(a) = maximum detected concentration is less than the ESV.
(b) = maximum detected concentration is less than the BSC.
(c) = essential nutrient.
(d) = statistical test shows background and site data to be the same; see Appendix C.
[d] Y = Chemical is chosen as COPEC.
[e] 95% UCL (Upper confidence limit) determined using ProUCL Version 4.00.05 (U.S. Environmental Protection Agency (EPA), 2010, ProUCL Version 4.00.05, Office of Research and Development, Las Vegas, Nevada, and Technology Support Center, Atlanta, GA, May, on line at http://www.epa.gov/esd/tsc/software.htm
[f] Concentration used in risk assessment equal to 95% UCL or maximum detected concentration, whichever is lower.
[g] The EPC for the COPEC at the 0-2 feet soil depth range is used as the exposure concentration for some ecological receptors.

Table 2-9

Statistical Summary and Selection of Chemicals of Potential Ecological Concern in Surface Water
Locomotive Building Area
Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Detection Frequency	Percent hits	Range of values, µg/L: Detected Concentration Minimum	VQ	Detected Concentration Maximum	VQ	Reporting Limits Minimum	Reporting Limits Maximum	Arithmetic Mean µg/L	ESV [a] µg/L	COPEC? [b,c]	Distribution [d]	95% UCL [d] µg/L	EPC [e] µg/L
Inorganics														
Aluminum	6 / 6	100	1.66E+03		2.38E+04		2.00E+02	2.00E+02	5.67E+03	87	Y	Nonparametric	2.15E+04	2.15E+04
Arsenic	1 / 7	14	8.80E+00	J	8.80E+00	J	1.00E+01	1.00E+01	5.54E+00	3.1	Y	Nonparametric	6.69E+00	6.69E+00
Barium	7 / 7	100	4.16E+01	J	1.55E+02	J	2.00E+02	2.00E+02	7.62E+01	4	Y	Approx Gamma	1.12E+02	1.12E+02
Beryllium	1 / 7	14	1.10E+00	J	1.10E+00	J	4.00E+00	4.00E+00	1.87E+00	0.66	Y	Nonparametric	2.12E+00	1.10E+00
Calcium	7 / 7	100	1.10E+05		1.51E+05		1.00E+03	1.00E+03	1.35E+05	Nutrient	N (b)			---
Chromium	6 / 7	86	2.60E+00	J	3.98E+01		1.00E+01	1.00E+01	8.85E+00	42	N (a)			---
Cobalt	5 / 7	71	2.35E+00	JJ	1.63E+01	J	5.00E+01	5.00E+01	1.12E+01	23	N (a)			---
Copper	1 / 7	14	3.85E+01		3.85E+01		2.50E+01	2.50E+01	1.62E+01	1.58	Y	Nonparametric	2.41E+01	2.41E+01
Iron	7 / 7	100	1.09E+03		4.39E+04		3.00E+02	3.00E+02	9.50E+03	1000/Nutrient	N (b)			---
Lead	6 / 7	86	2.60E+00	J	1.80E+01		5.00E+00	1.00E+01	6.15E+00	1.17	Y	Approx Gamma	9.79E+00	9.79E+00
Magnesium	7 / 7	100	1.74E+04		2.93E+04		5.00E+03	5.00E+03	2.66E+04	Nutrient	N (b)			---
Manganese	7 / 7	100	3.81E+02		2.22E+03		1.50E+01	1.50E+01	1.19E+03	120	Y	Normal	1.71E+03	1.71E+03
Nickel	6 / 7	86	4.80E+00	J	7.16E+01		4.00E+01	4.00E+01	1.85E+01	28.9	Y	Nonparametric	5.73E+01	5.73E+01
Potassium	7 / 7	100	1.28E+03	J	6.54E+03	J	1.00E+04	2.00E+04	3.03E+03	Nutrient	N (b)			---
Selenium	3 / 7	43	3.50E+00	J	4.40E+00	J	1.00E+01	1.00E+01	4.50E+00	0.39	Y	Approx Gamma	5.13E+00	4.40E+00
Sodium	7 / 7	100	1.82E+04		3.45E+04		1.00E+04	1.00E+04	2.81E+04	Nutrient	N (b)			---
Vanadium	6 / 7	86	4.50E+00	J	4.61E+01	J	5.00E+01	5.00E+01	1.40E+01	12	Y	Nonparametric	3.70E+01	3.70E+01
Zinc	6 / 7	86	1.97E+01	J	1.77E+02		2.00E+01	2.00E+01	4.80E+01	65.7	Y	Nonparametric	1.44E+02	1.44E+02
Volatile Organics														
Dichloroethane, 1,1-	4 / 7	57	2.50E-01	J	3.90E-01	J	1.00E+00	1.00E+00	4.12E-01	47	N (a)			---
Dichloroethene, cis-1,2-	1 / 7	14	2.30E-01	JJ	2.30E-01	JJ	1.00E+00	1.00E+00	4.61E-01	590	N (a)			---
Trichloroethane, 1,1,1-	2 / 7	29	4.70E-01	J	5.60E-01	JJ	1.00E+00	1.00E+00	5.04E-01	11	N (a)			---

ESV - Ecological screening value
EPC - Exposure point concentration
COPEC - Chemical of Potential Ecological Concern.
µg/L - micrograms per liter.
VQ - Validation qualifier.
J - The compound/analyte was positively identified; the reported result is the estimated concentration of the compound/analyte detected in the sample analyzed.

[a] ESVs and their sources are in Appendix B.
[b] N = Chemical is not chosen as a COPEC:
(a) = maximum detected concentration is less than the ESV.
(b) = essential nutrient.
[c] Y = Chemical is chosen as COPEC.
[d] 95% UCL (Upper confidence limit) determined using ProUCL Version 4.00.05 (U.S. Environmental Protection Agency (EPA), 2010, ProUCL Version 4.00.05, Office of Research and Development, Las Vegas, Nevada, and Technology Support Center, Atlanta, GA, May, on line at http://www.epa.gov/esd/tsc/software.htm.
[e] Concentration used in risk assessment equal to 95% UCL or maximum detected concentration, whichever is lower.

Table 2-10

Statistical Summary and Selection of Chemicals of Potential Concern in Sediment
Locomotive Building Area
Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	Detection Frequency	Percent Detection	Range of Values, mg/kg: Detected Concentrations Minimum	VQ	Maximum	VQ	Reporting Limits Minimum	Maximum	Mean mg/kg	BSC [a] mg/kg	ESV [b] mg/kg	COPEC? [c,d]	Distribution [e]	95% UCL [e] (mg/kg)	EPC [f] mg/kg
Inorganics															
Aluminum	6 / 6	100	5.71E+03	J	1.03E+04		1.30E+01	1.40E+01	7.78E+03	1.55E+04	NSV	N (b)			---
Arsenic	6 / 6	100	8.30E+00	J	1.78E+01	J	5.10E-01	5.60E-01	1.20E+01	3.65E+01	9.79E+00	N (b)			---
Barium	6 / 6	100	5.88E+01	J	9.21E+01	J	1.30E+01	1.40E+01	7.61E+01	8.26E+02	NSV	N (b)			---
Beryllium	6 / 6	100	6.10E-01		9.60E-01		3.20E-01	3.50E-01	7.46E-01	1.00E+00	NSV	N (b)			---
Cadmium	6 / 6	100	4.60E-01	J	1.90E+00		2.50E-01	2.80E-01	8.32E-01	NA	9.90E-01	Y	Gamma	1.46E+00	1.46E+00
Calcium	6 / 6	100	3.26E+03		1.12E+04	J	3.20E+02	3.50E+02	6.54E+03	5.23E+04	Nutrient	N (c)			---
Chromium	6 / 6	100	1.04E+01		1.82E+01		6.30E-01	6.90E-01	1.37E+01	2.90E+01	4.34E+01	N (a)			---
Cobalt	6 / 6	100	1.08E+01		2.60E+01	J	3.20E+00	3.50E+00	1.71E+01	1.16E+02	5.00E+01	N (a)			---
Copper	6 / 6	100	1.05E+01	J	2.28E+01		1.60E+00	1.70E+00	1.75E+01	5.62E+01	3.16E+01	N (a)			---
Iron	6 / 6	100	1.87E+04	J	3.02E+04	J	6.30E+00	6.90E+00	2.28E+04	2.34E+05	Nutrient	N (c)			---
Lead	6 / 6	100	9.00E+00	J	1.79E+01	J	6.30E+00	6.90E+00	1.15E+01	4.86E+01	3.58E+01	N (a)			---
Magnesium	6 / 6	100	1.59E+03	J	4.94E+03		3.20E+02	3.50E+02	3.00E+03	1.04E+04	NSV	N (b)			---
Manganese	6 / 6	100	7.37E+02		5.36E+03		5.00E+00	2.10E+01	1.84E+03	3.51E+03	4.60E+02	Y	Gamma	3.98E+03	3.98E+03
Mercury	5 / 6	83	2.20E-02	J	3.10E-02	J	9.90E-02	1.20E-01	2.88E-02	8.50E-02	1.80E-01	N (a)			---
Nickel	6 / 6	100	2.61E+01	J	5.22E+01		2.50E+00	2.80E+00	3.42E+01	5.51E+01	2.27E+01	N (b)			---
Potassium	6 / 6	100	6.14E+02	J	1.40E+03		1.30E+03	1.40E+03	9.43E+02	3.39E+03	Nutrient	N (c)			---
Selenium	6 / 6	100	1.70E+00	J	3.00E+00	J	6.30E+00	6.90E+00	2.09E+00	2.00E+00	NSV	Y	Normal	2.50E+00	2.50E+00
Sodium	6 / 6	100	1.10E+02	J	1.92E+02	J	1.30E+03	1.40E+03	1.57E+02	NA	Nutrient	N (c)			---
Thallium	2 / 6	33	2.60E-01	J	1.90E+00		6.30E-01	1.40E+00	5.78E-01	1.30E+00	NSV	Y	Nonparametric	1.90E+00	1.90E+00
Vanadium	6 / 6	100	1.94E+01	J	2.65E+01	J	3.20E+00	3.50E+00	2.35E+01	4.09E+01	NSV	N (b)			---
Zinc	6 / 6	100	5.24E+01	J	8.03E+01		1.30E+00	1.40E+00	6.28E+01	3.22E+02	1.21E+02	N (a)			---
Semivolatiles Organic Compounds															
Benzo(b)fluoranthene	1 / 6	17	4.70E-02	JJ	4.70E-02	JJ	2.10E-01	2.40E-01	1.03E-01		1.04E+01	N (a)			---
Fluoranthene	1 / 6	17	8.36E-02	JJ	8.36E-02	JJ	2.10E-01	2.40E-01	1.09E-01		4.23E-01	N (a)			---
Phenanthrene	1 / 6	17	5.46E-02	J	5.46E-02	J	2.10E-01	2.40E-01	1.04E-01		2.04E-01	N (a)			---
Pyrene	1 / 6	17	6.28E-02	JJ	6.28E-02	JJ	2.10E-01	2.40E-01	1.05E-01		1.95E-01	N (a)			---
Volatiles Organic Compounds															
Acetone	1 / 6	17	9.21E-02	J	9.21E-02	J	5.80E-02	7.10E-02	4.31E-02		9.90E-03	Y	Nonparametric	6.46E-02	6.46E-02
Carbon disulfide	1 / 6	17	1.90E-03	J	1.90E-03	J	5.80E-03	7.10E-03	3.11E-03		2.39E-02	N (a)			---
Methylene chloride	1 / 5	20	5.82E-02		5.82E-02		1.20E-02	1.40E-02	1.69E-02		1.59E-01	N (a)			---

BSC - Background screening concentration. The soil BSC is used for sediment in this evaluation. See text for details.
COPEC - Chemical of Potential Ecological Concern
EPC - Exposure point concentration
ESV - Ecological screening value
J - The compound/analyte was positively identified; the reported result is the estimated concentration of the compound/analyte detected in the sample analyzed.
mg/kg - milligrams per kilogram
NA - Not available
NSV - No screening value available
VQ - Validation qualifier

[a] Soil background screening concentrations are used for sediment. See text for details.
[b] ESVs and their sources are in Appendix B.
[c] N = Chemical is not chosen as a COPEC:
(a) = maximum detected concentration is less than the ESV.
(b) = maximum detected concentration is less than the BSC.
(c) = essential nutrient.
[d] Y = Chemical is chosen as COPEC.
[e] 95% UCL (Upper confidence limit) determined using ProUCL Version 4.00.05 (U.S. Environmental Protection Agency (EPA), 2010, ProUCL Version 4.00.05, Office of Research and Development, Las Vegas, Nevada, and Technology Support Center, Atlanta, GA, May, on line at http://www.epa.gov/esd/tsc/software.htm.
[f] Concentration used in risk assessment equal to 95% UCL or maximum detected concentration, whichever is lower.

Table 3-1

Data Used to Model Exposure in the Indicator Wildlife Species
Locomotive Building Area
Plum Brook Ordnance Works, Sandusky, Ohio

Indicator Species	Class/ Order	Average Body Weight[a] (kg)	Average Home Range[a] (ha)	Dietary Intake[a] (kg[dw]/day)	Soil/Sed. Intake (kg[dw]/day)	Water Intake (L/day)[b]	Trophic Level	Dietary Composition[a] (percent)
Deer mouse (*Peromyscus maniculatus*)	Mammalia/ Rodentia	0.0148	0.062	0.0028[d]	0.000056 (2%)	0.0022	Omnivore	Terr. Inverts. : 39 Plants: 61
Eastern cottontail *(Sylvilagus floridanus)*	Mammalia/ Lagomorpha	1.132	3.1	0.096[d]	0.006 (6.3%)	0.11	Herbivore	Plants: 100
Short-tailed shrew *(Blarina brevicauda)*	Mammalia/ Insectivora	0.015	0.39	0.0022[d]	0.00023 (10.4%)	0.0023	Insectivore	Terr. Inverts.: 100
White-tailed deer (*Odocoileus virginianus*)	Mammalia/ Artiodactyla	61[c]	518[c]	2.0[d]	0.04 (2%)	4	Herbivore	Plants: 100
Marsh wren (*Cistothorus palustris*)	Aves/ Passeriformes	0.01	0.054	0.0029[d]	0.000058 (2%)	0.0027	Insectivore	Terr. Inverts.: 100
Red-tailed hawk (*Buteo jamaicensis*)	Aves/ Falconiformes	0.957	842	0.057[d]	0.00114 (2%)	0.057	Carnivore	Rabbits: 25.3 Shrews: 25.3 Mice: 25.3 Birds: 24
Muskrat[e] (*Ondata zibethicus*)	Mammalia/ Rodentia	1.174	0.13	0.352	negligible	0.11	Herbivore	Aquatic plants: 100
Raccoon (*Procyon lotor*)	Mammalia/ Carnivora	5.1	156	0.26[d]	0.024 (9.4%) (assumed 50% soil and 50% sediment)	0.43	Omnivore	Aq. Inverts.: 21 Terr. Inverts.: 30 Mice: 5 Plants: 42 (50% terrestrial, 50% aquatic) Fish: 2

[a] From EPA (1993), except as noted.

[b] Allometric equations for mammals and birds from EPA (1993), as follows:

Mammals: WI (water ingestion; L/day) = 0.099 $Wt^{0.90}$ (kg), where Wt = body weight.

Birds: WI (L/day) = 0.059 $Wt^{0.67}$ (kg).

[c] Information is from *A Guide to the Mammals of Ohio* (Gottschang, 1981).

[d] Allometric equation for mammals: FI (kg/day) = 0.0687 $Wt^{0.822}$ for shrew, deer, and raccoon; FI (g/day) = 0.621 $Wt^{0.564}$ for rodents (deer mouse); and FI (g/day) = 0.577 $Wt^{0.727}$ for small herbivores (cottontail).
Allometric equation for birds: FI (kg/day) = 0.0582 Wt0.651 (EPA, 1993), where FI = food ingestion (dry weight) and Wt = body weight. Allometric equations from EPA (1993).

[e] Exposure parameters obtained from OEPA-DERR (2008) Ecological Risk Assessment Guidance Document, Revised April 2008, On line: http://www.epa.ohio.gov/portals/30/rules/RR-031.pdf.

References

U.S. Environmental Protection Agency (EPA), 1993, Wildlife Exposure Factors Handbook, Vols. I and II, Office of Research and Development, Washington, DC, EPA/600/R-93/187a.

Table 3-2

Bioaccumulation Factors or Regression
Equations Utilized for the Soil-to-Plant and Sediment-to-Aquatic Plant Pathways
Locomotive Building Area, Plum Brook Ordnance Works
Sandusky, Ohio

COPEC in Soil or Sediment	EPA, 2008	Efroymson et al., 2001 Minimum BAF/BCF	Median BAF/BCF	90th Percentile BAF/BCF[b]	Maximum BAF/BCF	Other BAF/BCF (1)		Regression Equation (2)	Recommended BAF/BCF (3)	Source
Inorganics										
Cadmium	ln (AGP)=0.546(ln[soil])-0.475	0.0087	0.59	3.3	23	0.35	a	ln (AGP)=0.55(ln[soil])-0.48	Eco-SSL Regression	EPA (2008), Table 4a
Manganese	0.079	--	--	--	--	--		ln (AGP)=0.56(ln[soil])-1.33	0.079	EPA (2008), Table 4a
Selenium	ln (AGP)=1.104(ln[soil])-0.677	0.02	0.67	3	77	0.025	a	ln (AGP)=0.56(ln[soil])+1.58	Eco-SSL Regression	EPA (2008), Table 4a
Thallium	--	--	--	--	--	0.0022	d	--	0.0022	Baes (1984)
Nitroaromatics										
4-Amino-2,6-dinitrotoluene	--	--	--	--	--	--		Log (BCF)=-0.578(Log[Kow])+1.588	3.346	Travis & Arms Kow Regression Eq.
2-Amino-4,6-dinitrotoluene	--	--	--	--	--	--		Log (BCF)=-0.578(Log[Kow])+1.588	3.346	Travis & Arms Kow Regression Eq.
Semivolatile Organics										
2,4-Dinitrotoluene	--	--	--	--	--	--		Log (BCF)=-0.578(Log[Kow])+1.588	0.444	Travis & Arms Kow Regression Eq.
2,6-Dinitrotoluene	--	--	--	--	--	--		Log (BCF)=-0.578(Log[Kow])+1.588	0.374	Travis & Arms Kow Regression Eq.
2-Methylnaphthalene	--	--	--	--	--	--		Log (BCF)=-0.578(Log[Kow])+1.588	0.27	Travis & Arms Kow Regression Eq.
Dibenzofuran	--	--	--	--	--	--		Log (BCF)=-0.578(Log[Kow])+1.588	0.084	Travis & Arms Kow Regression Eq.
Fluoranthene	0.5	--	--	--	--	0.5	b	--	0.5	EPA (2008), Table 4b
Pyrene	0.72	--	--	--	--	0.72	b	--	0.72	EPA (2008), Table 4b
Volatile Organics										
1,2,4-Trimethylbenzene	--	--	--	--	--	--		Log (BCF)=-0.578(Log[Kow])+1.588	0.3069	Travis & Arms Kow Regression Eq.
Acetone	--	--	--	--	--	--		Log (BCF)=-0.578(Log[Kow])+1.588	0.9	Travis & Arms Kow Regression Eq.

Notes:

1. For inorganic chemicals without BAF/BCF data, BAF/BCFs were derived from the Baes et al. (1984) and IAEA (1994) data.
2. Efroymson, R.A., et. al., 2001, *Uptake of Inorganic Chemicals from Soil by Plant Leaves: Regressions of Field Data*, Environ. Tox. Chem., 20:2561-2571 for AGP (above ground plant tissue concentration) and Travis and Arms (1988) for BCF.
3. For the values estimated using Travis and Arms (1988) Kow regression equation, Kow values were obtained using the Kow WIN application in EPA's EPI Suite software (http://www.epa.gov/oppt/exposure/pubs/episuite.htm).

[a] Average of the vegetative and reproductive transfer factors presented in Baes et al. (1984); note: value from this reference used if no appropriate value available from IAEA (1994).

[b] From EPA (2008).

[c] IAEA (1994); note: value from this reference used, compared with Baes et al. (1984), as IAEA (1994) is more current.
International Atomic Energy Agency (IAEA), 1994, Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Temperate Environments, Technical Report Series No. 364, Vienna.

[d] Average of the vegetative and reproductive transfer factors presented in Baes et al. (1984); note: value from this reference used if no appropriate value available from IAEA (1994).

References:

Baes, C. F., R.D. Sharp, A.L. Sjoreen and R. W. Shor, 1984, *A review and analysis of parameters for assessing transport of environmentally released radionuclides through agriculture,* ORNL-5786, September.

Efroymson, R.A., et. al., 2001, *Uptake of Inorganic Chemicals from Soil by Plant Leaves: Regressions of Field Data*, Environ. Tox. Chem., 20:2561-2571

EPA, 2008, *Guidance for Developing Ecological Soil Screening Levels (Eco-SSL)*, Office of Solid Waste and Emergency Response, OSWER 9285.7-55, November.

Travis, C.C., and A.D. Arms, 1988, *Bioconcentration of Organics in Beef, Milk, and Vegetation*, Enironmental Science and Technology 22(3): 271-274.

Table 3-3

Bioaccumulation Factors or Regression Equations Utilized for the Soil-to-Earthworm Pathway Locomotive Building Area Plum Brook Ordnance Works, Sandusky, Ohio

Constituent	PBOW Site-Specific BCF [a]	Sample, et al. 1998 Median BAF/BCF	Sample, et al. 1998 90th Percentile BAF/BCF	Sample, et al. 1998 Maximum BAF/BCF	Beyer, 1990 BAF/BCF	Regression Equation	Recommended BAF/BCF	Source of BAF/BCF	Rationale for BAF/BCF
Inorganics									
Cadmium	--	7.708	40.69	190	--	ln (EW)=0.795(ln[soil])+2.114	Regression Equation	EPA 2008, Table 4a	Chemical-specific regression equation
Nitroaromatics									
4-Amino-2,6-dinitrotoluene	--	--	--	--	--	--	0.1	Site field study	Use 2,4-Dinitrotoluene as surrogate
2-Amino-4,6-dinitrotoluene	--	--	--	--	--	--	0.1	Site field study	Use 2,4-Dinitrotoluene as surrogate
Semivolatile Organics									
2,4-Dinitrotoluene	0.1	--	--	--	--	--	0.1	Site field study	Plum Brook site-specific BAF (IT, 2001)
2,6-Dinitrotoluene	--	--	--	--	--	--	0.1	Site field study	Use 2,4-Dinitrotoluene as surrogate
2-Methylnaphthalene	--	--	--	--	--	Calculated; see footnote b	1.4	See footnote b	
Dibenzofuran	--	--	--	--	--	Calculated; see footnote b	14.4	See footnote b	
Fluoranthene	0.21	--	--	--	0.079	--	0.21	Site field study	Plum Brook site-specific BAF (IT, 2001)
Pyrene	0.45	--	--	--	0.092	--	0.45	Site field study	Plum Brook site-specific BAF (IT, 2001)
Volatile Organics									
1,2,4-Trimethylbenzene	--	--	--	--	--	Calculated; see footnote b	14.4	See footnote b	

-- indicates that a BAF/BCF or regression equation is not available.
BAF - Bioaccumulation factor.
BCF - Bioconcentration factor.
PAH - Polynuclear aromatic hydrocarbon

[a] IT Corporation (IT), 2001, *Redwater Pond Areas Baseline Ecological Risk Assessment, Plum Brook Ordnance Works, Sandusky, Ohio*, prepared for U.S. Army Corps of Engineers, Nashville District, April.

[b] For Organics: Ecological Soil Screening Level (SSL) Guidance, EPA, 2008 (Section 3.2.2 in Appendix 4-1, given site-specific soil total organic carbon [TOC]).

The biota/soil water partitioning coefficient of $10^{(\log Kow-0.6)}$ was replaced with Equation 3 from Jager (1998) of F_{lipid} x Kow. The F_{water} variable of Equation 3 was not included, since it only improves the model fit for extremely hydrophilic compounds (i.e. chemicals with log Kow < 2, approximately)

$$BAF - \frac{Flipid * Kow}{FOC * 10^{(0.983 * \log Kow + 0.00028)}}$$

Flipid = 0.079 The lipid content in insects was estimated at 3.1 percent fresh weight (Taylor, 1975), which is 7.9 percent of dry weight, using a value of 61 percent water content in beetles (EPA, 1993), calculated as follows: 0.031/(1-0.61) = 0.079, or 7.9 percent.

Kow values obtained from EPA EPI Suite Version 4.0, http://www.epa.gov/oppt/exposure/pubs/episuitedl.htm

References:

Beyer, W. N., 1990, *Evaluating Soil Contamination, Biological Report 90(2)*, U.S. Department of the Interior, U.S. Fish and Wildlife Service.
EPA, 1993, *Wildlife Exposure Factors Handbook, Volume I of II*, EPA 600/R-93/187a.
EPA, 2008, *Guidance for Developing Ecological Soil Screening Levels (Eco-SSL)*, Office of Solid Waste and Emergency Response, Directive 92857.7-55, Washington, D.C.
IT Corporation (IT), 2001, *Redwater Pond Areas Baseline Ecological Risk Assessment, Plum Brook Ordnance Works, Sandusky, Ohio*, prepared for U.S. Army Corps of Engineers, Nashville District, April.
Jager, T., 1998, *Mechanistic Approach for Estimating Bioconcentration of Organic Chemicals in Earthworms (Oligochaeta)*, Environmental Toxicology and Chemistry 17: 2080-2090.
Sample, B. E, et. al., 1998, *Development and Validation of Bioaccumulation Models for Earthworms*, ES/ER/TM-220.

Table 3-4

Bioaccumulation Factors or Regression Equations Utilized for the Soil-to-Mammal/Bird[a] Pathway Locomotive Building Area Plum Brook Ordnance Works, Sandusky, Ohio

Constituent	Sample et al., (1998)						EPA (1999)	Other BAF		Regression Equation	Recommended BAF	Rationale for Recommended BAF
	Insectivore Median BAF	Herbivore Median BAF	Omnivore Median BAF	General[b] Median BAF	General[b] Maximum BAF	General[b] 90th percentile BAF	Maximum BAF Avian or Mammal					
Inorganics												
Cadmium	2.105	0.1258	0.1217	0.3333	69.561	3.9905	0.0044	--	--	ln (M)=0.4723(ln[soil]) -1.2571	Regression	EPA (2008)-Attach 4-1, Table 4a
Nitroaromatics												
4-Amino-2,6-dinitrotoluene	--	--	--	--	--	--	7.24E-08	--	--	--	7.24E-08	Average of 2,4- and 2,-6 dinitrotoluene
2-Amino-4,6-dinitrotoluene	--	--	--	--	--	--	7.24E-08	--	--	--	7.24E-08	Average of 2,4- and 2,-6 dinitrotoluene
Semivolatile Organics												
2,4-Dinitrotoluene	--	--	--	--	--	--	8.14E-08	--	--	--	8.14E-08	EPA (1999), max for any taxa in Table D-3
2,6-Dinitrotoluene	--	--	--	--	--	--	6.34E-08	--	--	--	6.34E-08	EPA (1999), max for any taxa in Table D-3
2-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	0	EPA (2008) recommendation for PAHs
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	1.1	See Footnote c
Fluoranthene	--	--	--	--	--	--	--	--	--	--	0	EPA (2008) recommendation for PAHs
Pyrene	--	--	--	--	--	--	--	--	--	--	0	EPA (2008) recommendation for PAHs
Volatile Organics												
1,2,4-Trimethylbenzene	--	--	--	--	--	--	--	--	--	--	1.1	See Footnote c

-- indicates that a BAF is not available.
BAF = Bioaccumulation factor
PAH = Polycyclic aromatic hydrocarbon
[a] Bird BAF values were based on the recommended small mammal BAF values, as bird uptake values are not readily available.
[b] "General" indicates that the combination dataset used for insectivore, herbivore, and omnivore receptors was used to estimate a "general" receptor BAF value.
[c] The median BAF of 1.1 for dioxin (TCDD) from Sample et al. (1998) is used as a conservative surrogate for organic chemicals.

References:

EPA, 2008, *Guidance for Developing Ecological Soil Screening Levels (Eco-SSL)*, Office of Solid Waste and Emergency Response, Directive 92857.7-55, Washington, D.C.
EPA, 1999, *Screening level ecological risk assessment protocol for hazardous waste combustion facilities*, August, EPA530-D-99-001A.
Sample et al., 1998, *Development and Validation of Bioaccumulation Models for Small Mammals,* ES/ER/TM-219.

Table 3-5

Bioaccumulation Factors Utilized
for the Sediment-to-Benthic Invertebrate Pathway
Locomotive Building Area
Plum Brook Ordnance Works, Sandusky, Ohio

Constituent	PBOW Site-Specific BCFs [a]	Bechtel Jacobs (1998)			EPA (1999) BAF/BCF (dry weight)	Other BAF/BCF (dry weight)	Recommended BAF/BCF (dry weight)	Rationale for Recommended BAF/BCF
		Median BAF/BCF (dry weight)	90th Percentile BAF/BCF (dry weight)	Maximum BAF/BCF (dry weight)				
Inorganics								
Cadmium	--	0.6	7.99	41.55	17	--	0.6	Median Bechtel (1998) BAF based on empirical data
Manganese	0.006	0.42	2.1	--	--	--	0.006	Plum Brook site-specific BAF (IT, 2001)
Selenium	--	--	--	--	5.39 [b]	--	5.39	EPA, 1999
Thallium	--	--	--	--	5.39 [b]	--	5.39	EPA, 1999
Volatile Organics								
Acetone	--	--	--	--	--	--	0	EPA (2000). Acetone is not bioaccumulative.

-- indicates that a BAF/BCF or regression equation is not available.
BAF - Bioaccumulation factor.
BCF - Bioconcentration factor.

[a] IT Corporation (IT), 2001, *Redwater Pond Areas Baseline Ecological Risk Assessment, Plum Brook Ordnance Works, Sandusky, Ohio* , prepared for U.S. Army Corps of Engineers, Nashville District, April.

[b] Empirical data not available in EPA, 1999. Value presented is based on the mean of 6 recommended values for metals with empirical data as presented in Table C-6 (EPA, 1999).

References:

Bechtel Jacobs Company LLC, 1998, *Biota Sediment Accumulation Factors for Invertebrates: Review and Recommendations for the Oak Ridge Reservation* , BJC/OR-112. (Depurated and nondepurated results used).

EPA, 2000, *Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment* , USEPA Bioaccumulation Analysis Workgroup, February.

EPA, 1999, *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities* , EPA530-D-99-001A (Peer Review Draft). **Note:** Only values based on empirical studies were used. Values were reported on a wet weight basis. Values were multiplied by 5.99 to convert to a dry-weight basis (see EPA, 1999).

Table 3-6

Bioaccumulation Factors or Regression Equations Utilized for the Surface Water-to-Fish Pathway Locomotive Building Area Plum Brook Ordnance Works, Sandusky, Ohio

Constituent	PBOW Site-Specific BCFs [a]	EPA (1999) BAF/BCF [b] (dry weight)	EPA (1989) BAF/BCF [c] (dry weight)	RAIS Database [d] (dry weight)	Regression Equation	Recommended BCF	Rationale for Recommended BAF/BCF
Inorganic Chemicals							
Aluminum	780	13.5	--	2,500	--	780	Site specific BCF used (IT, 2001)
Arsenic	174	570	1,750	1,500	--	174	Site specific BCF used (IT, 2001)
Barium	146	3165	--	20	--	146	Site specific BCF used (IT, 2001)
Beryllium	--	310	--	500		310	EPA (1999)
Copper	1211.5	3,550	5,915	1,000	--	1211.5	Site specific BCF used (IT, 2001)
Lead	63.8	0.45	895	1,500	--	63.8	Site specific BCF used (IT, 2001)
Manganese	247	--	--	2,000		247	Site specific BCF used (IT, 2001)
Nickel	724	390	250	500	--	724	Site specific BCF used (IT, 2001)
Selenium	--	645	--	1,000	--	645	EPA (1999)
Vanadium	445.5	--	--	--		445.5	Site specific BCF used (IT, 2001)
Zinc	1217	10,295	2,890	5,000	--	1217	Site specific BCF used (IT, 2001)

-- indicates that a BAF/BCF or regression equation is not available.
BAF - Bioaccumulation factor.
BCF - Bioconcentration factor.

[a] Values are from IT, 2001. The listed BCF is the average of the West Area Red Water Pond reasonable maximum exposure value, and the average of the BCFs for the three aquatic organisms evaluated for the Pentolite Road area.

[b] Values are from EPA, 1999, adjusted to dry weight by multiplying by a factor of 5.

[c] Values are from EPA, 1989, and assumed to be in wet weight; adjusted to dry weight by multiplying by a factor of 5.

[d] Values are from Risk Assessment Information System (RAIS), current as of June 2010. Values were assumed to be in wet weight and were adjusted to dry weight by multiplying by a factor of 5.

References:

Bintein, S., and J. Devillers, 1992, *Nonlinear Dependence of Fish Bioconcentration on n-Octanol/Water Partition Coefficient*, CTIS.

EPA, 1999, *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities*, EPA530-D-99-001A (Peer Review Draft).

EPA, 1989, *Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish*, EPA503-8-89-002.

IT Corporation (IT), 2001, *Redwater Pond Areas Baseline Ecological Risk Assessment, Plum Brook Ordnance Works, Sandusky, Ohio*, prepared for U.S. Army Corps of Engineers, Nashville District, April.

Risk Assessment Information System (RAIS), on-line database, current as of June 2007, http://rais.ornl.gov

Table 4-1

Toxicity Reference Values for Mammals
Locomotive Building Area, Plum Brook Ordnance Works
Sandusky, Ohio

	Toxicity Value	NOAEL (mg/kg/d)	Test Species	Reference	Toxicity Value	LOAEL (mg/kg/d)	Test Species	Reference
Inorganics								
Aluminum	--	1.93	mouse	Sample, et al. (1996)	--	19.30	mouse	Sample, et al. (1996)
Arsenic	--	0.126	mouse	Sample, et al. (1996)	--	1.26	mouse	Sample, et al. (1996)
Barium	--	5.1	rat	Sample, et al. (1996)	--	19.8	rat	Sample, et al. (1996)
Beryllium	--	0.66	rat	Sample, et al. (1996)	0.66 (NOAEL)	3.3	rat	Sample, et al. (1996)
Cadmium	--	1	rat	Sample, et al. (1996)	--	10	rat	Sample, et al. (1996)
Copper	--	11.7	mink	Sample, et al. (1996)	--	15.14	mink	Sample, et al. (1996)
Lead	--	8	rat	Sample, et al. (1996)	--	80	rat	Sample, et al. (1996)
Manganese	--	88	rat	Sample, et al. (1996)	--	284	rat	Sample, et al. (1996)
Nickel	--	40	rat	Sample, et al. (1996)		80	rat	Sample, et al. (1996)
Selenium	--	0.2	rat	Sample, et al. (1996)	--	0.33	rat	Sample, et al. (1996)
Thallium	--	0.0074	rat	Sample, et al. (1996)	--	0.074	rat	Sample, et al. (1996)
Vanadium	--	0.21	rat	Sample, et al. (1996)	--	2.1	rat	Sample, et al. (1996)
Zinc	--	160	rat	Sample, et al. (1996)	--	320	rat	Sample, et al. (1996)
Nitroaromatics								
4-Amino-2,6-dinitrotoluene	--	9	mouse/rat	USACHPPM (2005)	--	48	mouse/rat	USACHPPM (2005)
2-Amino-4,6-dinitrotoluene	--	9	mouse/rat	USACHPPM (2005)	--	48	mouse/rat	USACHPPM (2005)
Semivolatile Organics								
2,4-Dinitrotoluene	--	0.2	beagle dog	IRIS on-line (2001)	--	1.5	beagle dog	IRIS on-line (2001)
2,6-Dinitrotoluene	--	0.2	beagle dog	2,4-DNT as surrogate	--	1.5	beagle dog	2,4-DNT as surrogate
2-Methylnaphthalene	--	2.45	rat	LANL (2010)	--	24.5	rat	LANL (2010)
Dibenzofuran	NA							
Fluoranthene	--	1	mouse	B(a)P as surrogate	--	10	mouse	B(a)P as surrogate
Pyrene	--	1	mouse	B(a)P as surrogate	--	10	mouse	B(a)P as surrogate
Volatile Organics								
1,2,4-Trimethylbenzene	NA							
Acetone	--	100	Rat	Sample, et al. (1996)	--	500	Rat	Sample, et al. (1996)

NA - No toxicity data available

REFERENCES

Los Alamos National Laboratory (LANL), 2010, ECORISK Database (Release 2.5), Environmental Restoration Project, Los Alamos National Laboratory, Los Alamos, NM, September.

Sample, B. E., D. M. Opresko, and G. W. Suter II. 1996, Toxicological Benchmarks for Wildlife, 1996 Revision, Risk Assessment Program, Health Sciences Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

USACHPPM, 2005, Wildlife Toxicity Aseessment for 2-Amino-4,6-Dinitrotoluene and 4,-Amino-2,6-Dinitrotoluene, Environmental Health Risk Assessment Program and Health Effects Research Program, Aberdeen Proving Ground, Maryland, December.

Table 4-2

Toxicity Reference Values for Birds
Locomotive Building Area, Plum Brook Ordnance Works
Sandusky, Ohio

COPEC	Toxicity Value	NOAEL (mg/kg/d)	Test Species	Reference	Toxicity Value	LOAEL (mg/kg/d)	Test Species	Reference
Inorganics								
Aluminum	--	110	ringed dove	Sample, et al. (1996)	--	1100	ringed dove	Sample, et al. (1996)
Arsenic	--	5.14	mallard duck	Sample, et al. (1996)	--	12.84	mallard duck	Sample, et al. (1996)
Barium	--	20.8	chicks	Sample, et al. (1996)	--	41.7	chicks	Sample, et al. (1996)
Beryllium	NA							
Cadmium	--	1.45	mallard duck	Sample, et al. (1996)	--	20	mallard duck	Sample, et al. (1996)
Copper	--	47	chicks	Sample, et al. (1996)	--	61.7	chicks	Sample, et al. (1996)
Lead (quail)	--	1.13	Japanese quail	Sample, et al. (1996)	--	11.3	Japanese quail	Sample, et al. (1996)
Lead (kestrel)	--	3.85	Am. Kestrel	Sample, et al. (1996)	--	38.50	Am. Kestrel	Sample, et al. (1996)
Manganese	--	977	Japanese quail	Sample, et al. (1996)	--	9770	Japanese quail	Sample, et al. (1996)
Nickel	--	77.4	mallard duck	Sample, et al. (1996)	--	107	mallard duck	Sample, et al. (1996)
Selenium (duck)	--	0.5	mallard duck	Sample, et al. (1996)	--	1	mallard duck	Sample, et al. (1996)
Selenium (owl)	--	0.44	screech owl	Sample, et al. (1996)	--	1.5	screech owl	Sample, et al. (1996)
Thallium	--	0.35	starling	LANL (2010)	--	3.5	starling	LANL (2010)
Vanadium	--	11.38	mallard duck	Sample, et al. (1996)	--	113.80	mallard duck	Sample, et al. (1996)
Zinc	--	14.50	hens	Sample, et al. (1996)	--	131.00	hens	Sample, et al. (1996)
Nitroaromatics								
4-Amino-2,6-dinitrotoluene	7	0.7	Bobwhite quail	2,4,6-TNT as surrogate; USACHPPM (2000)	178	17.8	Bobwhite quail	2,4,6-TNT as surrogate; USACHPPM (2000)
2-Amino-4,6-dinitrotoluene	7	0.7	Bobwhite quail	2,4,6-TNT as surrogate; USACHPPM (2000)	178	17.8	Bobwhite quail	2,4,6-TNT as surrogate; USACHPPM (2000)
Semivolatile Organics								
2,4-Dinitrotoluene	7	0.7	Bobwhite quail	2,4,6-TNT as surrogate; USACHPPM (2000)	178	17.8	Bobwhite quail	2,4,6-TNT as surrogate; USACHPPM (2000)
2,6-Dinitrotoluene	7	0.7	Bobwhite quail	2,4,6-TNT as surrogate; USACHPPM (2000)	178	17.8	Bobwhite quail	2,4,6-TNT as surrogate; USACHPPM (2000)
2-Methylnaphthalene [a]	--	22.8	Mallard	Naphthalene as surrogate; Patton and Dieter (1980)	--	228	Mallard	Naphthalene as surrogate; Patton and Dieter (1980)
Dibenzofuran	NA							
Fluoranthene	--	39.5	chicken	Rigdon and Neal, 1963	--	395	chicken	Rigdon and Neal, 1963
Pyrene	--	39.5	chicken	Rigdon and Neal, 1963	--	395	chicken	Rigdon and Neal, 1963
Volatile Organics								
1,2,4-Trimethylbenzene	NA							
Acetone	--	200.89	Japanese quail	LANL (2010)	--	2000.89	Japanese quail	LANL (2010)

NA - No toxicity value available

[a] Values for Naphthalene used as a surrogate.

REFERENCES

Los Alamos National Laboratory (LANL), 2010, ECORISK Database (Release 2.5), Environmental Restoration Project, Los Alamos National Laboratory, Los Alamos, NM, September.
Patton, J. F. and M. P. Dieter, 1980, "Effects of petroleum hydrocarbons on heptic function in the duck",*Comp. Biochem. Physiol.,* 65C:33-36.
Sample, B. E., D. M. Opresko, and G. W. Suter II, 1996, Toxicological Benchmarks for Wildlife, 1996 Revision, Risk Assessment Program, Health Sciences Research Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee.
Rigdon, RH and J Neal. 1963. *Absorption and Excretion of Benzo(a)pyrene, Observation in the Duck, Chicken, Mouse, and Dog*. Texas Rep. Biol. And Med. 21(2):247-261.
USACHPPM, 2000, Standard Practice for Wildlife Toxicity Reference Values, Environmental Health Risk Assessment Program and Health Effects Research Program, Aberdeen Proving Ground, Maryland, October.

Table 5-1

Wildlife Hazard Quotients for all Assessment Receptors
Locomotive Building Area
Plum Brook Ordnance Works, Sandusky, Ohio

COPEC	Deer Mouse		Short-tailed Shrew		Cottontail Rabbit		Marsh Wren		White-tailed Deer		Raccoon		Red-Tailed Hawk		Muskrat	
	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL
Metals																
Aluminum	**1.66E+00**	1.66E-01	**1.71E+00**	1.71E-01	5.65E-01	5.65E-02	5.27E-02	5.27E-03	2.28E-03	2.28E-04	1.02E-01	1.02E-02	2.24E-05	2.24E-06	1.04E+00	1.04E-01
Arsenic	7.89E-03	7.89E-04	8.14E-03	8.14E-04	2.69E-03	2.69E-04	3.51E-04	1.41E-04	1.09E-05	1.09E-06	1.44E-04	1.44E-05	1.49E-07	5.97E-08	4.97E-03	4.97E-04
Barium	3.26E-03	8.40E-04	3.36E-03	8.67E-04	1.11E-03	2.87E-04	1.45E-03	7.25E-04	4.50E-06	1.16E-06	5.32E-05	1.37E-05	6.16E-07	3.07E-07	2.06E-03	5.30E-04
Beryllium	2.48E-04	4.95E-05	2.56E-04	5.11E-05	8.46E-05	1.69E-05	NA	NA	3.42E-07	6.83E-08	6.93E-06	1.39E-06	NA	NA	1.56E-04	3.12E-05
Cadmium	4.18E-01	4.18E-02	6.06E-01	6.06E-02	2.08E-02	2.08E-03	9.93E-01	7.20E-02	4.01E-05	4.01E-06	1.07E-03	1.07E-04	1.74E-05	1.26E-06	2.29E-01	2.29E-02
Copper	3.06E-04	2.36E-04	3.15E-04	2.44E-04	1.04E-04	8.06E-05	1.38E-04	1.05E-04	4.21E-07	3.26E-07	2.82E-05	2.18E-05	5.86E-08	4.46E-08	1.93E-04	1.49E-04
Lead	1.82E-04	1.82E-05	1.88E-04	1.88E-05	6.21E-05	6.21E-06	2.34E-03	2.34E-04	2.51E-07	2.51E-08	1.90E-06	1.90E-07	2.91E-07	2.91E-08	1.15E-04	1.15E-05
Manganese	2.89E-03	8.97E-04	2.98E-03	9.25E-04	9.88E-04	3.06E-04	4.73E-04	4.73E-05	3.99E-06	1.24E-06	1.62E-03	5.03E-04	2.01E-07	2.01E-08	1.07E+00	3.33E-01
Nickel	2.13E-04	1.06E-04	2.20E-04	1.10E-04	7.27E-05	3.63E-05	2.00E-04	1.45E-04	2.93E-07	1.47E-07	1.22E-05	6.12E-06	8.48E-08	6.13E-08	1.34E-04	6.71E-05
Selenium	3.27E-03	1.98E-03	3.37E-03	2.04E-03	1.12E-03	6.77E-04	2.38E-03	1.19E-03	4.51E-06	2.73E-06	8.73E-03	5.29E-03	1.15E-06	3.36E-07	**2.09E+00**	1.27E+00
Thallium	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.60E-01	1.60E-02	0.00E+00	0.00E+00	1.69E-01	1.69E-02
Vanadium	2.62E-02	2.62E-03	2.70E-02	2.70E-03	8.93E-03	8.93E-04	8.77E-04	8.77E-05	3.61E-05	3.61E-06	9.85E-04	9.85E-05	3.72E-07	3.72E-08	1.65E-02	1.65E-03
Zinc	1.34E-04	6.68E-05	1.38E-04	6.90E-05	4.56E-05	2.28E-05	2.68E-03	2.97E-04	1.84E-07	9.21E-08	1.24E-05	6.19E-06	1.14E-06	1.26E-07	8.43E-05	4.21E-05
Nitroaromatics																
4-Amino-2,6-dinitrotoluene	2.33E-02	4.36E-03	1.26E-03	2.36E-04	8.84E-03	1.66E-03	2.62E-02	1.03E-03	1.45E-05	2.72E-06	2.42E-05	4.53E-06	1.72E-06	6.78E-08	0.00E+00	0.00E+00
2-Amino-4,6-dinitrotoluene	1.30E-02	2.43E-03	8.05E-04	1.51E-04	4.93E-03	9.25E-04	1.46E-02	5.75E-04	9.27E-06	1.74E-06	1.35E-05	2.53E-06	9.62E-07	3.78E-08	0.00E+00	0.00E+00
Semivolatile Organics																
2,4-Dinitrotoluene	4.49E-01	5.98E-02	1.23E-01	1.63E-02	1.61E-01	2.15E-02	7.15E-02	2.81E-03	1.94E-04	2.59E-05	6.48E-04	8.65E-05	4.71E-06	1.85E-07	0.00E+00	0.00E+00
2,6-Dinitrotoluene	5.54E-02	7.39E-03	3.99E-02	5.33E-03	1.97E-02	2.63E-03	1.01E-02	3.99E-04	5.39E-05	7.19E-06	8.41E-05	1.12E-05	6.68E-07	2.63E-08	0.00E+00	0.00E+00
All Nitrotoluenes (summed)	***5.40E-01***	***7.40E-02***	***1.65E-01***	***2.20E-02***	***1.95E-01***	***2.67E-02***	***1.22E-01***	***4.82E-03***	***2.72E-04***	***3.76E-05***	***7.70E-04***	***1.05E-04***	***8.06E-06***	***3.17E-07***	***0.00E+00***	***0.00E+00***
2-Methylnapthalene	1.63E-01	1.63E-02	1.97E-01	1.97E-02	1.74E-02	1.74E-03	5.23E-02	5.23E-03	2.66E-05	2.66E-06	3.28E-04	3.28E-05	2.91E-07	2.91E-08	0.00E+00	0.00E+00
Dibenzofuran	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoranthene	3.61E-02	3.61E-03	1.35E-02	1.35E-03	1.17E-02	1.17E-03	7.92E-04	7.92E-05	1.56E-05	1.56E-06	5.34E-05	5.34E-06	2.72E-08	2.72E-09	0.00E+00	0.00E+00
Pyrene	5.75E-02	5.75E-03	2.66E-02	2.66E-03	1.66E-02	1.66E-03	1.65E-03	1.65E-04	2.48E-05	2.48E-06	8.45E-05	8.45E-06	2.78E-08	2.78E-09	0.00E+00	0.00E+00
Volatile Organics																
1,2,4-Trimethylbenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Acetone	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.08E-08	1.62E-08	0.00E+00	0.00E+00	1.74E-04	3.49E-05

COPEC - Chemical of potential ecological concern.
LOAEL - Lowest-observed-adverse-effect level.
NA - No toxicity data available; hazard quotients not calculated.
NOAEL - No-observed-adverse-effect level.

Shaded cells indicate a hazard quotient greater than 1, when rounded.

FIGURES

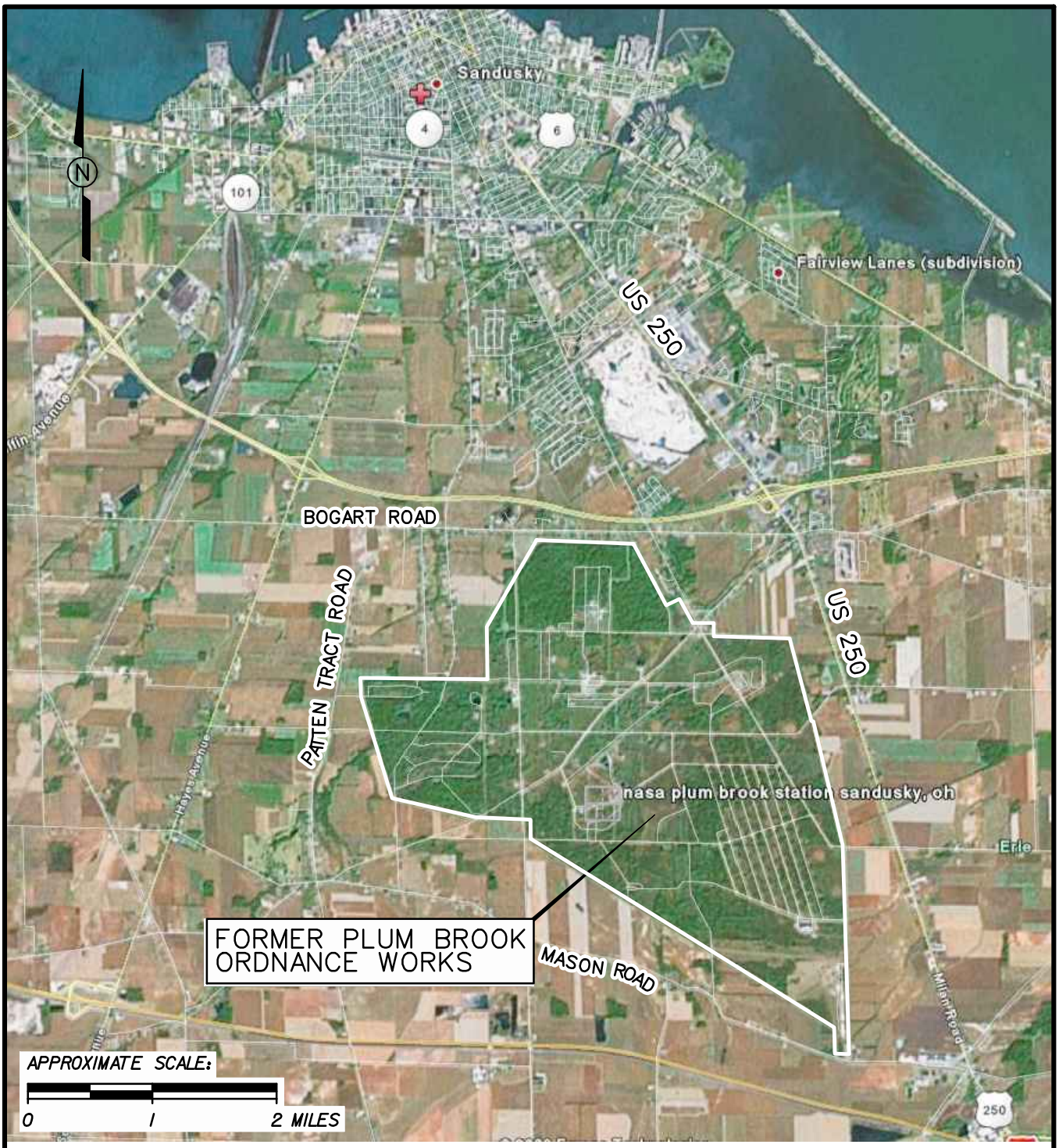


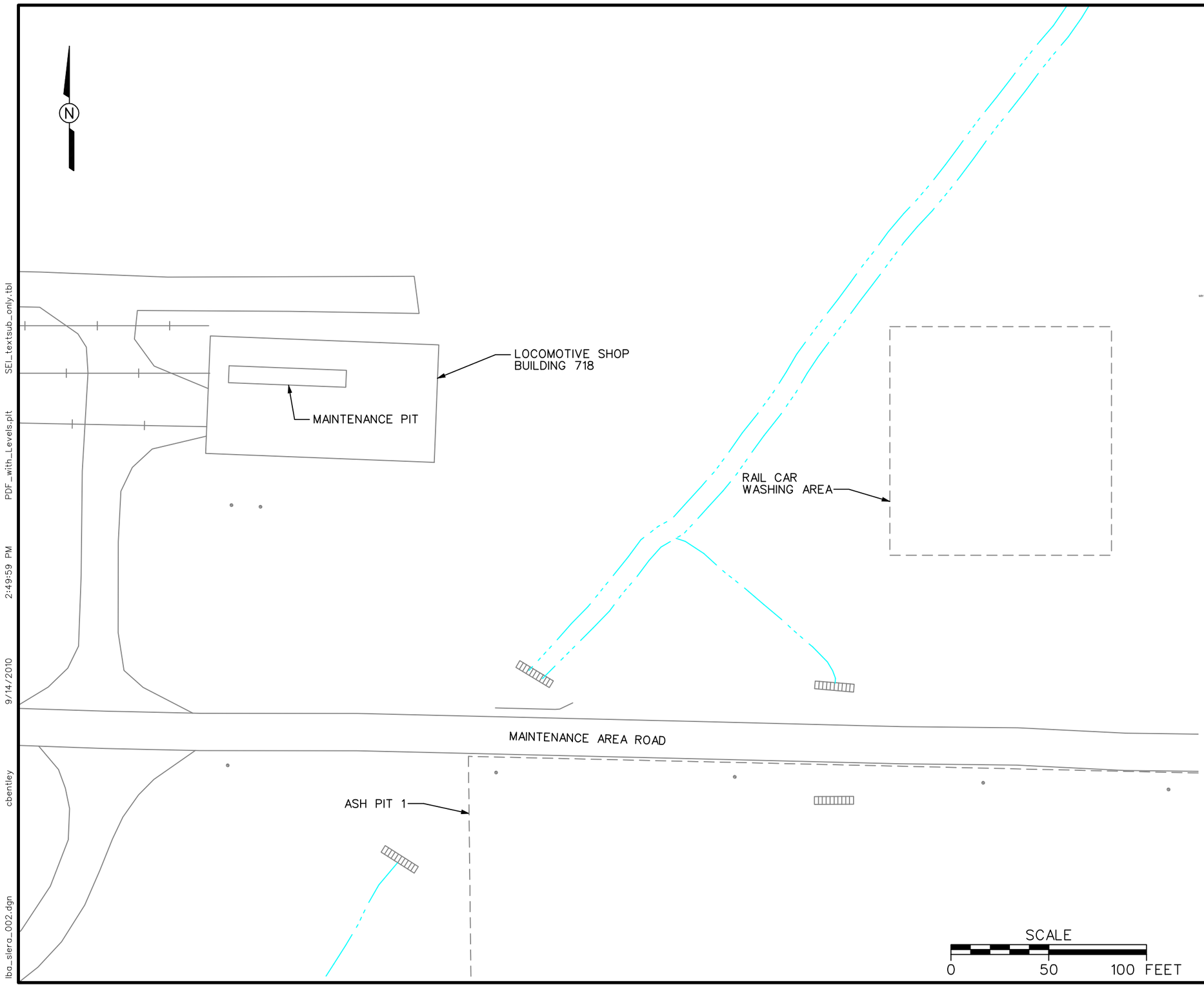
FIGURE 1-1
PBOW VICINITY MAP

LOCOMOTIVE BUILDING AREA
SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

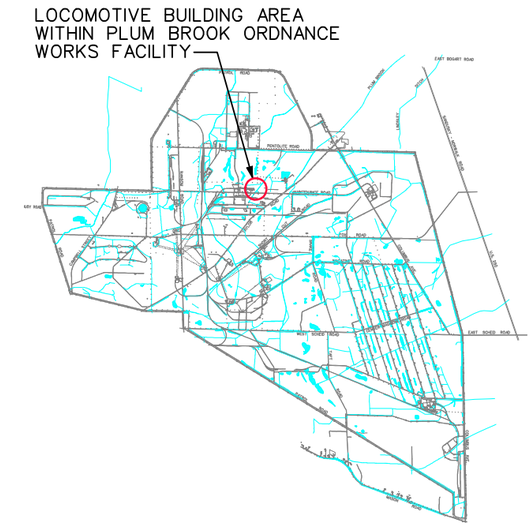
Shaw® a world of Solutions™

lba_slera_001.dgn cbentley 9/1/2010 11:01:43 AM PDF_with_Levels.plt SEI_textsub_only.tbl



LEGEND:

- HEADWALL
- UTILITY POLE
- CREEK, DITCH, CONVEYANCE



NOTES:

1. ASH PIT 1 IS NOT PART OF THE LOCOMOTIVE BUILDING AREA, BUT IS AN ADJACENT STUDY AREA.

FIGURE 1-2
SITE LOCATION MAP

LOCOMOTIVE BUILDING AREA SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

FORMER PLUM BROOK ORDNANCE WORKS NASA PLUM BROOK STATION SANDUSKY, OHIO

Shaw® a world of Solutions™

lbo_slera_002.dgn cbentley 9/14/2010 2:49:59 PM PDF_with_Levels.plt SEL_textsub_only.tbl

Figure 2-1

Photo Log of Locomotive Building Area, Plum Brook Ordnance Works
Sandusky, Ohio

Photo 1. Overgrown weeds east of the Locomotive Shop.

Photo 2. Overgrown weeds east of the Locomotive Shop.

Figure 2-1

Photo Log of Locomotive Building Area, Plum Brook Ordnance Works
Sandusky, Ohio

Photo 3. Overgrown weeds north of the Locomotive Shop.

Photo 4. View of unnamed tributary to Plum Brook, located betewen the Locomotive Shop and the Rail Car Washing Area.

Figure 2-1

Photo Log of Locomotive Building Area, Plum Brook Ordnance Works
Sandusky, Ohio

Photo 5. Gravel parking area and road north of Locomotive Shop.

Photo 6. View of souteast corner of Locomotive Shop, showing mowed grass and Maintenance Road in the background.

Figure 2-1

Photo Log of Locomotive Building Area, Plum Brook Ordnance Works
Sandusky, Ohio

Photo 7. Mowed Area between Maintenance Road and Locomotive Shop.

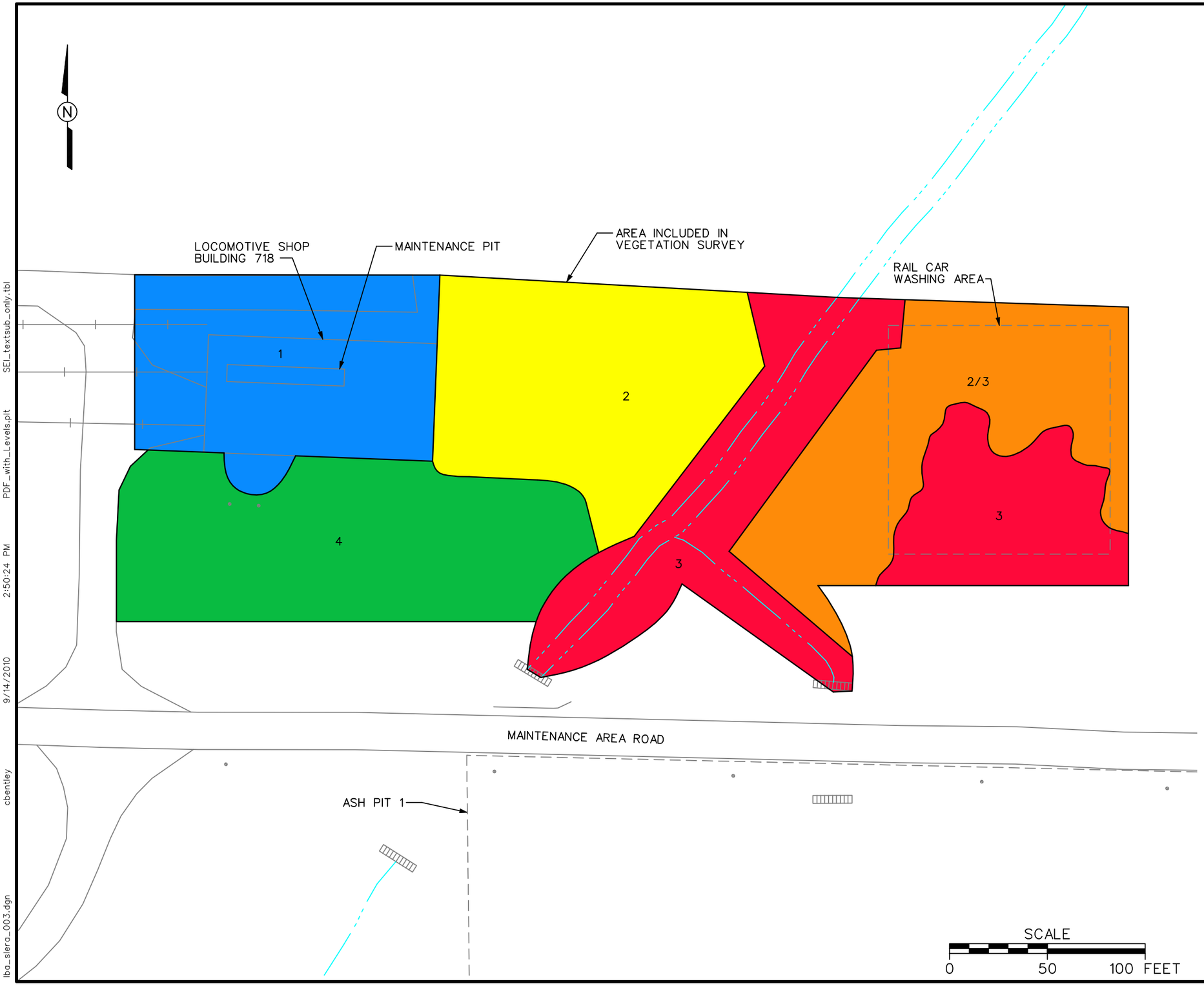
Photo 8. View of unnamed tributary to Plum Brook between the Locomotive Shop and the Rail Car Washing Area.

Figure 2-1

Photo Log of Locomotive Building Area, Plum Brook Ordnance Works
Sandusky, Ohio

Photo 9. Disturbed soil at the Rail Car Washing Area.

Photo 10. Rail Car Washing Area.



LEGEND:

- HEADWALL
- UTILITY POLE
- CREEK, DITCH, CONVEYANCE
- 1 PARKING LOT/BUILDING
- 2 UPLAND OLD FIELD
- 2/3 UPLAND OLD FIELD/SHRUB THICKET
- 3 SHRUB THICKET
- 4 MOWED FIELD

NOTES:

1. ASH PIT 1 IS NOT PART OF THE LOCOMOTIVE BUILDING AREA, BUT IS AN ADJACENT STUDY AREA.

FIGURE 2-2
VEGETATION COMMUNITIES AT LOCOMOTIVE BUILDING AREA

LOCOMOTIVE BUILDING AREA SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

FORMER PLUM BROOK ORDNANCE WORKS NASA PLUM BROOK STATION SANDUSKY, OHIO

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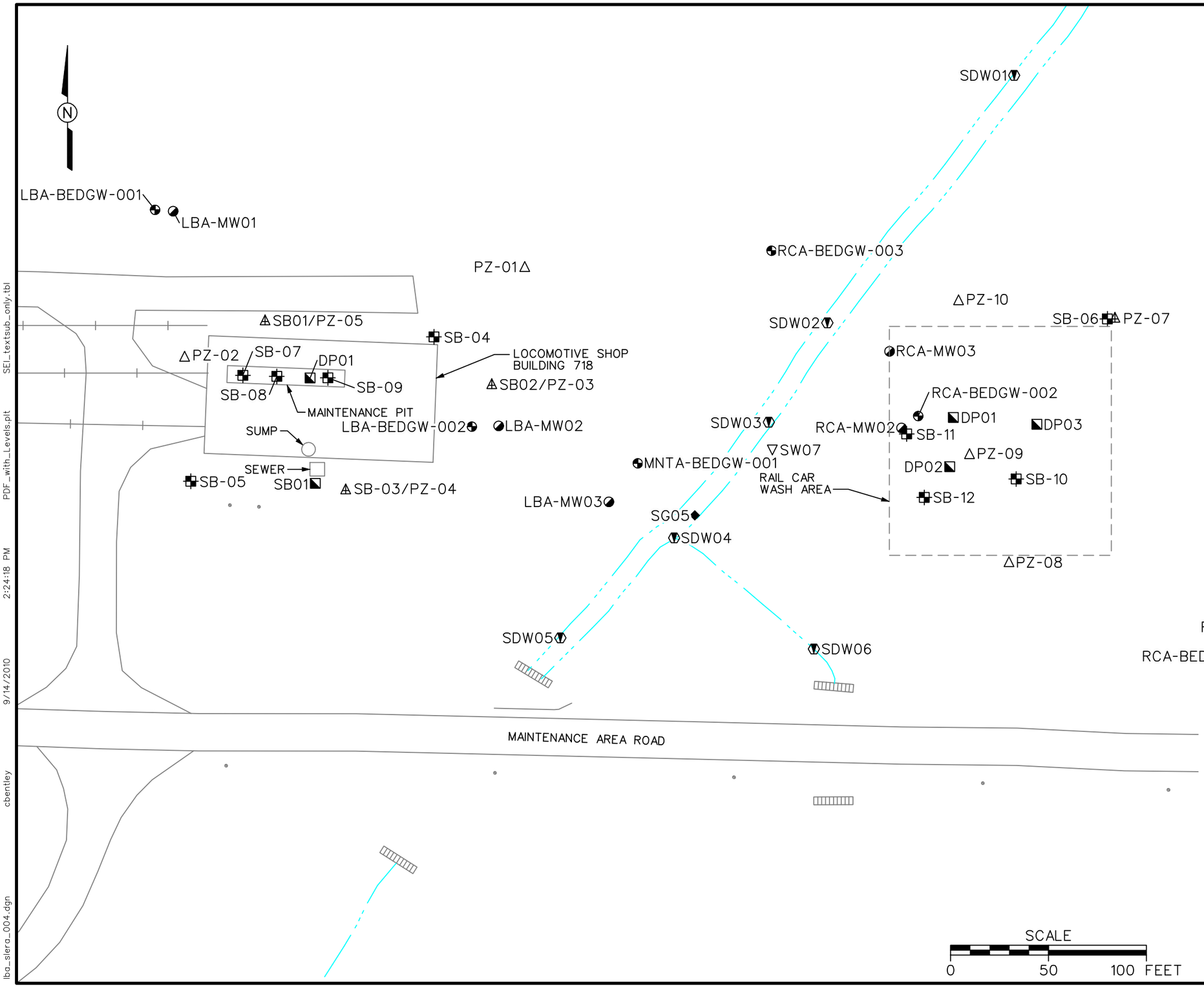

LEGEND:

- OVERBURDEN MONITORING WELL (SCREENED IN SHALE)
- BEDROCK MONITORING WELL (SCREENED IN LIMESTONE)
- SOIL BORING
- PIEZOMETER
- SOIL BORING/PIEZOMETER
- SURFACE WATER SAMPLE
- SURFACE WATER/SEDIMENT SAMPLE
- STAFF GAUGE
- HISTORICAL SOIL BORING

NOTES:

1. SAMPLES FROM THE HISTORICAL SOIL BORINGS WERE COLLECTED AND ANALYZED IN 1999 AS PART OF THE LIMITED SITE INVESTIGATION (USACE, 2000).

FIGURE 2-3
SITE MAP WITH SAMPLE LOCATIONS

LOCOMOTIVE BUILDING AREA
SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

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Figure 2-4

Simplified Terrestrial Food Web Conceptual Site Model (CSM)
Locomotive Building Area
Plum Brook Ordnance Works, Sandusky, Ohio

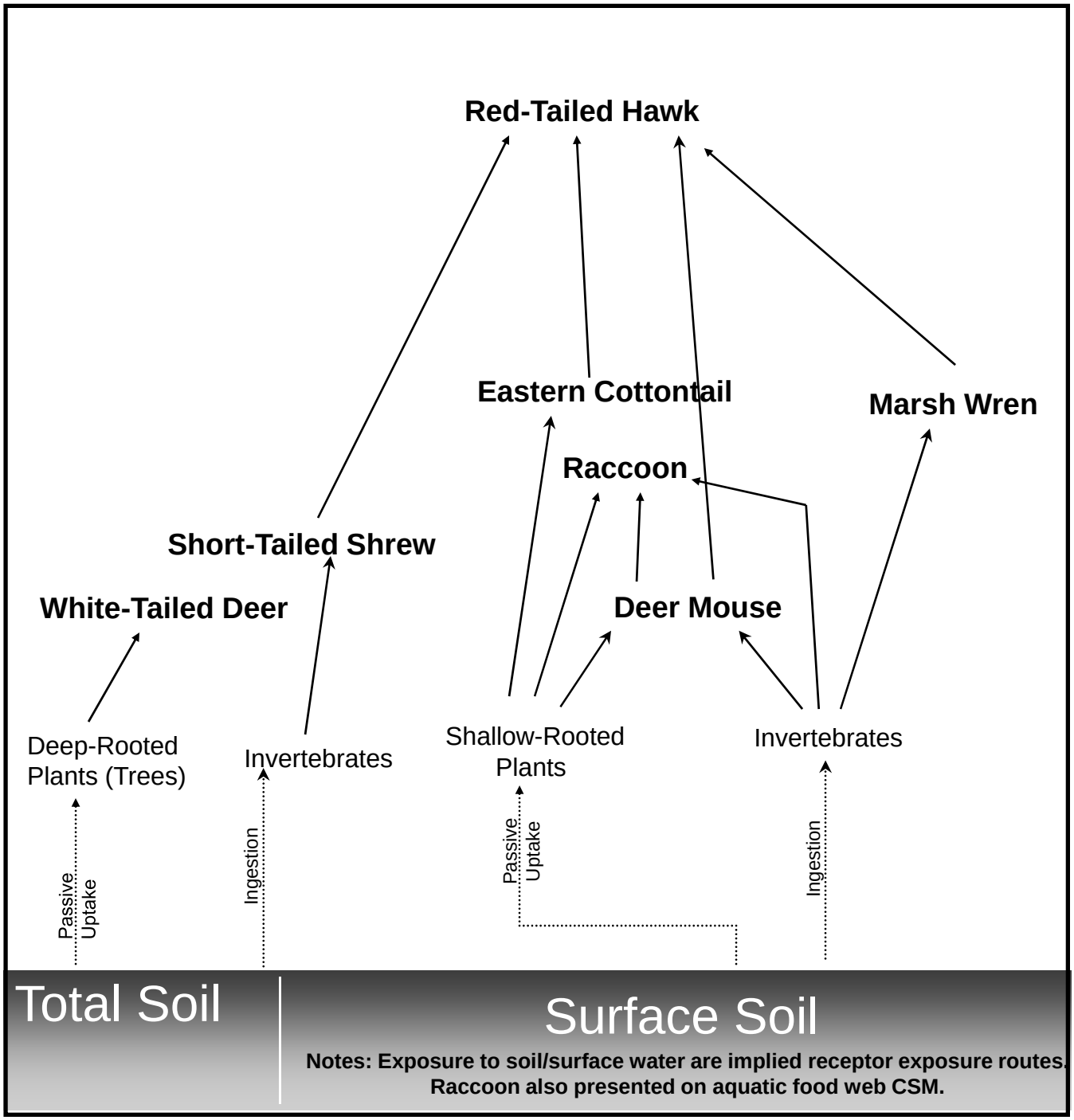
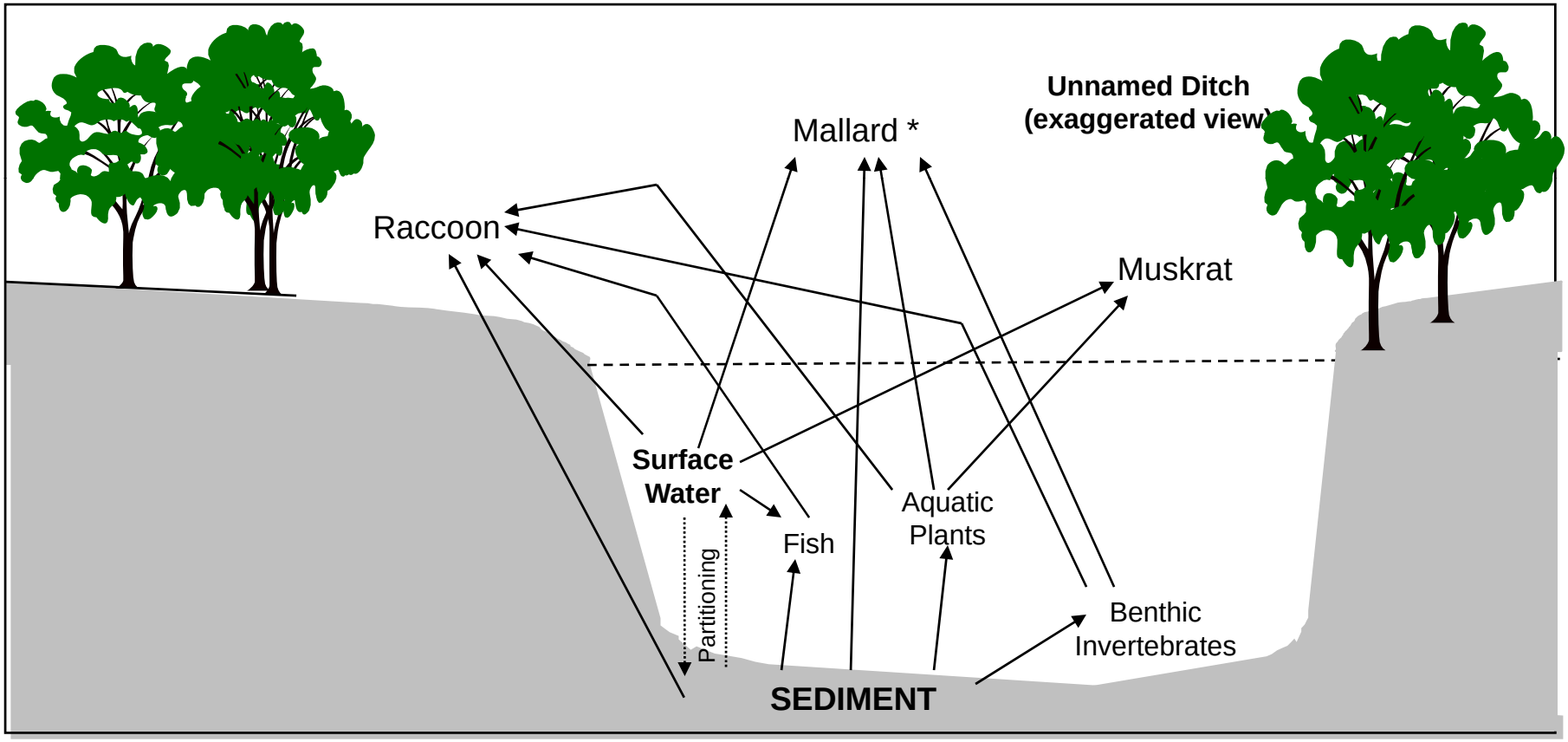


Figure 2-5

Simplified Aquatic Food Web Conceptual Site Model (CSM)
Locomotive Building Area
Plum Brook Ordnance Works, Sandusky, Ohio

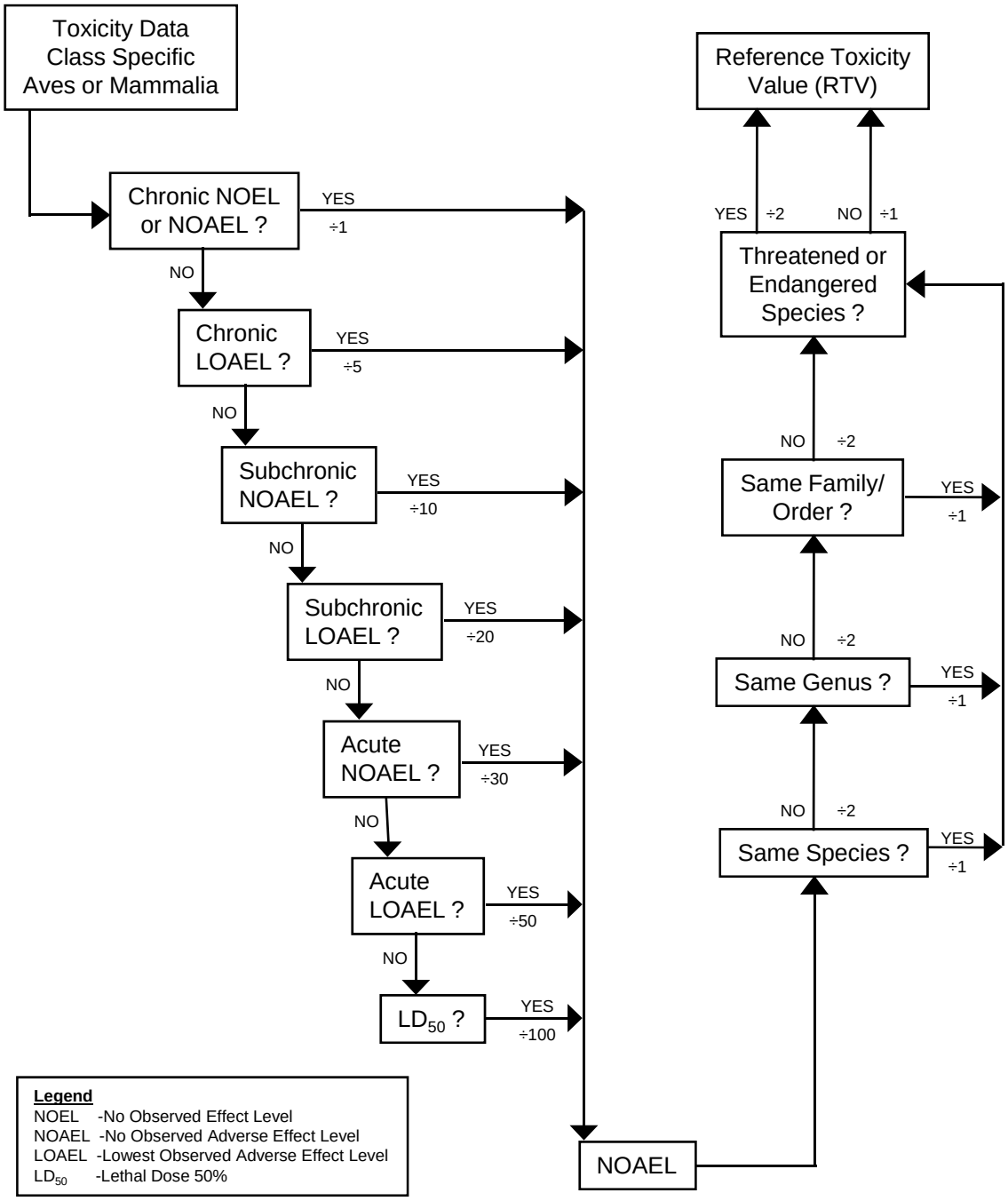


Note: The raccoon is also presented on terrestrial food web CSM.

*** = The mallard is not evaluated in the risk assessment.**

Figure 4-1

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



Credit: Adapted from Ford et al. (1992) in *Tri-Service Procedural Guidelines for Ecological Risk Assessments*, 1996

KN/4466/ECO-RA/fig4-1.ppt/10/22/01

APPENDIX A

VACULAR PLANT SPECIES DOCUMENTED ON SITE

Appendix A
Vascular Plant Species Documented On Site
Locomotive Building Area
Plum Brook Ordnance Works
Sandusky, Ohio

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
**Acer platanoides*	Norway maple	Occasional		Disturbed woods	1
**Achillea millefolium*	Yarrow	Frequent		Dry fields, roadsides, and about buildings	1,2
**Agropyron repens*	Quack grass	Frequent		Old fields and roadsides	2
**Agrostis gigantea*	Redtop	Common		Moist fields, ditches, and roadsides	1,2
**Alliaria petiolata*	garlic mustard	Frequent		Dry to moist wood lots	1,2
**Andropogon virginicus*	broom-sedge	Occasional, frequent		Dry fields and roadsides	1,2
**Anthoxanthum odoratum*	vernal-grass	Occasional		Dry fields and openings, especially on shale	1
**Arabidopsis thaliana*	mouse-ear cress	Occasional		Road berms and about buildings	1
**Arctium minus*	Burdock	Occasional		Disturbed fields and about buildings	1
**Artemisia ludoviciana var. gnaphaloides*	white sage	Occasional		Grassy roadsides	1
**Berberis thunbergii*	Japanese barberry	Occasional, rare		Woodland borders	1
**Brassica nigra*	black mustard	Occasional		Roadsides	1
**Bromus inermis*	smooth brome	Frequent		Dry to moist fields and roadsides	1,2
**Bromus tectorum*	downy chess	Occasional		Dry openings and roadsides on shale	1
**Campsis radicans*	trumpet-vine	Occasional		Disturbed openings and roadsides	1
**Capsella bursa-pastoris*	shepherd's-purse	Occasional		Roadsides and about buildings	1,2
**Cardamine hirsuta*	bitter-cress	Occasional		Roadsides and about buildings	1
**Carduus nutans*	musk-thistle	Occasional, frequent		Dry fields and roadsides	1
**Cerastium fontanum*	mouse-ear chickweed	Frequent		Road berms and about buildings	1
**Cerastium semidecandrum*	NA	Occasional		Road berms and about buildings	1
**Chaenorrhinum minus*	dwarf snapdragon	Occasional		Road berms and about buildings	1
**Chrysanthemum leucanthemum*	ox-eye daisy	Frequent		Dry to moist fields and roadsides	1
**Cichorium intybus*	Chicory	Occasional		Roadsides	1,3
**Cirsium arvense*	Canada thistle	Common		Disturbed fields and roadsides	1,3
**Cirsium vulgare*	bull thistle	Frequent		Disturbed fields and roadsides	1
**Confolvulus arvensis*	field bindweed	Occasional		Disturbed fields and roadsides	1,3
**Convallaria majalis*	lilly-of-the-valley	Rare		Grassy field along Columbus Avenue	1
**Coronilla varia*	crown-vetch	Occasional, common		Grassy fields and roadsides	1,2
**Cyperus esculentus*	yellow nutgrass	Occasional, frequent		Moist, disturbed openings	1
**Dactylis glomerata*	orchard-grass	Occasional		Dry to moist fields and roadsides	1,2
**Daucus carota*	wild carrot	Frequent		Dry fields and roadsides	1
**Dianthus armeria*	Deptford pink	Occasional, rare		Dry openings and roadsides on shale	1
**Dipsacus fullonum*	common teasel	Frequent		Dry, disturbed openings and roadsides	1
**Draba verna*	early whitlow-wort	Occasional		Dry roadsides and about buildings	1
**Eleagnus umbellata*	autumn-olive	Occasional		Roadsides and woodland borders	1,2
**Elytrigia repens*	quack-grass	Frequent		Dry fields and roadsides	1
**Festuca elatior*	tall fescue	Occasional		Roadsides and grassy fields	1
**Festuca obtusa*	Fescue	Common		Old fields	2
**Glecoma hederacea*	ground-ivy	Frequent		Moist openings, roadsides, and about buildings	1,3
**Hieracium pilosselloides*	king-devil	Frequent		Dry openings on shale, fields	1
**Hypericum perforatum*	dotted St. John's-wort	Frequent		Disturbed fields and roadsides	1
**Inula helenium*	Elecampane	Rare		Moist roadside along Taft Road	1
**Lamium purpureum*	dead-nettle	Frequent		Disturbed fields, roadsides, and about buildings	1
**Lepidium campestre*	field-cress	Occasional		Roadsides and about buildings	1
**Linaria vulgaris*	butter-and-eggs	Occasional		Roadsides and about buildings	1
**Lonicera maackii*	Amur honeysuckle	Rare		Roadsides and thickets along Columbus Avenue near Scheid Ditch	1
**Lonicera morrowii*	Asiatic honeysuckle	Frequent		Thickets, borders, and roadsides	1
**Lonicera tatarica*	Tatarian honeysuckle	Frequent, common		Thickets, borders, and roadsides	1,2
**Lotus corniculatus*	bird's-foot trefoil	Occasional		Grassy fields and road berms	1
**Matricaria matricarioides*	pineapple-weed	Occasional		Roadsides and about buildings	1
**Medicago lupulina*	Black medic	Occasional		Old fields and disturbed areas	2
**Melilotus alba*	white sweet-clover	Occasional, frequent		Disturbed fields and roadsides	1,2
**Melilotus officinalis*	yellow sweet-clover	Occasional		Disturbed fields and roadsides	1,2
**Najas minor*	Eurasian naiad	Frequent		Artificial ponds	1
**Nepeta cataria*	catnip	Occasional, frequent		Roadsides and weedy openings	1,2
**Oxalis europea*	Sorrel	Common		Old fields and disturbed areas	2
**Pastinaca sativa*	wild parsnip	Occasional		Roadsides	1
**Phleum pratense*	timothy	Frequent		Disturbed fields and roadsides	1,2
**Plantago lanceolata*	English plantain	Frequent		Disturbed openings and about buildings	1,2
**Plantago major*	broad-leaved plantain	Frequent		Road berms and about buildings (1) disturbed areas and old fields (2a)	1
**Poa annua*	early bluegrass	Common		Road berms and about buildings	1
**Poa compressa*	Canada bluegrass	Frequent		Dry openings, especially on shale, and roadsides	1,3
**Polygonum caespitosum*	NA	Rare		Moist, shaded ground in bunker area	1

Appendix A
Vascular Plant Species Documented On Site
Locomotive Building Area
Plum Brook Ordnance Works
Sandusky, Ohio

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
**Polygonum hydropiper*	water-pepper	Occasional		Margins of ponds	1,3
**Rosa multiflora*	multiflora rose	Occasional		Disturbed openings, borders, and thickets	1,2
**Rumex acetosella*	red sorrel	Occasional		Dry openings over shale	1
**Rumex crispus*	curly dock	Occasional		Roadsides and about buildings	1,2
**Saponaria officinalis*	soapwort	Frequent, occasional		Dry fields, roadsides, and about buildings	1
**Setaria faberi*	nodding foxtail-grass	Occasional, common		Grassy roadsides in the bunker area	1,3
**Setaria viridis*	green foxtail-grass	Frequent, common		Dry roadsides and about buildings	1
**Solanum caroliniense*	horse-nettle	Occasional, common		Dry openings and roadsides	1
**Solanum dulcamara*	bittersweet-nightshade	Occasional		Roadsides, ditches, thickets, and about buildings	1
**Stellaria media*	chickweed	Common		Road berms and about buildings	1
**Taraxacum officinalis*	dandelion	Frequent, occasional		Roadsides and about buildings	1,2
**Tragopogon pratensis*	Yellow goatsbeard	Rare		Old fields	3
**Trifolium pratense*	red clover	Occasional		Grassy fields and roadsides	1,2
**Trifolium repens*	common white clover	Common		Grassy roadsides and about buildings	1,3
**Verbascum blattaria*	moth-mullein	Occasional, rare		Disturbed fields and roadsides	1,2
**Verbascum thapsus*	common mullein	Frequent, occasional		Disturbed fields	1
**Veronica officinalis*	common speedwell	Occasional		Dry openings on shale	1
**Veronica serpyllifolia*	thyme-leaved speedwell	Occasional		Roadsides and about buildings	1
Acalypha rhomboidea	Three-seeded mercury	NA		NA	3
Acer negundo	box-elder maple	Frequent		Stream banks, ditches, and moist woods	1,2
Acer rubrum	red maple	Common		Dry to moist woods	1
Acer saccharinum	Silver maple	Rare		Dry to moist woods	3
Acer saccharum	Sugar maple	Occasional		Dry to moist woods	3
Acorus calamus	Sweet flag	Rare		Wet ditches	3
Agalinis purpurea	purple false-foxglove	Frequent		Moist openings and ditches	1
Agrimonia parviflora	southern agrimony	Frequent		Moist fields and ditches	1,3
Agrostis hyemalis	Ticklegrass	Occasional		Dry, grassy fields and shaley openings	1
Agrostis perennans	autumn bent-grass	Frequent		Dry woods and borders on shale	1
Ailanthus altissima	tree of heaven	NA		NA	3
Alisma subcordatum	water-plantain	Occasional		Ponds and ditches	1,2
Allium canadense	Field garlic	NA		NA	3
Allium canadense	Wild garlic	Occasional		Successional woods	3
Ambrosia artemisiifolia	common ragweed	Frequent, occasional		Dry fields and roadsides	1,2
Ambrosia trifida	giant ragweed	Occasional		Dry fields and roadsides	1
Andropogon gerardii	big bluestem	Frequent, 0ccasional		Dry to moist fields and roadsides	1,2
Antennaria parlinii	pussy-toes	Occasional		Dry fields and openings, especially on shale	1
Apocynum cannabinum	Dogbane	Frequent		Dry to moist fields and roadsides	1,2
Arctium minus	lesser burdock	NA		NA	2
Arenaria lateriflora	grove sandwort	Rare	T	Woods along Ransom Brook north of reactor	1
Arisaema triphyllum	Jack-in-the-pulpit	Rare		Moist to dry woods	3
Aristida dichotoma	Churchmouse grass	Occasional		Dry fields and openings	1
Aristida longespica	slimspike triple-awned grass	Common		Dry fields and openings	1
Aristida oligantha	prairie triple-awned grass	Occasional		Dry openings and roadsides	1
Asclepias hirtella	prairie milkweed	Common		Dry to moist openings	1
Asclepias incarnata	Swamp milkweed	Occasional		Wet ditches	3
Asclepias sullivantii	Sullivant's milkweed	Rare		Moist field along Patrol Road south of Scheid Road	1
Asclepias syriaca	common milkweed	Frequent		Dry to moist fields and roadsides	1,2
Asclepias tuberosa	butterfly-weed	Occasional		Dry openings and roadsides	1
Asparagus officinalis	asparagus	NA		NA	2
Aster ericoides	white heath aster	Rare, frequent		Grassy strip along Patrol Road southeast of Taft Road	1
Aster laevis	smooth aster	Rare		White oak grove on Taft Road	1
Aster lateriflorus	calico aster	Common, frequent		Moist woods and thickets	1,2
Aster novae-angliae	New England aster	Occasional		Dry fields and roadsides	1,2
Aster pilosus	common white aster	Common		Dry fields, roadsides, and about buildings	1
Aster sagittifolius	Arrow-leaved aster	Frequent		Woods and fields	3
Aster umbellatus	flat-top aster	Frequent, rare		Dry to moist fields and roadsides	1
Baptisia lactea	prairie false indigo	Occasional	P	Dry openings in bunker area	1
Baptisia tinctoria	yellow false indigo	Occasional		Dry openings in bunker area	1
Bidens coronata	northern tickseed-sunflower	Common		Moist fields and ditches	1
Bidens frondosa	Beggar ticks	Rare		Ditches	2
Boehmeria cylindrica	false nettle	Occasional		Ponds and ditches	1,3
Botrychium virginianum	Rattlesnake fern	Occasional		Successional woods	3
Brassica nigra	mustard	NA		NA	2
Bromus pubescens	Brome	Occasional		Dry fields	3
Cacalia atriplicifolia	pale Indian-plantain	Occasional		Dry fields and roadsides; woods	1

Appendix A
Vascular Plant Species Documented On Site
Locomotive Building Area
Plum Brook Ordnance Works
Sandusky, Ohio

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Calamagrostis canadensis	blue-joint	Occasional		Moist fields and ditches	1
Callitriche heterophylla	water-starwort	Occasional		Pond margins and seasonally-moist depressions	1
Calystegia sepium	Hedge bindweed	Occasional		Fields	3
Carduus nutans	nodding musk thistle	NA			2
Carex aggregata	sedge	Occasional		Moist woods	3
Carex alata	broad-winged sedge	Rare	P	Grassy field along Patrol Road south of Scheid Road also in grassy strip between Patrol Road and artificia pond southeast of Taft Road	1
Carex amphibola	NA	Occasional		Thickets and woods borders	1
Carex amphibola var. turgida	Eastern narrowleaf sedge	NA		NA	2
Carex annectens var. annectens	NA	Occasional		Moist, grassy fields	1
Carex annectens var. xanthocarpa	yellow-fruited sedge	Occasional		Moist, grassy fields	1
Carex blanda	eastern woodland sedge	Frequent		Moist woods	1,2
Carex bromoides	Brome-like sedge	NA		NA	3
Carex cephaloidea	thin-leaf sedge	Rare	E	Woods border along Pentolite Road west of reactor	1
Carex complanata var. hirsutella	NA	Frequent		Dry fields and woods borders	1
Carex conoidea	field sedge	Rare	T	Grassy depression along Taft Road south of North Magazine Road	1
Carex cristatella	NA	Occasional		Moist fields and ditches	1
Carex festucacea	fescue sedge	Occasional		Moist, grassy fields	1
Carex gracillima	NA	Occasional		Moist woods	1
Carex granularis	meadow sedge	Common		Moist, grassy fields and ditches	1
Carex hirtifolia	NA	Rare		Disturbed oak woods along angling road	1
Carex hystericina	Bottlebrush sedge	Rare		Moist depression along Taft Road	1
Carex pensylvanica	Pennsylvania sedge	Common		Dry woods	1
Carex radiata	Eastern star sedge	NA		NA	3
Carex rosea	NA	Frequent		Dry to moist woods	1
Carex scoparia	NA	Frequent		Moist, grassy fields	1
Carex stipata	NA	Frequent		Moist fields and ditches	1
Carex stricta	tussock sedge	Occasional		Moist fields and ditches	1
Carex swanii	Swan's sedge	Occasional		Dry, grassy fields	1
Carex tribuloides	NA	Occasional		Moist, grassy fields and ditches	1,3
Carex umbellata	NA	Occasional		Well-drained, grassy fields on sandy soil	1
Carex vulpinoidea	fox sedge	Common		Moist fields, ditches, and about ponds	1,2
Carya ovata	shagbark hickory	Rare		Sandy soil along fence at far southeast boundary	1,3
Catalpa speciosa	Catalpa	NA		NA	3
Celastrus orbiculatus	Bittersweet	Occasional		Thickets and woods borders	3
Celtis occidentalis	Hackberry	Occasional		dry to moist woods and borders	1,3
Cephalanthus occidentalis	Buttonbush	Occasional		Moist depressions and ditches	1,3
Cerastium arvense	field chickweed	Rare		White oak grove along Taft Road	1
Chamaecrista fasciculata	partridge-pea	Occasional		Dry openings on shale	1
Chenopodium album	lamb's quarters	NA			2
Cinna arundinacea	Wood reed grass	Occasional		Woods	3
Circaea lutetiana	Southern broad-leaved enchanter's nightshade	Frequent		Woods	3
Cirsium arvense	creeping thistle	NA		NA	2
Cirsium discolor	prairie thistle	Frequent, occasional		Grassy fields and roadsides	1
Clinopodium vulgaris	wild basil	Occasional		Dry roadsides and openings	1
Conyza canadensis	Horseweed	Frequent		Dry fields and roadsides	1,2
Cornus amomum	swamp dogwood	Frequent, occasional		Moist fields and thickets	1
Cornus drummondii	rough-leaved dogwood	Frequent		Moist borders, thickets, and roadsides	1.2
Cornus florida	flowering dogwood	Occasional		Woodland borders and roadsides	1
Cornus racemosa	gray dogwood	Frequent		Dry fields and roadsides	1
Crataegus mollis	downy hawthorn	Frequent		Thickets and woodland borders	1
Crataegus punctata	dotted hawthorn	Frequent		Thickets and woodland borders	1
Cryptotaenia canadensis	honewort	Occasional, rare		Dry to moist woods	1
Cuscuta gronovii	dodder	Frequent		Moist fields and ditches	1
Cyperus flavescens	Umbrella sedge	occasional		Old fields and waste places	3
Cyperus strigosus	umbrella-sedge	Frequent		Moist openings, ponds, and ditches	1,2
Danthonia spicata	poverty-grass	Occasional		Dry openings over shale	1
Datura stramonium	jimson-weed	Occasional		Disturbed openings and roadsides	1
Daucus carota	Queen Anne's lace	NA		NA	2
Desmodium canescens	Tick trefoil	Occasional		Fields	3
Dichanthelium dichotomum	cypress panic grass	NA		NA	2

Appendix A
Vascular Plant Species Documented On Site
Locomotive Building Area
Plum Brook Ordnance Works
Sandusky, Ohio

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Digitaria cognatum (Leptoloma cognatum)	NA	Occasional		Old fields	3
Digitaria ischaemum	smooth crabgrass	NA		NA	2
Diodia teres	buttonweed	Occasional		Dry openings over shale	1
Dipsacus sylvestris	teasel	NA			2
Dryopteris carthusiana	spinulose woodfern	Frequent		Moist woods and shaded borders	1
Eleocharis acicularis	needle spikerush	Frequent		Margins of artificial pond	1
Eleocharis erythropoda	red-footed spikerush	Occasional		Moist openings and ditches	1
Eleocharis obtusa	NA	Common		Moist openings and ditches	1
Eleocharis smallii	Small's spikerush	Frequent		Margins of artificial pond	1
Eleocharis tenuis	NA	Frequent		Moist openings and ditches	1
Elymus virginica	Wild rye	Occasional		Moist to dry woods	3
Epilobium coloratum	purple-leaved willow herb	NA		NA	2
Equisetum arvense	horsetail	Frequent		Moist openings, roadsides, and ditches	1,2
Equisetum hyemale	scouring-rush	Occasional		Moist roadsides and ditches	1
Eragrostis frankii	NA	Occasional		Moist openings and ditches	1
Eragrostis spectabilis	showy lovegrass	Occasional		Dry to moist fields	1
Erechtites hieracifolia	Pilewort	Common		Disturbed woods, borders, and roadsides	1,2
Erigeron anuus	Fleabane	NA		NA	2
Erigeron philadelphicus	Philadelphia fleabane	Frequent, occasional		Roadsides and borders	1
Erigeron strigosus	smooth fleabane	Occasional		Dry openings and roadsides	1
Eupatorium perfoliatum	Boneset	Occasional, frequent		Moist fields, ponds, and ditches	1
Eupatorium purpureum	purple joe-pye-weed	Occasional		Borders of moist woods, fields	1,3
Eupatorium rugosum	White snake root	Common		Woods and fields	2
Euphorbia corollata	Flowering spurge	Occasional		Dry fields	1
Euphorbia maculata	Prostrate spurge	Occasional		Dry openings, road berms, and about buildings	1,2
Euphorbia supina	Milk purslane	NA		NA	3
Euthamia graminifolia	grass-leaved goldenrod	Common		Dry to moist fields and roadsides	1,2
Fragaria virginiana	wild strawberry	Frequent		Dry to moist fields and roadsides	1
Fraxinus americana	white ash	Frequent		Dry to moist woods and borders	1
Fraxinus pensylvanica	green ash	Frequent, common		Moist woods and stream banks	1,2
Galine aparine	Cleavers	Occasional		Moist woods and borders	1,2
Galium asperellum	Rough bedstraw	NA		NA	2
Galium circaezans	wild licorice	Rare		Dry woods	1
Galium tinctorium	Southern bedstraw	Rare		Moist depression along Taft Road	1
Gentianopsis crinita	Fringed gentian	Occasional	P	Old fields along ditch banks, small groups and scattered individuals in northeast portion of TNT area A	3
Geranium maculatum	Wild geranium	Occasional		Successional woods	3
Gerardia tenuifolia	Slender gerardia	Frequent		Disturbed fields	3
Geum vernum	spring avens	Occasional		Moist woods and borders	1
Geum virginianum	white avens	Occasional		Woods borders and roadsides	1
Gleditsia triacanthos	honey-locust	Occasional, rare		Dry to moist woods and borders	1,2
Glyceria striata	manna-grass	Occasional		Moist woods and about ponds	1,3
Gnaphalium obtusifolium	Cudweed	Frequent, occasional		Dry openings on shale, fields	1,2
Gratiola virginiana	round-fruited hedge-hyssop	Rare	P	ca 20 plants; moist, shaded ground by pond west of Snake Road	1
Hackelia virginiana	Virginia stickseed	Rare		Woods	2
Hedyotis caerula	Bluets	Occasional		Dry openings and roadsides on shale	1
Helenium autumnale	Sneezeweed	Occasional		Disturbed fields	3
Helenium flexuosum	Southern sneezeweed	Occasional		Moist, open ground and ditches	1
Helianthus mollis	ashy sunflower	Rare	T	ca 200 plants in grassy field south and southwest of junction of Fox and Patrol Roads; the exact number of individuals in this population is uncertain since excessive browsing by deer has reduced the plants to leafy tufts.	1
Helianthus tuberosus	Jerusalem artichoke	Occasional		Old fields	3
Hemerocallus fulva	Daylily	NA		NA	3
Hesperis matronalis	Dame's rocket	NA		NA	3
Hibiscus moscheutos	rose-mallow	Rare		Moist swale along Ransom Road	1
Hypericum gentianoides	orange-grass	Frequent		Dry openings	1
Hypericum gymnanthum	least St. John's-wort	Rare	E	ca 50 plants; moist, open ground along Patrol Road south of Fox Road	1
Hypericum majus	tall St. John's-wort	Rare	P	Moist, shaded ground by pond west of Snake Road	1
Hypericum mutilum	little St. John's-wort	Frequent		Moist openings, ponds, and ditches	1
Hypericum perforatum	common St. John's wort	NA			2
Hypericum punctatum	St. Johns wort	Rare		Fields	3

Appendix A
Vascular Plant Species Documented On Site
Locomotive Building Area
Plum Brook Ordnance Works
Sandusky, Ohio

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Hypoxis hirsuta	yellow-eyed-grass	Occasional		Grassy fields	1
Hystrix patula	Bottlebrush grass	Occasional		Woods	3
Impatiens capensis	Jewelweed	NA		NA	3
Ipomoea pandurata	wild sweet-potato	Occasional		Dry openings over shale	1
Ipomoea purpurea	common morning glory	NA		NA	2
Iris versicolor	Northern blue flag	Occasional		Moist woods and ditches	1
Isanthus brachiatus	false pennyroyal	Rare		Moist opening on limestone, west of Snake Road and south of North Magazine Road	1
Juglans nigra	black walnut	Rare		A few young trees at edge of grassy field southwest of junction of Fox and Patrol Roads, woods (2b)	1
Juncus acuminatus	NA	Common		Moist openings and ditches	1
Juncus biflorus	NA	Occasional		Moist openings and ditches	1
Juncus brachycarpus	NA	Occasional		Moist openings	1
Juncus canadensis	Canada rush	Frequent		Moist openings	1
Juncus dudleyi	Dudley's rush	Frequent		Moist openings	1
Juncus effusus	Common rush	Frequent		Moist openings, ponds, and ditches	1,2
Juncus marginatus	NA	Occasional		Moist openings	1
Juncus nodosus	rush	Occasional		Old fields and ditches	3
Juncus tenuis	path rush	Frequent, occasional		Dry openings, road berms, and about buildings	1
Juncus torreyi	Torrey's rush	Occasional		Moist fields	3
Laportea Canadensis	Wood nettle	NA		NA	3
*Lathyrus latifolius**	Everlasting pea	Occasional		Old fields	3
Leersia oryzoides	rice cutgrass	Occasional		Moist fields and ditches	1
Leersia virginica	White grass	NA		NA	3
Lemna minor	little duckweed	Occasional		Ponds and standing water	1,2
Lepidium campestre	field peppergrass	NA		NA	2
Lepidium virginicum	poor man's pepper	Frequent		Roadsides, disturbed openings, and about buildings	1
Leptoloma cognatum	fall witch grass	NA		NA	3
Lespedeza capitata	bush-clover	Occasional		Dry fields	1
Leucospora multifida	NA	Rare		Moist opening on limestone, west of Snake Road and south of North Magazine Road	1
Liatris scariosa var. novae-angliae	northern blazing-star	Rare		Dry ground along Patrol Road at Olemacher Ditch	1
Liatris spicata	spiked blazing-star	Occasional		Moist openings	1
Lindernia dubia	false pimpernel	Occasional		Moist openings, ditches, and pond margins	1
Linum medium	wild flax	Frequent		Dry to moist openings	1
Linum virginianum	Virginia flax	Rare		About pond in northern bunker area	1
Lobelia siphilitica	Great lobelia	Frequent		Moist fields	3
Lonicera japonica	Japanese honeysuckle	Occasional		Fields and disturbed areas	3
Ludwigia alternifolia	rattlebox	Occasional		Ponds and ditches	1
Ludwigia palustris	water-purslane	Frequent, occasional		Ponds and ditches	1
Ludwigia polycarpa	NA	Rare		Moist, shaded ground by pond on Snake Road	1
Lycopus americanus	American water-horehound	Frequent		Ponds and ditches	1,2
Lycopus uniflorus	northern water-horehound	Frequent		Moist woods and shaded borders	1
Lysimachia terrestris	swamp loosestrife	Occasional		Moist openings	1,3
Lythrum alatum	prairie loosestrife	Occasional		Moist openings	1
Maclura pomifera	osage-orange	Occasional		Disturbed woods and borders	1,3
Mentha piperita	peppermint	NA		NA	3
Mentha spicata	Spearmint	Occasional		Moist fields	3
Mimulus ringens	monkey-flower	Occasional, rare		Moist openings and ditches	1
Monarda fistulosa	bergamont	Occasional		Grassy fields	1
Monarda sp.	bee balm	NA		NA	2
Morus alba	Mulberry	Occasional		Fields and thickets	3
Muhlenbergia frondosa	muhly grass	Frequent		Moist fields and ditches	1
Myrica pensylvanica	Bayberry	Rare	E	One individual in old field in northern portion of area	3
Najas flexilis	northern naiad	Occasional		Artificial ponds	1
Nyssa sylvatica	blackgum	Occasional		Thickets and woods borders	1
Oenothera biennis	evening-primrose	Frequent		Dry fields, roadsides, and about buildings	1
Oenothera tetragona	northern sundrops	Frequent		Moist, grassy fields	1
Onoclea sensibilis	Sensitive fern	frequent		Wet areas	3
Osmunda cinnamomea	cinnamon fern	Rare		Depressions in moist woods along angling road	1
Osmunda regalis	royal fern	Occasional		Depressions in moist woods	1
Oxalis stricta	sorrel	NA		NA	3
Oxalis violacea	purple wood-sorrel	Occasional		Drier oak woods and borders on shale	1

Appendix A
Vascular Plant Species Documented On Site
Locomotive Building Area
Plum Brook Ordnance Works
Sandusky, Ohio

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Panicum capillare	witchgrass	NA		NA	2
Panicum clandestinum	deer tongue grass	NA		NA	2
Panicum dichotomiflorum	Panic grass	Frequent		Fields	3
Panicum flexile	wiry witch-grass	Rare		Moist opening on limestone, west of Snake Road and south of North Magazine Road	1
Panicum lanuginosum	hairy panic-grass	common		Dry, grassy fields and roadsides	1
Panicum oligosanthes	sand panic-grass	Occasional		Dry, grassy fields	1
Panicum rigidulum	stiff panic-grass	Frequent		Moist openings and ditches	1
Panicum virgatum	switch-grass	Occasional		Dry fields	1,2
Parietaria pensylvanica	pellitory	Occasional		Dry, disturbed wood lots and borders	1
Paronychia fastigata	forked chickweed	Occasional		Dry woods and borders on shale	1
Parthenocissus quinquefolia	Virginia-creeper	Occasional		Dry to moist woods borders and thickets	1,3
Parthenocissus vitacea	grape-woodbine	Rare		Dry opening north of Center Magazine Road	1
Penstemon digitalis	tall white beard-tongue	Frequent		Grassy fields and roadsides	1,2
Phalaris arundinacea	reed canary-grass	Common		Moist fields and ditches	1
Phragmites australis	reed-grass	Occasional, rare		Moist openings and ditches	1,2
Phryma leptostachya	lopseed	Rare		Edge of woods along Scheid Ditch near Columbus Avenue; successional woods	1
Phytolacca americana	pokeberry	Occasional, rare		Moist woods and borders	1,2
Pilea pumila	clearweed	NA		NA	3
Plantago major	common plantain	NA		NA	2
Platanthera lacera	ragged fringe-orchid	Rare		Ditch along south Patrol Road	1
Platanus occidentalis	sycamore	Occasional, frequent		Moist woods and stream banks, fields and waste areas	1,3
Poa pratensis	Kentucky bluegrass	NA			2
Podophyllum peltatum	may-apple	Occasional		Dry to moist woods	1,2
Polygala sanguinea	blood milkwort	Frequent		Moist openings	1
Polygala verticillata	whorled milkwort	Occasional		Moist openings	1
Polygonum hydropiperoides	false water-pepper	Occasional		Wet ditches and pond margins	1
Polygonum pennsylvanicum	Pennsylvania smartweed	NA		NA	2
Polygonum sagittatum	arrow-leaved tearthumb	Occasional		Moist thickets and ditches	1
Polygonum scandens	climbing false buckwheat	Occasional		Thickets and roadsides	1
Polygonum virginianum	Virginia knotweed	Common		Moist to dry woods	2
Populus deltoides	cottonwood	Frequent, common		Moist woods, borders, and stream banks	1,2
Potamogeton diversifolius	snailseed pondweed	Frequent		Artificial ponds	1
Potamogeton foliosus	leafy pondweed	Occasional		Artificial ponds	1
Potamogeton nodosus	longleaf pondweed	Occasional		Artificial ponds	1
Potamogeton pectinatus	Sago pondweed	NA		NA	2
Potentilla simplex	cinquefoil	Frequent		Dry openings and roadsides on shale	1
Prunella vulgaris	self-heal	Occasional, frequent		Roadsides and about buildings	1
Prunus americana	wild plum	Occasional		Thickets and roadsides	1
Prunus serotina	wild black cherry	Frequent, common		Dry to moist woods and borders	1
Pycnanthemum tenuifolium	narrow-leaved mountain-mint	Frequent, common		Moist openings, especially on shale, old fields	1
Pycnanthemum virginianum	Virginia mountain-mint	Occasional		Moist openings and ditches	1
Pyrus coronaria	crab-apple	Frequent		Thickets and borders	1,3
Quercus alba	white oak	Occasional		Dry woods and sandy ridges; a small grove on Taft Road has an unusually pure stand of this species	1
Quercus bicolor	swamp white oak	Frequent		Moist woodlands	1
Quercus imbricaria	shingle oak	Frequent, occasional		Moist to dry woodlands	1,3
Quercus macrocarpa	bur oak	Rare		ca 5 trees on sandy ridge in bunker area south of North Magazine Road; a few trees in area 2a	1
Quercus palustris	pin oak	Common, frequent		Moist woods	1,2
Ranunculus sceleratus	cursed crowfoot	NA		NA	2
Ratibida pinnata	green-headed coneflower	Occasional, frequent		Roadsides and dry fields	1
Rhexia virginica	Virginia meadow-beauty	Occasional	P	Moist openings and pond margins, south of North Magazine Road and along the angling road	1
Ribes americanum	American currant	NA		NA	3
Ribes cynosbati	Gooseberry	Rare		Woods	3
Riccia sp.	liverwort	NA		NA	3
Robinia pseudoacacia	Black locust	Rare		Old fields and thickets	3
Rosa carolina	pasture rose	Occasional		Dry fields	1
Rosa setigera	prairie rose	Rare		Grassy roadside and thickets along Patrol Road at Olemacher Ditch	1,2
Rotala ramosior	toothcup	Occasional		Moist openings and about ponds	1
Rubus allegheniensis	blackberry	Common		Woods, fields, and borders	2
Rubus flagellaris	dewberry	Frequent, common		Dry openings and roadsides on shale, old fields	1,2
Rubus occidentalis	Black raspberry	common		Dry woods, and borders	2

Appendix A
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Locomotive Building Area
Plum Brook Ordnance Works
Sandusky, Ohio

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Rudbeckia hirta	black-eyed susan	Frequent		Dry fields and roadsides	1
Rumex acetosella	sheep sorrel	NA		NA	2
Rumex verticillatus	Swamp dock	Rare		Ditches	3
Sagittaria latifolia	broad-leaved arrowhead	Occasional		Ponds and ditches	1
Salix amygdaloides	peachleaf willow	Occasional		Ditches and about ponds	1
Salix discolor	pussy willow	Occasional		Moist openings, ponds, and ditches	1
Salix exigua	sandbar willow	Frequent		Moist openings, stream banks, and ditches	1,2
Salix nigra	black willow	Common		Moist woods, stream banks, and ditches	1,3
Sambucus canadensis	elder-berry	Frequent, occasional		Moist openings, stream banks, and ditches	1.2
Sassafras albidum	sassafras	Occasional		Dry woods and borders	1
Schizachyrium scoparium	little bluestem	Frequent		Dry fields and roadsides	1
Scirpus acutus	hardstem bulrush	Rare		Moist depression west of Taft Road	1
Scirpus americanus	Three square	rare		Ditches	3
Scirpus atrovirens	dark green bulrush	Common, occasional		Moist openings, roadsides, and ditches	1.2
Scirpus cyperinus	woolgrass	Occasional		About artificial ponds	1
Scirpus fluviatilis	river bulrush	Rare		Moist depression west of Taft Road	1
Scirpus pendulus	NA	Occasional		Moist openings	1
Scirpus validus	softstem bulrush	Occasional		Moist openings, ponds, and ditches	1
Scleria triglomerata	tall nut-rush	Rare	P	Moist swale in northern bunker area	1
Scutellaria lateriflora	mad-dog skullcap	Occasional		Moist depressions and ditches	1,3
Senecio aureus	golden ragwort	Occasional		Moist woods borders	1
Setaria faberi	foxtail	NA		NA	2
Setaria glauca	Yellow foxtail-grass	NA		NA	2
Silphium terebinthinaceum	prairie-dock	Rare		Dry openings at crossing of Patrol Road and Olemacher Ditch	1
Sisyrinchium albidum	prairie blue-eyed-grass	Frequent		Grassy fields	1
Sisyrinchium angustifolium	common blue-eyed-grass	Frequent		Grassy fields	1
Solanum nigrum	Black nightshade	Occasional		Fields and waste areas	2
Solidago canadensis	Canada goldenrod	Common		Grassy fields	1,2
Solidago juncea	early goldenrod	Frequent		Dry to moist fields and roadsides	1
Solidago nemoralis	gray goldenrod	Common		Dry fields and roadsides	1
Solidago riddellii	Riddell's goldenrod	Rare		Moist opening over limestone, west of Snake Road and south of North Magazine Road	1
Sparganium eurycarpum	giant bur-reed	Rare		Wet ditch along Ransom Road	1
Spartina pectinata	prairie cord-grass	Frequent, occasional		Moist depressions, fields, and ditches	1
Spenopholis intermedia	slender wedgescale	NA		NA	2
Spiranthes ochroleuca	creamy ladies'-tresses	Occasional, rare		Ditches and moist openings	1
Sporobolus asper	tall dropseed	Rare		A single stand in dry opening along angling road	1
Sporobolus neglectus	NA	Frequent		Dry openings and road berms	1
Stachys tenuifolia	Hedge nettle	Occasional		Fields	3
Stellaria longifolia	long-leaved stitchwort	Occasional		Moist, grassy fields	1
Symphoricarpos orbiculatus	coralberry	Occasional		Thickets, woods borders, and roadsides	1
Teucrium canadense	American germander	Occasional		Moist openings	1,3
Thelypteris palustris	marsh fern	Occasional, frequent		Moist depressions and roadsides	1
Toxicodendron radicans	Poison ivy	Frequent		Upland and facultative woods, old fields	2
Tradescantia ohioensis	Ohio spiderwort	Occasional		Old fields	3
Triadenum virgnianum	pink St. John's-wort	Rare		Moist swale in northern bunker area	1
Tridens flavus	purpletop	Occasional		Moist fields and roadsides	1
Trifolium hybridum	Alsike clover	Occasional		Fields	3
Triosteum perfoliatum	Wild coffee	Rare		Fields	3
Tussilago farfara	coltsfoot	NA		NA	3
Typha angustifolia	Narrow-leaved cattail	frequent		Ditches	3
Typha latifolia	broad-leaved cattail	Frequent		Moist openings, ponds, and ditches	1
Ulmus americana	American elm	Occasional		Moist woods and stream banks	1,3
Ulmus rubra	slippery elm	Occasional		Moist woods and stream banks	1
Urtica dioica var. procera	American stinging nettle	Occasional, common		Moist fields and openings	1
Urtica dioicia	stinging nettle	NA		NA	2
Verbascum thapsus	woolly mullein	NA		NA	2
Verbena hastata	purple vervain	Frequent		Moist fields, stream banks, and ditches	1,2
Verbena simplex	prairie vervain	Rare		A single stand in dry opening along angling road	1
Verbena stricta	Vervain	Occasional		Fields	3
Verbena urticifolia	white vervain	Occasional, frequent		Moist woods borders and roadsides	1,2
Verbesina alternifolia	wingstem	Frequent, occasional		Moist woods borders, stream banks, and ditches	1,3
Vernonia gigantea	tall ironweed	Occasional, frequent		Dry to moist fields	1
Viburnum lentago	nannyberry	Frequent		Moist thickets and borders	1
Vicia americana	American vetch	Rare		Old field	3

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Plum Brook Ordnance Works
Sandusky, Ohio

Scientific Name	Common Name	Relative Frequency[a]	Rank[b]	Habitat	Observed On Site[c]
Viola canadensis	Canada violet	NA		NA	3
Viola cucullata	violet	NA		NA	3
Viola lanceolata	lance-leaved violet	Frequent	P	Ditches and moist openings	1
Viola sagittata	arrow-leaved violet	Frequent		Grassy fields and dry banks	1
Viola sororia	common blue violet	Common, occasional		Grassy fields, roadsides, and about buildings	1
Vitis aestivalis	summer grape	NA		NA	2
Vitis riparia	riverbank grape	Frequent		Woods borders, thickets, and stream banks	1,2
Vitis vulpina	fox grape	Occasional		Woods borders and thickets	1
Zanichellia palustris	horned pondweed	Rare		Artificial pond west of Snake Road	1
Zizia aurea	Golden alexanders	Rare		Old fields	3

[a] Common = Species which occur in large numbers throughout.
Frequent = Species regularly encountered, but occurring in lesser numbers than common ones.
Occasional = Species found in several places, but never present in large numbers.
Rare = Species found in few places and in low numbers.

[b] T = Ohio Threatened Species. P = Ohio Potentially Threatened Species. E = Ohio Endangered Species.

[c] 1 = Biological Inventory of Plum Brook Station (Ohio Department of Natural Resources, 1994).
2 =Shaw site reconnaissance June 2, 2009 and September 9, 2009.
3 =Observed during a site reconnaissance at another Plum Brook site.

NA – Not available

* Non-native species.

APPENDIX B

ECOLOGICAL SCREENING VALUES

Table B-1

Ecological Screening Values for Soil
Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	CAS No.	EPA Eco-SSLs [a] (mg/kg)	Eco Endpoints PRGs [b] (mg/kg)	EPA Region V ESL [c] (mg/kg)	Tox. Benchmark [d] (earthworm only) (mg/kg)	Tox Benchmarks [e] Terrestrial Plants (mg/kg)	Selected ESV (mg/kg)	Reference
Inorganic Analytes								
Aluminum	7429-90-5	pH Dependent	NSV	NSV	NSV	50	pH Dependent	a
Antimony	7440-36-0	0.27	5	0.142	NSV	5	0.27	a
Arsenic	7440-38-2	18	9.9	5.7	60	10	18	a
Barium	7440-39-3	330	283	1.04	NSV	500	330	a
Beryllium	7440-41-7	21	10	1.06	NSV	10	21	a
Cadmium	7440-43-9	0.36	4	0.00222	20	4	0.36	a
Calcium	7440-70-2	NSV	NSV	NSV	NSV	NSV	Nutrient	
Chromium	7440-47-3	26	0.4	0.4	0.4	1	26	a
Chromium, hexavalent	18540-29-9	81	NSV	NSV	NSV	NSV	81	a
Cobalt	7440-48-4	13	20	0.14	NSV	20	13	a
Copper	7440-50-8	28	60	5.4	50	100	28	a
Iron	7439-89-6	pH Dependent	NSV	NSV	NSV	NSV	pH Dependent	a
Lead	7439-92-1	11	40.5	0.0537	500	50	11	a
Magnesium	7439-95-4	NSV	NSV	NSV	NSV	NSV	Nutrient	
Manganese	7439-96-5	220	NSV	NSV	NSV	500	220	a
Mercury	7439-97-6	NSV	0.00051	0.1	0.1	0.3	0.00051	b
Nickel	7440-02-0	38	30	13.6	200	30	38	a
Potassium	7440-09-7	NSV	NSV	NSV	NSV	NSV	Nutrient	
Selenium	7782-49-2	0.52	0.21	0.0276	70	1	0.52	a
Silver	7440-22-4	4.2	2	4.04	NSV	2	4.2	a
Sodium	7440-23-5	NSV	NSV	NSV	NSV	NSV	Nutrient	
Thallium	7440-28-0	NSV	1	0.0569	NSV	1	1	b
Vanadium	7440-62-2	7.8	2	1.59	NSV	2	7.8	a
Zinc	7440-66-6	46	8.5	6.62	200	50	46	a
Cyanide								
Cyanide, Total	57-12-5	NSV	NSV	1.33	NSV	NSV	1.33	c
Polychlorinated Biphenyls								
Aroclor 1016	12674-11-2	NSV	0.371 [f]	0.000332 [f]	NSV	40 [f]	0.371	b
Aroclor 1221	11104-28-2	NSV	0.371 [f]	0.000332 [f]	NSV	40 [f]	0.371	b
Aroclor 1260	11096-82-5	NSV	0.371 [f]	0.000332 [f]	NSV	40 [f]	0.371	b
Organochlorine Pesticides								
4,4'-DDE	72-55-9	0.021 [g]	NSV	0.596	NSV	NSV	0.021	a
4,4'-DDT	50-29-3	0.021 [g]	NSV	0.0035	NSV	NSV	0.021	a
Methoxychlor	72-43-5	NSV	NSV	0.0199	NSV	NSV	0.0199	c
Nitroaromatics								
Amino-2,6-dinitrotoluene, 4-	19406-51-0	NSV	NSV	0.0328 [i]	NSV	NSV	0.0328	c
Amino-4,6-dinitrotoluene, 2-	35572-78-2	NSV	NSV	0.0328 [i]	NSV	NSV	0.0328	c
Dinitrotoluene, 2,4-	121-14-2	NSV	NSV	1.28	NSV	NSV	1.28	c
Dinitrotoluene, 2,6-	606-20-2	NSV	NSV	0.0328	NSV	NSV	0.0328	c
Semivolatile Organic Compounds								
Acenaphthylene	208-96-8	29	NSV	682	NSV	NSV	29	a
Anthracene	120-12-7	29	NSV	1480	NSV	NSV	29	a
Benzo(a)anthracene	56-55-3	1.1	NSV	5.21	NSV	NSV	1.1	a
Benzo(a)pyrene	50-32-8	1.1	NSV	1.52	NSV	NSV	1.1	a
Benzo(b)fluoranthene	205-99-2	1.1	NSV	59.8	NSV	NSV	1.1	a
Benzo(ghi)perylene	191-24-2	1.1	NSV	119	NSV	NSV	1.1	a
Benzo(k)fluoranthene	207-08-9	1.1	NSV	148	NSV	NSV	1.1	a
Benzoic acid	65-85-0	NSV	NSV	NSV	NSV	NSV	NSV	
bis(2-Ethylhexyl)phthalate	117-81-7	NSV	NSV	0.925	NSV	NSV	0.925	c
Chrysene	218-01-9	1.1	NSV	4.73	NSV	NSV	1.1	a

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Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	CAS No.	EPA Eco-SSLs [a] (mg/kg)	Eco Endpoints PRGs [b] (mg/kg)	EPA Region V ESL [c] (mg/kg)	Tox. Benchmark [d] (earthworm only) (mg/kg)	Tox Benchmarks [e] Terrestrial Plants (mg/kg)	Selected ESV (mg/kg)	Reference
Dibenzofuran	132-64-9	NSV	NSV	NSV	NSV	NSV	NSV	
Di-n-butyl phthalate	84-74-2	NSV	200	0.15	NSV	200	200	b
Fluoranthene	206-44-0	1.1	NSV	122	NSV	NSV	1.1	a
Indeno(1,2,3-cd)pyrene	193-39-5	1.1	NSV	109	NSV	NSV	1.1	a
Methylnaphthalene, 2-	91-57-6	NSV	NSV	3.24	NSV	NSV	3.24	c
Naphthalene	91-20-3	29	NSV	0.0994	NSV	NSV	29	a
Phenanthrene	85-01-8	29	NSV	45.7	NSV	NSV	29	a
Pyrene	129-00-0	1.1	NSV	78.5	NSV	NSV	1.1	a
Volatile Organic Compounds								
Acetone	67-64-1	NSV	NSV	2.5	NSV	NSV	2.5	c
Benzene	71-43-2	NSV	NSV	0.255	NSV	NSV	0.255	c
Bromomethane	74-83-9	NSV	NSV	0.235	NSV	NSV	0.235	c
Butanone, 2-	78-93-3	NSV	NSV	89.6	NSV	NSV	89.6	c
Carbon disulfide	75-15-0	NSV	NSV	0.0941	NSV	NSV	0.0941	c
Dichloroethane, 1,1-	75-34-3	NSV	NSV	20.1	NSV	NSV	20.1	c
Dichloroethene, 1,1-	75-35-4	NSV	NSV	8.28	NSV	NSV	8.28	c
Dichloroethene, cis-1,2-	156-59-2	NSV	NSV	0.784 [h]	NSV	NSV	0.784	c
Methylene chloride	75-09-2	NSV	NSV	4.05	NSV	NSV	4.05	c
Toluene	108-88-3	NSV	200	5.45	NSV	200	200	b
Trichloroethane, 1,1,1-	79-00-5	NSV	NSV	29.8	NSV	NSV	29.8	c
Trichloroethene	79-01-6	NSV	NSV	12.4	NSV	NSV	12.4	c
Trimethylbenzene, 1,2,4-	95-63-6	NSV	NSV	NSV	NSV	NSV	NSV	
Xylene, Total	1330-20-7	NSV	NSV	10	NSV	NSV	10	c

EPA = U.S. Environmental Protection Agency
ESV = Ecological screening value
NSV = No screening value available
mg/kg = milligrams per kilogram

Priority for Selection of ESVs:
1) EPA Eco-SSL
2) PRG for Eco Endpoints, (Efroymson, et.al, 1997a);
3) EPA Region 5 Ecological Screening Levels;
4) Efroymson, 1997b.
5) Efroymson, 1997c.

[a] EPA, 2008, Ecological Soil Screening Level (SSL) guidance. On-line at: http://www.epa.gov/ecotox/ecossl/index.html
[b] Efroymson, 1997a, *Preliminary Remediation Goals for Ecological Endpoints*. www.esd.ornl.gov/programs/ecorisk/documents/tm162r2.pdf .
[c] Screening value based on: EPA , 2003, *Region 5 Ecological Screening Level (ESL)* , Website version last updated August 22, 2003: http://www.epa.gov/Region5/rcraca/edql.htm.
[d] Efroymson, R.A., M.E. Will, G.W. Suter, 1997b, *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Soil and Litter Invertebrates and Heterotrophic Process* : 1997 Revision, ES/ER/TM-126/R2 (microbial screening values are not included). http://www.esd.ornl.gov/programs/ecorisk/documents/tm126r21.pdf.
[e] Efroymson, R.A., M.E. Will, G.W. Suter, 1997c, T*oxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Terrestrial Plants: 1997 Revision* , ES/ER/TM-85/R3. http://www.esd.ornl.gov/programs/ecorisk/documents/tm85r3.pdf
[f] Based on the screening value for total PCBs.
[g] Based on the screening value for DDT and metabolites.
[h] Based on the screening value for dichloroethylene [trans-1,2].

Table B-2

Ecological Screening Values for Surface Water
Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	CAS No.	Ohio Water Quality Criteria [a] µg/L		Eco PRG [b] µg/L	EPA Region 5 ESV [c] µg/L	Selected Surface Water ESV [d] µg/L
Inorganic Analytes						
Aluminum	7429-90-5	NSV		87	NSV	87
Arsenic	7440-38-2	150	f	3.1	148	3.1
Barium	7440-39-3	220		4	220	4
Beryllium	7440-41-7	100	e	0.66	3.6	0.66
Calcium	7440-70-2	NSV		NSV	NSV	Nutrient
Chromium	7440-47-3	270	e,f	210	42	42
Cobalt	7440-48-4	24		23	24	23
Copper	7440-50-8	30	e,f	12	1.58	1.58
Iron	7439-89-6	NSV		1000	NSV	1000
Lead	7439-92-1	37	e,f	3.2	1.17	1.17
Magnesium	7439-95-4	NSV		NSV	NSV	Nutrient
Manganese	7439-96-5	NSV		120	NSV	120
Nickel	7440-02-0	170	e,f	160	28.9	28.9
Potassium	7440-09-7	NSV		NSV	NSV	Nutrient
Selenium	7782-49-2	5	f	0.39	5	0.39
Sodium	7440-23-5	NSV		NSV	NSV	Nutrient
Vanadium	7440-62-2	44		20	12	12
Zinc	7440-66-6	390	e,f	110	65.7	65.7
Semivolatile Organic Compounds						
bis(2-Ethylhexyl)phthalate	117-81-7	8.4		0.12	0.3	0.12
Volatile Organic Compounds						
Dichloroethane, 1,1-	75-34-3	410		47	47	47
Dichloroethene, cis-1,2-	156-59-2	970		590	970	590
Trichloroethane, 1,1,1-	71-55-6	76		11	76	11

COPEC = Chemical of potential ecological concern
ESV = Ecological screening value
µg/L = microgram per liter
NSV = No screening value available

[a] Ohio Environmental Protection Agency (OEPA, 2002), Division of Surface Water, Water Quality Standards, Chapter 3745-1 of the Ohio Administrative Code, Dec 30. http://www.epa.state.oh.us/dsw/rules/3745-1.html. Value is the Outside Mixing Zone Average value.

[b] *Preliminary Remediation Goals (PRG) for Ecological Endpoints* , (Efroymson et. al., 1997).

[c] Screening value based on: EPA , 2003, *Region 5 Ecological Screening Level* , Website version last updated August 22, 2003: http://www.epa.gov/Region5/rcraca/edql.htm.

[d] Surface water ESVs are selected by choosing the minimum screening value based on the three sources provided.

[e] Hardness dependent value (see Table 7-9 in the OAC Chapters 3741-1 and 3791-2). Screening values using a hardness of 400 mg/L $CaCO_3$ were selected, based on a site-specific water hardness of 464 mg/L $CaCO_3$.

[f] Total Recoverable (TR) value is used, per Ohio Administrative Code Chapter 3745-2-04.

Table B-3

Ecological Screening Values for Sediment
Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	CAS No.	TEC [a] mg/kg	EPA Region 5 ESV [b] mg/kg	Ecological PRG [c] mg/kg	Ontario Sediment Quality Guidelines [d] mg/kg	Selected ESV [e] mg/kg
Inorganic Analytes						
Aluminum	7429-90-5	NSV	NSV	NSV	NSV	NSV
Arsenic	7440-38-2	9.79	9.79	42	6	9.79
Barium	7440-39-3	NSV	NSV	NSV	NSV	NSV
Beryllium	7440-41-7	NSV	NSV	NSV	NSV	NSV
Cadmium	7440-43-9	0.99	0.99	4.2	0.6	0.99
Calcium	7440-70-2	NSV	NSV	NSV	NSV	NSV
Chromium	7440-47-3	43.4	43.4	159	26	43.4
Cobalt	7440-48-4	NSV	50	NSV	50	50
Copper	7440-50-8	31.6	31.6	77.7	16	31.6
Iron	7439-89-6	NSV	NSV	NSV	NSV	NSV
Lead	7439-92-1	35.8	35.8	110	31	35.8
Magnesium	7439-95-4	NSV	NSV	NSV	NSV	NSV
Manganese	7439-96-5	NSV	NSV	NSV	460	460
Mercury	7439-97-6	0.18	0.174	0.7	0.2	0.18
Nickel	7440-02-0	22.7	22.7	38.5	16	22.7
Potassium	7440-09-7	NSV	NSV	NSV	NSV	NSV
Selenium	7782-49-2	NSV	NSV	NSV	NSV	NSV
Silver	7440-22-4	NSV	0.5	1.8	0.5	0.5
Sodium	7440-23-5	NSV	NSV	NSV	NSV	NSV
Thallium	7440-28-0	NSV	NSV	NSV	NSV	NSV
Vanadium	7440-62-2	NSV	NSV	NSV	NSV	NSV
Zinc	7440-66-6	121	121	270	120	121
Nitroaromatics						
2,4,6-Trinitrotoluene	118-96-7	NSV	NSV	NSV	NSV	NSV
Semivolatile Organic Compounds						
Benzo(b)fluoranthene	205-99-2	NSV	10.4	NSV	NSV	10.4
Fluoranthene	206-44-0	NSV	0.423	0.834	0.75	0.423
Phenanthrene	85-01-8	0.204	0.204	0.54	0.56	0.204
Pyrene	129-00-0	0.195	0.195	1.4	0.49	0.195

Table B-3

Ecological Screening Values for Sediment
Plum Brook Ordnance Works, Sandusky, Ohio

Chemical	CAS No.	TEC [a] mg/kg	EPA Region 5 ESV [b] mg/kg	Ecological PRG [c] mg/kg	Ontario Sediment Quality Guidelines [d] mg/kg	Selected ESV [e] mg/kg
Volatiles Organic Compounds						
Acetone	67-64-1	NSV	0.0099	0.0091	NSV	0.0099
Carbon disulfide	75-15-0	NSV	0.0239	0.00086	NSV	0.0239
Methylene chloride	75-09-2	NSV	0.159	18	NSV	0.159

ESV = Ecological screening value
mg/kg = milligrams per kilogram
NSV = No screening value available

Priority for Selection of ESVs:

1. Threshold effect concentrations (MacDonald et al., 2000)
2. EPA Region 5 ESLs (EPA, 2003)
3. Sediment PRGs (Efroymson, 1997)
4. Sediment quality criteria (OME, 1993)

[a] Threshold Effect Concentrations (TECs), MacDonald, et al., 2000 (MacDonald, 2000). Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. Arch Environ Contam Toxicol 39:20-31.

[b] Screening value based on: EPA , 2003, *Region 5 Ecological Screening Level*, Website version last updated August 22, 2003: http://www.epa.gov/Region5/rcraca/edql.htm.

[c] Efroymson,et. al., 1997, *Preliminary Remediation Goals for Ecological Endpoints*.

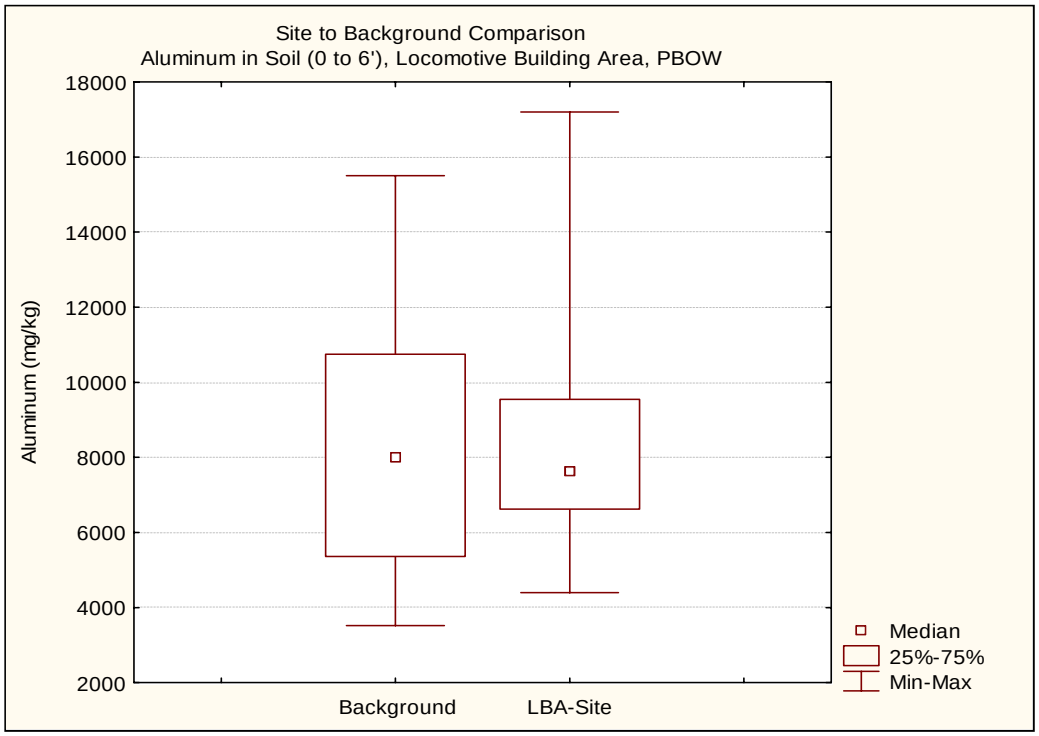
[d] Ontario Ministry of the Environment, 1993 (OME, 1993). Persaud, et al. *Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario,* August.

APPENDIX C

WILCOXON RANK SUM TEST RESULTS AND BOX PLOTS FOR LEAD AND MANGANESE

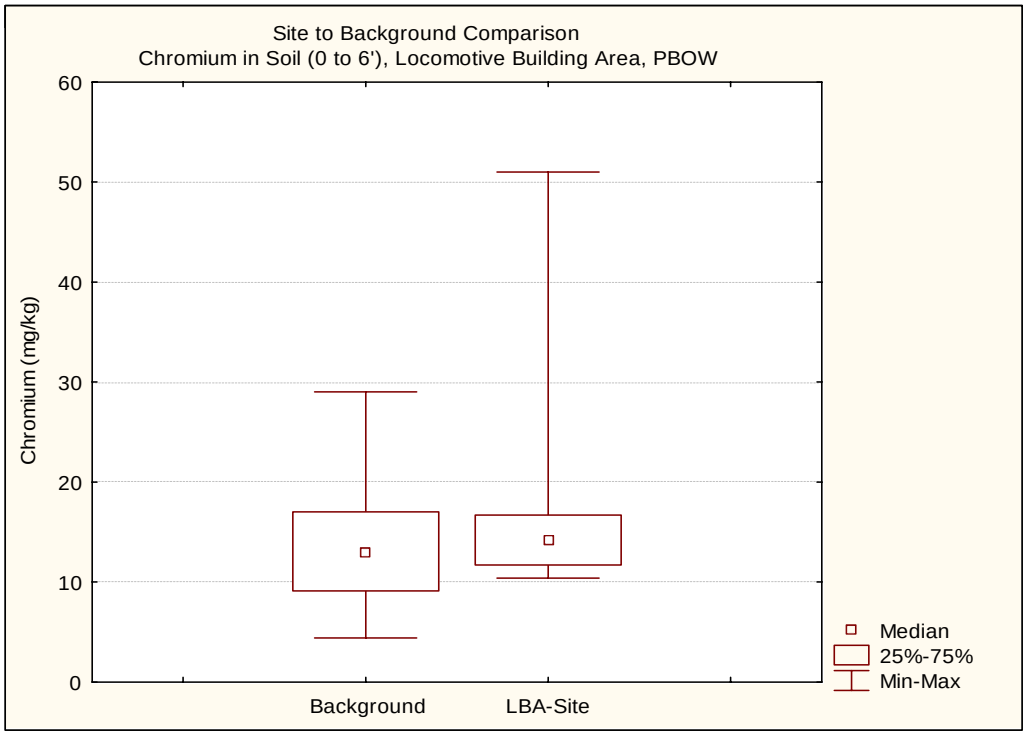
Appendix C

Wilcoxon Rank Sum Test Results and Box Plots for Soil Concentrations of Aluminum in Background Vs. Locomotive Building Area Samples



	Rank Sum	Rank Sum	U	Z	p-level	Z	p-level	Valid N	Valid N	2*1sided
Aluminum	247	573	167	0.02951	0.976	0.0295	0.976	12	28	0.988394

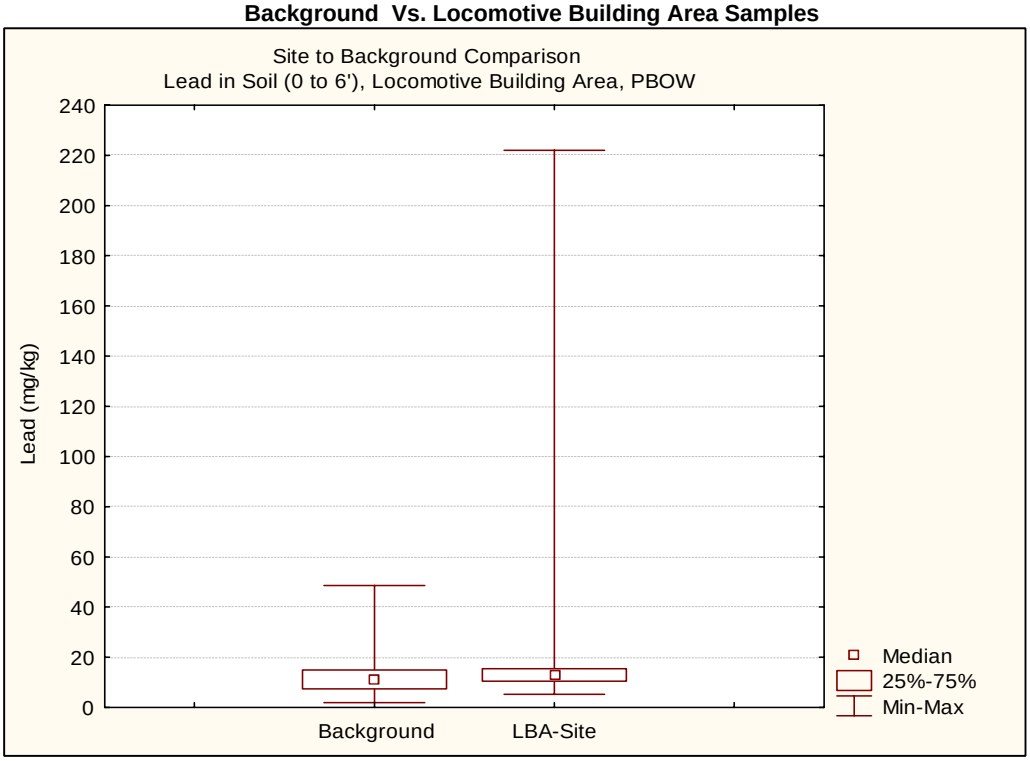
Wilcoxon Rank Sum Test Results and Box Plots for Soil Concentrations of Chromium in Background Vs. Locomotive Building Area Samples



	Rank Sum	Rank Sum	U	Z	p-level	Z	p-level	Valid N	Valid N	2*1sided
Chromium	634.0000	851.0000	283.0000	-1.40226	0.160839	-1.40280	0.160679	26	28	0.164717

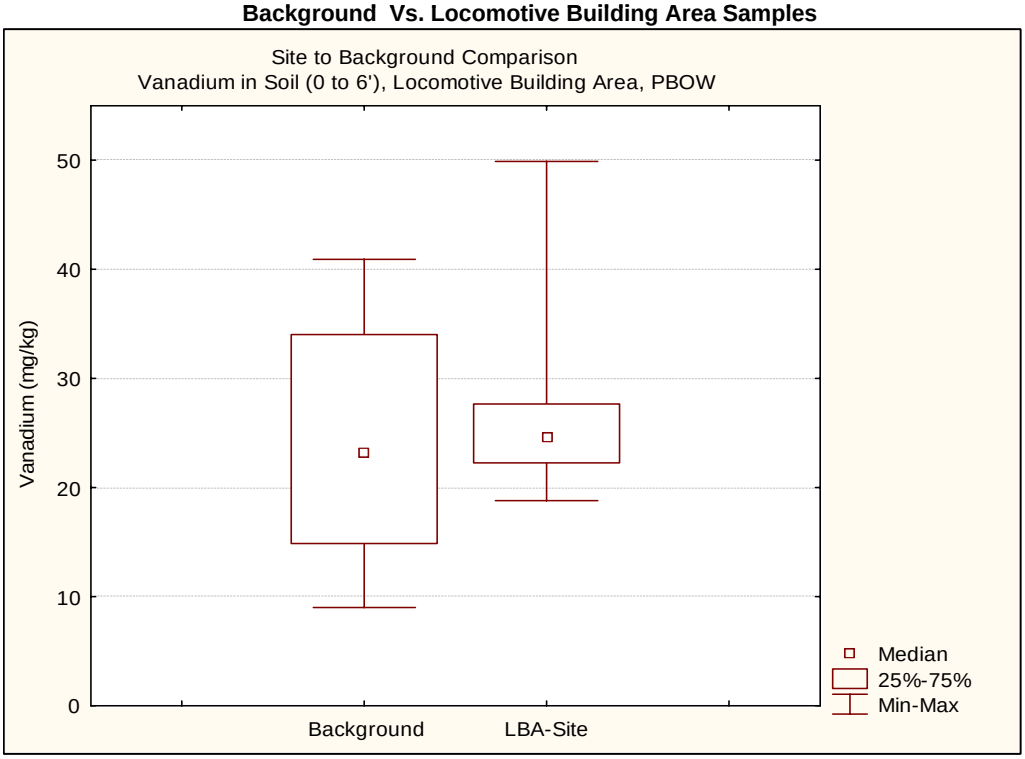
Appendix C

Wilcoxon Rank Sum Test Results and Box Plots for Soil Concentrations of Lead in Background Vs. Locomotive Building Area Samples



	Rank Sum	Rank Sum	U	Z	p-level	Z	p-level	Valid N	Valid N	2*1sided
Lead	618.0	867.0	267.0	-1.67925	0.093	-1.68	0.093	26	28	0.095

Wilcoxon Rank Sum Test Results and Box Plots for Soil Concentrations of Vanadium in Background Vs. Locomotive Building Area Samples



Rank Sum	Rank Sum	U	Z	p-level	Z	p-level	Valid N	Valid N	2*1sided

Vanadium	226.5	593.5	148.5	-0.57552	0.564937	-0.57563	0.564864	12	28	0.569913

Wilcoxon Rank Sum Test Results and Box Plots for Soil/Sediment Concentrations of Manganese in Background Vs. Locomotive Building Area Samples

	Rank Sum	Rank Sum	U	Z	p-level	Z	p-level	Valid N	Valid N	2*1sided
Manganese	358.0	170.0	7.0	-3.42791	0.001	-3.43	0.001	26	6	0.000

APPENDIX D

ASSESSMENT RECEPTOR PROFILES

Appendix D

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 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, these 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 short-haired, 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 (Anas 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 remate 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 renest 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 interdispersed 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 Naturalist***, 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 underparts 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., 1981, ***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 Factors Handbook***, EPA/600/R-93/187a.

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

Muskrat (Ondata zibethicus). The muskrat is a member of the Family Muridaee. Muskrats are the most aquatic of this family of rodents, and spend much of their lives in or near bogs, marshes, lakes or streams. Their diet consists primarily of aquatic vegetation (in particular the roots or basal portions of aquatic plants), although they can be omnivorous if other food sources are more common. Marsh grasses, sedges, and cattails are important muskrat food items. They are indigenous and common throughout most of the United States. Muskrats have relatively small home ranges that vary in configuration based on the physical attributes of their aquatic habitat. The average weight for the species is approximately 1.3 kilograms for males and 1.2 kilograms for females during the winter, and 0.9 kg for males and 0.8 kg for females during the spring. Muskrats typically breed during the first spring after birth, and typically produce 1-12

pups, with southern populations producing more litters, but fewer pups per litter compared with northern populations (EPA, 1993).

References:

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

APPENDIX E

FOOD CHAIN MODEL EXPOSURE DOSES AND HAZARD QUOTIENTS

Table E-1
Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the Deer Mouse
Locomotive Building Area
Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Surface Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF	EED Surface Water	EED Sediment	EED Soil	EED Fish	EED Aq. Invert.	EED Terr. Invert.	EED Aq. Plants	EED Terr. Plants	EED Mammals	EED Birds	Total EED	TRV_{NOAEL}	HQ_{NOAEL}	TRV_{LOAEL}	HQ_{LOAEL}
							----------Unitless----------								mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d
Metals																													
Aluminum	2.15E+01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	7.80E+02							3.19E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.19E+00	1.93E+00	1.66E+00	1.93E+01	1.66E-01
Arsenic	6.69E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.74E+02							9.94E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.94E-04	1.26E-01	7.89E-03	1.26E+00	7.89E-04
Barium	1.12E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.46E+02							1.66E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.66E-02	5.10E+00	3.26E-03	1.98E+01	8.40E-04
Beryllium	1.10E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	3.10E+02							1.64E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.64E-04	6.60E-01	2.48E-04	3.30E+00	4.95E-05
Cadmium	0.00E+00	mg/L	1.46E+00	mg/kg	5.24E-01	mg/kg	1.00E+00		6.00E-01	9.45E+00	5.24E-01	8.34E-01	4.00E-01	4.00E-01	0.00E+00	0.00E+00	1.98E-03	0.00E+00	0.00E+00	3.66E-01	0.00E+00	5.04E-02	0.00E+00	0.00E+00	4.18E-01	1.00E+00	4.18E-01	1.00E+01	4.18E-02
Copper	2.41E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.21E+03							3.58E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.58E-03	1.17E+01	3.06E-04	1.51E+01	2.36E-04
Lead	9.79E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.38E+01							1.45E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.45E-03	8.00E+00	1.82E-04	8.00E+01	1.82E-05
Manganese	1.71E+00	mg/L	3.98E+03	mg/kg	0.00E+00	mg/kg	1.00E+00	2.47E+02	6.00E-03		7.90E-02	7.90E-02			2.55E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.55E-01	8.80E+01	2.89E-03	2.84E+02	8.97E-04
Nickel	5.73E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	7.24E+02							8.51E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.51E-03	4.00E+01	2.13E-04	8.00E+01	1.06E-04
Selenium	4.40E-03	mg/L	2.50E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.45E+02	5.39E+00		5.59E-01	NA			6.54E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	0.00E+00	0.00E+00	6.54E-04	2.00E-01	3.27E-03	3.30E-01	1.98E-03
Thallium	0.00E+00	mg/L	1.90E+00	mg/kg	0.00E+00	mg/kg	1.00E+00		5.39E+00		2.20E-03	2.20E-03			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.40E-03	0.00E+00	7.40E-02	0.00E+00
Vanadium	3.70E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	4.46E+02							5.49E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.49E-03	2.10E-01	2.62E-02	2.10E+00	2.62E-03
Zinc	1.44E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.22E+03							2.14E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.14E-02	1.60E+02	1.34E-04	3.20E+02	6.68E-05
Nitroaromatics																													
4-Amino-2,6-dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	5.27E-01	mg/kg	1.00E+00			1.00E-01	3.35E+00	3.35E+00	7.24E-08	7.24E-08	0.00E+00	0.00E+00	1.99E-03	0.00E+00	0.00E+00	3.89E-03	0.00E+00	2.03E-01	0.00E+00	0.00E+00	2.09E-01	9.00E+00	2.33E-02	4.80E+01	4.36E-03
2-Amino-4,6-dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	2.94E-01	mg/kg	1.00E+00			1.00E-01	3.35E+00	3.35E+00	7.24E-08	7.24E-08	0.00E+00	0.00E+00	1.11E-03	0.00E+00	0.00E+00	2.17E-03	0.00E+00	1.14E-01	0.00E+00	0.00E+00	1.17E-01	9.00E+00	1.30E-02	4.80E+01	2.43E-03
Semivolatile Organics																													
2,4-Dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	1.44E+00	mg/kg	1.00E+00			1.00E-01	4.44E-01	4.44E-01	8.14E-08	8.14E-08	0.00E+00	0.00E+00	5.44E-03	0.00E+00	0.00E+00	1.06E-02	0.00E+00	7.37E-02	0.00E+00	0.00E+00	8.97E-02	2.00E-01	4.49E-01	1.50E+00	5.98E-02
2,6-Dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	2.04E-01	mg/kg	1.00E+00			1.00E-01	3.74E-01	3.74E-01	6.34E-08	6.34E-08	0.00E+00	0.00E+00	7.72E-04	0.00E+00	0.00E+00	1.51E-03	0.00E+00	8.81E-03	0.00E+00	0.00E+00	1.11E-02	2.00E-01	5.54E-02	1.50E+00	7.39E-03
2-Methylnaphthalene	0.00E+00	mg/L	0.00E+00	mg/kg	2.89E+00	mg/kg	1.00E+00			1.40E+00		2.70E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E-02	0.00E+00	0.00E+00	2.99E-01	0.00E+00	9.02E-02	0.00E+00	0.00E+00	4.00E-01	2.45E+00	1.63E-01	2.45E+01	1.63E-02
Dibenzofuran	0.00E+00	mg/L	0.00E+00	mg/kg	7.55E-01	mg/kg	1.00E+00			1.44E+01	8.40E-02	8.40E-02	1.10E+00	1.10E+00	0.00E+00	0.00E+00	2.86E-03	0.00E+00	0.00E+00	8.02E-01	0.00E+00	7.32E-03	0.00E+00	0.00E+00	8.12E-01	NA	NA	NA	NA
Fluoranthene	0.00E+00	mg/L	0.00E+00	mg/kg	4.69E-01	mg/kg	1.00E+00			2.10E-01	5.00E-01	5.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.77E-03	0.00E+00	0.00E+00	7.27E-03	0.00E+00	2.71E-02	0.00E+00	0.00E+00	3.61E-02	1.00E+00	3.61E-02	1.00E+01	3.61E-03
Pyrene	0.00E+00	mg/L	0.00E+00	mg/kg	4.79E-01	mg/kg	1.00E+00			4.50E-01	7.20E-01	7.20E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.81E-03	0.00E+00	0.00E+00	1.59E-02	0.00E+00	3.98E-02	0.00E+00	0.00E+00	5.75E-02	1.00E+00	5.75E-02	1.00E+01	5.75E-03
Volatile Organics																													
1,2,4-Trimethylbenzene	0.00E+00	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00			1.44E+01	3.07E-01	3.07E-01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	NA	NA	NA
Acetone	0.00E+00	mg/L	6.46E-02	mg/kg	0.00E+00	mg/kg	1.00E+00		0.00E+00		9.00E-01	9.00E-01			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+02	0.00E+00	5.00E+02	0.00E+00

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi \, x Cij}{BW} \right) \right] \right)$$

Where:

Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:

BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
HQ = Hazard Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box):
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or N See appropriate text tables for equations.
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Terrestrial plant diet fraction =	0.61	unitless
Aquatic plant diet fraction =	0	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	0.39	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0.000056	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.0028	kg/d
Body weight =	0.0148	kg
Home range =	0.153	acres
Water intake rate =	0.0022	L/d
Site Area =	4	acres
Area Use Factor (AUF) =	1	unitless
Exposure Frequency (EF) =	1	unitless

Table E-2
Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the Short-Tailed Shrew
Locomotive Building Area
Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Total Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF	EED Surface Water	EED Sediment	EED Soil	EED Fish	EED Aq. Invert.	EED Terr. Invert.	EED Aq. Plants	EED Terr. Plants	EED Mammals	EED Birds	Total EED	TRV_{NOAEL}	HQ_{NOAEL}	TRV_{LOAEL}	HQ_{LOAEL}
							----------Unitless----------								mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	
Metals																													
Aluminum	2.15E+01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	7.80E+02							3.29E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.29E+00	1.93E+00	1.71E+00	1.93E+01	1.71E-01
Arsenic	6.69E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.74E+02							1.03E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.03E-03	1.26E-01	8.14E-03	1.26E+00	8.14E-04
Barium	1.12E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.46E+02							1.72E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.72E-02	5.10E+00	3.36E-03	1.98E+01	8.67E-04
Beryllium	1.10E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	3.10E+02							1.69E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.69E-04	6.60E-01	2.56E-04	3.30E+00	5.11E-05
Cadmium	0.00E+00	mg/L	1.46E+00	mg/kg	4.12E-01	mg/kg	1.00E+00		6.00E-01	9.93E+00	5.24E-01	9.30E-01	4.54E-01	4.54E-01	0.00E+00	0.00E+00	6.28E-03	0.00E+00	0.00E+00	6.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.06E-01	1.00E+00	6.06E-01	1.00E+01	6.06E-02
Copper	2.41E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.21E+03							3.69E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.69E-03	1.17E+01	3.15E-04	1.51E+01	2.44E-04
Lead	9.79E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.38E+01							1.50E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.50E-03	8.00E+00	1.88E-04	8.00E+01	1.88E-05
Manganese	1.71E+00	mg/L	3.98E+03	mg/kg	0.00E+00	mg/kg	1.00E+00	2.47E+02	6.00E-03		7.90E-02	7.90E-02			2.63E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.63E-01	8.80E+01	2.98E-03	2.84E+02	9.25E-04
Nickel	5.73E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	7.24E+02							8.78E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.78E-03	4.00E+01	2.20E-04	8.00E+01	1.10E-04
Selenium	4.40E-03	mg/L	2.50E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.45E+02	5.39E+00		5.59E-01	NA			6.75E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	0.00E+00	0.00E+00	6.75E-04	2.00E-01	3.37E-03	3.30E-01	2.04E-03
Thallium	0.00E+00	mg/L	1.90E+00	mg/kg	0.00E+00	mg/kg	1.00E+00		5.39E+00		2.20E-03	2.20E-03			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.40E-03	0.00E+00	7.40E-02	0.00E+00
Vanadium	3.70E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	4.46E+02							5.67E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.67E-03	2.10E-01	2.70E-02	2.10E+00	2.70E-03
Zinc	1.44E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.22E+03							2.21E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.21E-02	1.60E+02	1.38E-04	3.20E+02	6.90E-05
Nitroaromatics																													
4-Amino-2,6-dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	3.79E-01	mg/kg	1.00E+00			1.00E-01	3.35E+00	3.35E+00	7.24E-08	7.24E-08	0.00E+00	0.00E+00	5.78E-03	0.00E+00	0.00E+00	5.56E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-02	9.00E+00	1.26E-03	4.80E+01	2.36E-04
2-Amino-4,6-dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	2.42E-01	mg/kg	1.00E+00			1.00E-01	3.35E+00	3.35E+00	7.24E-08	7.24E-08	0.00E+00	0.00E+00	3.69E-03	0.00E+00	0.00E+00	3.55E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.24E-03	9.00E+00	8.05E-04	4.80E+01	1.51E-04
Semivolatile Organics																													
2,4-Dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	8.19E-01	mg/kg	1.00E+00			1.00E-01	4.44E-01	4.44E-01	8.14E-08	8.14E-08	0.00E+00	0.00E+00	1.25E-02	0.00E+00	0.00E+00	1.20E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.45E-02	2.00E-01	1.23E-01	1.50E+00	1.63E-02
2,6-Dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	2.67E-01	mg/kg	1.00E+00			1.00E-01	3.74E-01	3.74E-01	6.34E-08	6.34E-08	0.00E+00	0.00E+00	4.07E-03	0.00E+00	0.00E+00	3.92E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.99E-03	2.00E-01	3.99E-02	1.50E+00	5.33E-03
2-Methylnaphthalene	0.00E+00	mg/L	0.00E+00	mg/kg	2.19E+00	mg/kg	1.00E+00			1.40E+00		2.70E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.34E-02	0.00E+00	0.00E+00	4.50E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.83E-01	2.45E+00	1.97E-01	2.45E+01	1.97E-02
Dibenzofuran	0.00E+00	mg/L	0.00E+00	mg/kg	5.88E-01	mg/kg	1.00E+00			1.44E+01	8.40E-02	8.40E-02	1.10E+00	1.10E+00	0.00E+00	0.00E+00	8.97E-03	0.00E+00	0.00E+00	1.24E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.25E+00	NA	NA	NA	NA
Fluoranthene	0.00E+00	mg/L	0.00E+00	mg/kg	2.93E-01	mg/kg	1.00E+00			2.10E-01	5.00E-01	5.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.47E-03	0.00E+00	0.00E+00	9.02E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.35E-02	1.00E+00	1.35E-02	1.00E+01	1.35E-03
Pyrene	0.00E+00	mg/L	0.00E+00	mg/kg	3.27E-01	mg/kg	1.00E+00			4.50E-01	7.20E-01	7.20E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.99E-03	0.00E+00	0.00E+00	2.16E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.66E-02	1.00E+00	2.66E-02	1.00E+01	2.66E-03
Volatile Organics																													
1,2,4-Trimethylbenzene	0.00E+00	mg/L	0.00E+00	mg/kg	1.78E-03	mg/kg	1.00E+00			1.44E+01	3.07E-01	3.07E-01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	2.72E-05	0.00E+00	0.00E+00	3.76E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.79E-03	NA	NA	NA	NA
Acetone	0.00E+00	mg/L	6.46E-02	mg/kg	0.00E+00	mg/kg	1.00E+00		0.00E+00		9.00E-01	9.00E-01			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+02	0.00E+00	5.00E+02	0.00E+00

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi \, x Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
HQ = Hazard Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box):
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or N See appropriate text tables for equations.
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Terrestrial plant diet fraction =	0	unitless
Aquatic plant diet fraction =	0	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	1	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0.0002288	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.0022	kg/d
Body weight =	0.015	kg
Home range =	0.96	acres
Water intake rate =	0.0023	L/d
Site Area =	4	acres
Area Use Factor (AUF) =	1	unitless
Exposure Frequency (EF) =	1	unitless

Table E-3
Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the Cottontail Rabbit
Locomotive Building Area
Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Surface Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF	EED Surface Water	EED Sediment	EED Soil	EED Fish	EED Aq. Invert.	EED Terr. Invert.	EED Aq. Plants	EED Terr. Plants	EED Mammals	EED Birds	Total EED	TRV NOAEL	HQ NOAEL	TRV LOAEL	HQ LOAEL
							----------Unitless----------								mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	
Metals																													
Aluminum	2.15E+01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	7.80E+02							1.09E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.09E+00	1.93E+00	5.65E-01	1.93E+01	5.65E-02
Arsenic	6.69E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.74E+02							3.39E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.39E-04	1.26E-01	2.69E-03	1.26E+00	2.69E-04
Barium	1.12E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.46E+02							5.68E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.68E-03	5.10E+00	1.11E-03	1.98E+01	2.87E-04
Beryllium	1.10E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	3.10E+02							5.58E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.58E-05	6.60E-01	8.46E-05	3.30E+00	1.69E-05
Cadmium	0.00E+00	mg/L	1.46E+00	mg/kg	5.24E-01	mg/kg	1.00E+00		6.00E-01	9.45E+00	5.24E-01	8.34E-01	4.00E-01	4.00E-01	0.00E+00	0.00E+00	1.46E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.94E-02	0.00E+00	0.00E+00	2.08E-02	1.00E+00	2.08E-02	1.00E+01	2.08E-03
Copper	2.41E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.21E+03							1.22E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.22E-03	1.17E+01	1.04E-04	1.51E+01	8.06E-05
Lead	9.79E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.38E+01							4.97E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.97E-04	8.00E+00	6.21E-05	8.00E+01	6.21E-06
Manganese	1.71E+00	mg/L	3.98E+03	mg/kg	0.00E+00	mg/kg	1.00E+00	2.47E+02	6.00E-03		7.90E-02	7.90E-02			8.69E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.69E-02	8.80E+01	9.88E-04	2.84E+02	3.06E-04
Nickel	5.73E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	7.24E+02							2.91E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.91E-03	4.00E+01	7.27E-05	8.00E+01	3.63E-05
Selenium	4.40E-03	mg/L	2.50E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.45E+02	5.39E+00		5.59E-01	NA			2.23E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	0.00E+00	0.00E+00	2.23E-04	2.00E-01	1.12E-03	3.30E-01	6.77E-04
Thallium	0.00E+00	mg/L	1.90E+00	mg/kg	0.00E+00	mg/kg	1.00E+00		5.39E+00		2.20E-03	2.20E-03			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.40E-03	0.00E+00	7.40E-02	0.00E+00
Vanadium	3.70E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	4.46E+02							1.88E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.88E-03	2.10E-01	8.93E-03	2.10E+00	8.93E-04
Zinc	1.44E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.22E+03							7.30E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.30E-03	1.60E+02	4.56E-05	3.20E+02	2.28E-05
Nitroaromatics																													
4-Amino-2,6-dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	5.27E-01	mg/kg	1.00E+00			1.00E-01	3.35E+00	3.35E+00	7.24E-08	7.24E-08	0.00E+00	0.00E+00	1.47E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.81E-02	0.00E+00	0.00E+00	7.96E-02	9.00E+00	8.84E-03	4.80E+01	1.66E-03
2-Amino-4,6-dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	2.94E-01	mg/kg	1.00E+00			1.00E-01	3.35E+00	3.35E+00	7.24E-08	7.24E-08	0.00E+00	0.00E+00	8.20E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.36E-02	0.00E+00	0.00E+00	4.44E-02	9.00E+00	4.93E-03	4.80E+01	9.25E-04
Semivolatile Organics																													
2,4-Dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	1.44E+00	mg/kg	1.00E+00			1.00E-01	4.44E-01	4.44E-01	8.14E-08	8.14E-08	0.00E+00	0.00E+00	4.01E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.83E-02	0.00E+00	0.00E+00	3.23E-02	2.00E-01	1.61E-01	1.50E+00	2.15E-02
2,6-Dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	2.04E-01	mg/kg	1.00E+00			1.00E-01	3.74E-01	3.74E-01	6.34E-08	6.34E-08	0.00E+00	0.00E+00	5.69E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.38E-03	0.00E+00	0.00E+00	3.95E-03	2.00E-01	1.97E-02	1.50E+00	2.63E-03
2-Methylnaphthalene	0.00E+00	mg/L	0.00E+00	mg/kg	2.89E+00	mg/kg	1.00E+00			1.40E+00		2.70E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.07E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.46E-02	0.00E+00	0.00E+00	4.27E-02	2.45E+00	1.74E-02	2.45E+01	1.74E-03
Dibenzofuran	0.00E+00	mg/L	0.00E+00	mg/kg	7.55E-01	mg/kg	1.00E+00			1.44E+01	8.40E-02	8.40E-02	1.10E+00	1.10E+00	0.00E+00	0.00E+00	2.11E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.81E-03	0.00E+00	0.00E+00	4.91E-03	NA	NA	NA	NA
Fluoranthene	0.00E+00	mg/L	0.00E+00	mg/kg	4.69E-01	mg/kg	1.00E+00			2.10E-01	5.00E-01	5.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.31E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.04E-02	0.00E+00	0.00E+00	1.17E-02	1.00E+00	1.17E-02	1.00E+01	1.17E-03
Pyrene	0.00E+00	mg/L	0.00E+00	mg/kg	4.79E-01	mg/kg	1.00E+00			4.50E-01	7.20E-01	7.20E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.34E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.53E-02	0.00E+00	0.00E+00	1.66E-02	1.00E+00	1.66E-02	1.00E+01	1.66E-03
Volatile Organics																													
1,2,4-Trimethylbenzene	0.00E+00	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00			1.44E+01	3.07E-01	3.07E-01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	NA	NA	NA
Acetone	0.00E+00	mg/L	6.46E-02	mg/kg	0.00E+00	mg/kg	1.00E+00		0.00E+00		9.00E-01	9.00E-01			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+02	0.00E+00	5.00E+02	0.00E+00

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi \, x Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
HQ = Hazard Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box):
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or N See appropriate text tables for equations.
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Terrestrial plant diet fraction =	1	unitless
Aquatic plant diet fraction =	0	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	0	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0.006048	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.096	kg/d
Body weight =	1.132	kg
Home range =	7.66	acres
Water intake rate =	0.11	L/d
Site Area =	4	acres
Area Use Factor (AUF) =	0.52219321	unitless
Exposure Frequency (EF) =	1	unitless

Table E-4
Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the Marsh Wren
Locomotive Building Area
Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Surface Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF	EED Surface Water	EED Sediment	EED Soil	EED Fish	EED Aq. Invert.	EED Terr. Invert.	EED Aq. Plants	EED Terr. Plants	EED Mammals	EED Birds	Total EED	TRV NOAEL	HQ NOAEL	TRV LOAEL	HQ LOAEL
							----------Unitless----------								mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d
Metals																													
Aluminum	2.15E+01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	7.80E+02							5.80E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.80E+00	1.10E+02	5.27E-02	1.10E+03	5.27E-03
Arsenic	6.69E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.74E+02							1.81E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.81E-03	5.14E+00	3.51E-04	1.28E+01	1.41E-04
Barium	1.12E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.46E+02							3.02E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.02E-02	2.08E+01	1.45E-03	4.17E+01	7.25E-04
Beryllium	1.10E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	3.10E+02							2.97E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.97E-04	NA	NA	NA	NA
Cadmium	0.00E+00	mg/L	1.46E+00	mg/kg	5.24E-01	mg/kg	1.00E+00		6.00E-01	9.45E+00	5.24E-01	8.34E-01	4.00E-01	4.00E-01	0.00E+00	0.00E+00	3.04E-03	0.00E+00	0.00E+00	1.44E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.44E+00	1.45E+00	9.93E-01	2.00E+01	7.20E-02
Copper	2.41E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.21E+03							6.49E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.49E-03	4.70E+01	1.38E-04	6.17E+01	1.05E-04
Lead	9.79E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.38E+01							2.64E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.64E-03	1.13E+00	2.34E-03	1.13E+01	2.34E-04
Manganese	1.71E+00	mg/L	3.98E+03	mg/kg	0.00E+00	mg/kg	1.00E+00	2.47E+02	6.00E-03		7.90E-02	7.90E-02			4.63E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.63E-01	9.77E+02	4.73E-04	9.77E+03	4.73E-05
Nickel	5.73E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	7.24E+02							1.55E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.55E-02	7.74E+01	2.00E-04	1.07E+02	1.45E-04
Selenium	4.40E-03	mg/L	2.50E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.45E+02	5.39E+00		5.59E-01	NA			1.19E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	0.00E+00	0.00E+00	1.19E-03	5.00E-01	2.38E-03	1.00E+00	1.19E-03
Thallium	0.00E+00	mg/L	1.90E+00	mg/kg	0.00E+00	mg/kg	1.00E+00		5.39E+00		2.20E-03	2.20E-03			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.50E-01	0.00E+00	3.50E+00	0.00E+00
Vanadium	3.70E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	4.46E+02							9.98E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.98E-03	1.14E+01	8.77E-04	1.14E+02	8.77E-05
Zinc	1.44E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.22E+03							3.89E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.89E-02	1.45E+01	2.68E-03	1.31E+02	2.97E-04
Nitroaromatics																													
4-Amino-2,6-dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	5.27E-01	mg/kg	1.00E+00			1.00E-01	3.35E+00	3.35E+00	7.24E-08	7.24E-08	0.00E+00	0.00E+00	3.06E-03	0.00E+00	0.00E+00	1.53E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.83E-02	7.00E-01	2.62E-02	1.78E+01	1.03E-03
2-Amino-4,6-dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	2.94E-01	mg/kg	1.00E+00			1.00E-01	3.35E+00	3.35E+00	7.24E-08	7.24E-08	0.00E+00	0.00E+00	1.71E-03	0.00E+00	0.00E+00	8.53E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-02	7.00E-01	1.46E-02	1.78E+01	5.75E-04
Semivolatile Organics																													
2,4-Dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	1.44E+00	mg/kg	1.00E+00			1.00E-01	4.44E-01	4.44E-01	8.14E-08	8.14E-08	0.00E+00	0.00E+00	8.35E-03	0.00E+00	0.00E+00	4.17E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.01E-02	7.00E-01	7.15E-02	1.78E+01	2.81E-03
2,6-Dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	2.04E-01	mg/kg	1.00E+00			1.00E-01	3.74E-01	3.74E-01	6.34E-08	6.34E-08	0.00E+00	0.00E+00	1.18E-03	0.00E+00	0.00E+00	5.92E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.10E-03	7.00E-01	1.01E-02	1.78E+01	3.99E-04
2-Methylnaphthalene	0.00E+00	mg/L	0.00E+00	mg/kg	2.89E+00	mg/kg	1.00E+00			1.40E+00		2.70E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.68E-02	0.00E+00	0.00E+00	1.17E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E+00	2.28E+01	5.23E-02	2.28E+02	5.23E-03
Dibenzofuran	0.00E+00	mg/L	0.00E+00	mg/kg	7.55E-01	mg/kg	1.00E+00			1.44E+01	8.40E-02	8.40E-02	1.10E+00	1.10E+00	0.00E+00	0.00E+00	4.38E-03	0.00E+00	0.00E+00	3.15E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.16E+00	NA	NA	NA	NA
Fluoranthene	0.00E+00	mg/L	0.00E+00	mg/kg	4.69E-01	mg/kg	1.00E+00			2.10E-01	5.00E-01	5.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.72E-03	0.00E+00	0.00E+00	2.86E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.13E-02	3.95E+01	7.92E-04	3.95E+02	7.92E-05
Pyrene	0.00E+00	mg/L	0.00E+00	mg/kg	4.79E-01	mg/kg	1.00E+00			4.50E-01	7.20E-01	7.20E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.78E-03	0.00E+00	0.00E+00	6.25E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.53E-02	3.95E+01	1.65E-03	3.95E+02	1.65E-04
Volatile Organics																													
1,2,4-Trimethylbenzene	0.00E+00	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00			1.44E+01	3.07E-01	3.07E-01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	NA	NA	NA
Acetone	0.00E+00	mg/L	6.46E-02	mg/kg	0.00E+00	mg/kg	1.00E+00		0.00E+00		9.00E-01	9.00E-01			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.01E+02	0.00E+00	2.00E+03	0.00E+00

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi x Cij}{BW} \right) \right] \right)$$

Where:

Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:

BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
HQ = Hazard Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box):
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or N See appropriate text tables for equations.
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Terrestrial plant diet fraction =	0	unitless
Aquatic plant diet fraction =	0	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	1	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0.000058	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.0029	kg/d
Body weight =	0.01	kg
Home range =	0.13	acres
Water intake rate =	0.0027	L/d
Site Area =	4	acres
Area Use Factor (AUF) =	1	unitless
Exposure Frequency (EF) =	1	unitless

Table E-5
Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the White-Tailed Deer
Locomotive Building Area
Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Total Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF	EED Surface Water	EED Sediment	EED Soil	EED Fish	EED Aq. Invert.	EED Terr. Invert.	EED Aq. Plants	EED Terr. Plants	EED Mammals	EED Birds	Total EED	TRV_{NOAEL}	HQ_{NOAEL}	TRV_{LOAEL}	HQ_{LOAEL}
							----------Unitless----------								mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d
Metals																													
Aluminum	2.15E+01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	7.80E+02							4.40E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.40E-03	1.93E+00	2.28E-03	1.93E+01	2.28E-04
Arsenic	6.69E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.74E+02							1.37E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E-06	1.26E-01	1.09E-05	1.26E+00	1.09E-06
Barium	1.12E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.46E+02							2.29E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.29E-05	5.10E+00	4.50E-06	1.98E+01	1.16E-06
Beryllium	1.10E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	3.10E+02							2.25E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.25E-07	6.60E-01	3.42E-07	3.30E+00	6.83E-08
Cadmium	0.00E+00	mg/L	1.46E+00	mg/kg	4.12E-01	mg/kg	1.00E+00		6.00E-01	9.93E+00	5.24E-01	9.30E-01	4.54E-01	4.54E-01	0.00E+00	0.00E+00	8.44E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.93E-05	0.00E+00	0.00E+00	4.01E-05	1.00E+00	4.01E-05	1.00E+01	4.01E-06
Copper	2.41E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.21E+03							4.93E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.93E-06	1.17E+01	4.21E-07	1.51E+01	3.26E-07
Lead	9.79E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.38E+01							2.01E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.01E-06	8.00E+00	2.51E-07	8.00E+01	2.51E-08
Manganese	1.71E+00	mg/L	3.98E+03	mg/kg	0.00E+00	mg/kg	1.00E+00	2.47E+02	6.00E-03		7.90E-02	7.90E-02			3.51E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.51E-04	8.80E+01	3.99E-06	2.84E+02	1.24E-06
Nickel	5.73E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	7.24E+02							1.17E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E-05	4.00E+01	2.93E-07	8.00E+01	1.47E-07
Selenium	4.40E-03	mg/L	2.50E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.45E+02	5.39E+00		5.59E-01	NA			9.02E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	0.00E+00	0.00E+00	9.02E-07	2.00E-01	4.51E-06	3.30E-01	2.73E-06
Thallium	0.00E+00	mg/L	1.90E+00	mg/kg	0.00E+00	mg/kg	1.00E+00		5.39E+00		2.20E-03	2.20E-03			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.40E-03	0.00E+00	7.40E-02	0.00E+00
Vanadium	3.70E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	4.46E+02							7.57E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.57E-06	2.10E-01	3.61E-05	2.10E+00	3.61E-06
Zinc	1.44E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.22E+03							2.95E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.95E-05	1.60E+02	1.84E-07	3.20E+02	9.21E-08
Nitroaromatics																													
4-Amino-2,6-dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	3.79E-01	mg/kg	1.00E+00			1.00E-01	3.35E+00	3.35E+00	7.24E-08	7.24E-08	0.00E+00	0.00E+00	7.77E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.30E-04	0.00E+00	0.00E+00	1.31E-04	9.00E+00	1.45E-05	4.80E+01	2.72E-06
2-Amino-4,6-dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	2.42E-01	mg/kg	1.00E+00			1.00E-01	3.35E+00	3.35E+00	7.24E-08	7.24E-08	0.00E+00	0.00E+00	4.96E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.30E-05	0.00E+00	0.00E+00	8.35E-05	9.00E+00	9.27E-06	4.80E+01	1.74E-06
Semivolatile Organics																													
2,4-Dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	8.19E-01	mg/kg	1.00E+00			1.00E-01	4.44E-01	4.44E-01	8.14E-08	8.14E-08	0.00E+00	0.00E+00	1.68E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.72E-05	0.00E+00	0.00E+00	3.89E-05	2.00E-01	1.94E-04	1.50E+00	2.59E-05
2,6-Dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	2.67E-01	mg/kg	1.00E+00			1.00E-01	3.74E-01	3.74E-01	6.34E-08	6.34E-08	0.00E+00	0.00E+00	5.47E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-05	0.00E+00	0.00E+00	1.08E-05	2.00E-01	5.39E-05	1.50E+00	7.19E-06
2-Methylnaphthalene	0.00E+00	mg/L	0.00E+00	mg/kg	2.19E+00	mg/kg	1.00E+00			1.40E+00		2.70E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.49E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.06E-05	0.00E+00	0.00E+00	6.51E-05	2.45E+00	2.66E-05	2.45E+01	2.66E-06
Dibenzofuran	0.00E+00	mg/L	0.00E+00	mg/kg	5.88E-01	mg/kg	1.00E+00			1.44E+01	8.40E-02	8.40E-02	1.10E+00	1.10E+00	0.00E+00	0.00E+00	1.20E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.06E-06	0.00E+00	0.00E+00	6.27E-06	NA	NA	NA	NA
Fluoranthene	0.00E+00	mg/L	0.00E+00	mg/kg	2.93E-01	mg/kg	1.00E+00			2.10E-01	5.00E-01	5.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.00E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.50E-05	0.00E+00	0.00E+00	1.56E-05	1.00E+00	1.56E-05	1.00E+01	1.56E-06
Pyrene	0.00E+00	mg/L	0.00E+00	mg/kg	3.27E-01	mg/kg	1.00E+00			4.50E-01	7.20E-01	7.20E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.70E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.41E-05	0.00E+00	0.00E+00	2.48E-05	1.00E+00	2.48E-05	1.00E+01	2.48E-06
Volatile Organics																													
1,2,4-Trimethylbenzene	0.00E+00	mg/L	0.00E+00	mg/kg	1.78E-03	mg/kg	1.00E+00			1.44E+01	3.07E-01	3.07E-01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	3.65E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.60E-08	0.00E+00	0.00E+00	5.96E-08	NA	NA	NA	NA
Acetone	0.00E+00	mg/L	6.46E-02	mg/kg	0.00E+00	mg/kg	1.00E+00		0.00E+00		9.00E-01	9.00E-01			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+02	0.00E+00	5.00E+02	0.00E+00

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRixCij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
HQ = Hazard Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box):
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or N See appropriate text tables for equations.
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Terrestrial plant diet fraction =	1	unitless
Aquatic plant diet fraction =	0	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	0	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0.04	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	2	kg/d
Body weight =	61	kg
Home range =	1280	acres
Water intake rate =	4	L/d
Site Area =	4	acres
Area Use Factor (AUF) =	0.003125	unitless
Exposure Frequency (EF) =	1	unitless

Table E-6
Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the Raccoon
Locomotive Building Area
Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Surface Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF	EED Surface Water	EED Sediment	EED Soil	EED Fish	EED Aq. Invert.	EED Terr. Invert.	EED Aq. Plants	EED Terr. Plants	EED Mammals	EED Birds	Total EED	TRV NOAEL	HQ NOAEL	TRV LOAEL	HQ LOAEL
							----------Unitless----------								mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d
Metals																													
Aluminum	2.15E+01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	7.80E+02							1.88E-02	0.00E+00	0.00E+00	1.78E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.96E-01	1.93E+00	1.02E-01	1.93E+01	1.02E-02
Arsenic	6.69E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.74E+02							5.86E-06	0.00E+00	0.00E+00	1.23E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.82E-05	1.26E-01	1.44E-04	1.26E+00	1.44E-05
Barium	1.12E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.46E+02							9.80E-05	0.00E+00	0.00E+00	1.73E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.71E-04	5.10E+00	5.32E-05	1.98E+01	1.37E-05
Beryllium	1.10E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	3.10E+02							9.64E-07	0.00E+00	0.00E+00	3.61E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.58E-06	6.60E-01	6.93E-06	3.30E+00	1.39E-06
Cadmium	0.00E+00	mg/L	1.46E+00	mg/kg	5.24E-01	mg/kg	1.00E+00		6.00E-01	9.45E+00	5.24E-01	8.34E-01	4.00E-01	4.00E-01	0.00E+00	3.63E-05	1.30E-05	0.00E+00	9.73E-05	7.87E-04	8.50E-05	4.86E-05	5.55E-06	0.00E+00	1.07E-03	1.00E+00	1.07E-03	1.00E+01	1.07E-04
Copper	2.41E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.21E+03							2.11E-05	0.00E+00	0.00E+00	3.09E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.30E-04	1.17E+01	2.82E-05	1.51E+01	2.18E-05
Lead	9.79E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.38E+01							8.57E-06	0.00E+00	0.00E+00	6.61E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.52E-05	8.00E+00	1.90E-06	8.00E+01	1.90E-07
Manganese	1.71E+00	mg/L	3.98E+03	mg/kg	0.00E+00	mg/kg	1.00E+00	2.47E+02	6.00E-03		7.90E-02	7.90E-02			1.50E-03	9.91E-02	0.00E+00	4.48E-03	2.66E-03	0.00E+00	3.50E-02	0.00E+00	0.00E+00	0.00E+00	1.43E-01	8.80E+01	1.62E-03	2.84E+02	5.03E-04
Nickel	5.73E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	7.24E+02							5.02E-05	0.00E+00	0.00E+00	4.39E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.89E-04	4.00E+01	1.22E-05	8.00E+01	6.12E-06
Selenium	4.40E-03	mg/L	2.50E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.45E+02	5.39E+00		5.59E-01	NA			3.85E-06	6.21E-05	0.00E+00	3.01E-05	1.50E-03	0.00E+00	1.55E-04	NA	0.00E+00	0.00E+00	1.75E-03	2.00E-01	8.73E-03	3.30E-01	5.29E-03
Thallium	0.00E+00	mg/L	1.90E+00	mg/kg	0.00E+00	mg/kg	1.00E+00		5.39E+00		2.20E-03	2.20E-03			0.00E+00	4.73E-05	0.00E+00	0.00E+00	1.14E-03	0.00E+00	4.65E-07	0.00E+00	0.00E+00	0.00E+00	1.19E-03	7.40E-03	1.60E-01	7.40E-02	1.60E-02
Vanadium	3.70E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	4.46E+02							3.24E-05	0.00E+00	0.00E+00	1.74E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.07E-04	2.10E-01	9.85E-04	2.10E+00	9.85E-05
Zinc	1.44E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.22E+03							1.26E-04	0.00E+00	0.00E+00	1.86E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.98E-03	1.60E+02	1.24E-05	3.20E+02	6.19E-06
Nitroaromatics																													
4-Amino-2,6-dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	5.27E-01	mg/kg	1.00E+00			1.00E-01	3.35E+00	3.35E+00	7.24E-08	7.24E-08	0.00E+00	0.00E+00	1.31E-05	0.00E+00	0.00E+00	8.37E-06	0.00E+00	1.96E-04	1.01E-12	0.00E+00	2.18E-04	9.00E+00	2.42E-05	4.80E+01	4.53E-06
2-Amino-4,6-dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	2.94E-01	mg/kg	1.00E+00			1.00E-01	3.35E+00	3.35E+00	7.24E-08	7.24E-08	0.00E+00	0.00E+00	7.32E-06	0.00E+00	0.00E+00	4.67E-06	0.00E+00	1.09E-04	5.64E-13	0.00E+00	1.21E-04	9.00E+00	1.35E-05	4.80E+01	2.53E-06
Semivolatile Organics																													
2,4-Dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	1.44E+00	mg/kg	1.00E+00			1.00E-01	4.44E-01	4.44E-01	8.14E-08	8.14E-08	0.00E+00	0.00E+00	3.58E-05	0.00E+00	0.00E+00	2.29E-05	0.00E+00	7.10E-05	3.10E-12	0.00E+00	1.30E-04	2.00E-01	6.48E-04	1.50E+00	8.65E-05
2,6-Dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	2.04E-01	mg/kg	1.00E+00			1.00E-01	3.74E-01	3.74E-01	6.34E-08	6.34E-08	0.00E+00	0.00E+00	5.08E-06	0.00E+00	0.00E+00	3.24E-06	0.00E+00	8.49E-06	3.43E-13	0.00E+00	1.68E-05	2.00E-01	8.41E-05	1.50E+00	1.12E-05
2-Methylnaphthalene	0.00E+00	mg/L	0.00E+00	mg/kg	2.89E+00	mg/kg	1.00E+00			1.40E+00		2.70E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.20E-05	0.00E+00	0.00E+00	6.44E-04	0.00E+00	8.69E-05	0.00E+00	0.00E+00	8.03E-04	2.45E+00	3.28E-04	2.45E+01	3.28E-05
Dibenzofuran	0.00E+00	mg/L	0.00E+00	mg/kg	7.55E-01	mg/kg	1.00E+00			1.44E+01	8.40E-02	8.40E-02	1.10E+00	1.10E+00	0.00E+00	0.00E+00	1.88E-05	0.00E+00	0.00E+00	1.73E-03	0.00E+00	7.05E-06	2.20E-05	0.00E+00	1.78E-03	NA	NA	NA	NA
Fluoranthene	0.00E+00	mg/L	0.00E+00	mg/kg	4.69E-01	mg/kg	1.00E+00			2.10E-01	5.00E-01	5.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.17E-05	0.00E+00	0.00E+00	1.57E-05	0.00E+00	2.61E-05	0.00E+00	0.00E+00	5.34E-05	1.00E+00	5.34E-05	1.00E+01	5.34E-06
Pyrene	0.00E+00	mg/L	0.00E+00	mg/kg	4.79E-01	mg/kg	1.00E+00			4.50E-01	7.20E-01	7.20E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.19E-05	0.00E+00	0.00E+00	3.43E-05	0.00E+00	3.84E-05	0.00E+00	0.00E+00	8.45E-05	1.00E+00	8.45E-05	1.00E+01	8.45E-06
Volatile Organics																													
1,2,4-Trimethylbenzene	0.00E+00	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00			1.44E+01	3.07E-01	3.07E-01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	NA	NA	NA
Acetone	0.00E+00	mg/L	6.46E-02	mg/kg	0.00E+00	mg/kg	1.00E+00		0.00E+00		9.00E-01	9.00E-01			0.00E+00	1.61E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.47E-06	0.00E+00	0.00E+00	0.00E+00	8.08E-06	1.00E+02	8.08E-08	5.00E+02	1.62E-08

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi \, x Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
HQ = Hazard Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box):
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or N See appropriate text tables for equations.
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Terrestrial plant diet fraction =	0.21	unitless
Aquatic plant diet fraction =	0.21	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0.02	unitless
Aq. Invert diet fraction =	0.21	unitless
Terr. Invert diet fraction =	0.3	unitless
Mammal diet fraction =	0.05	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0.01222	kg/d
Sediment ingestion rate =	0.01222	kg/d
Food ingestion rate =	0.26	kg/d
Body weight =	5.1	kg
Home range =	385	acres
Water intake rate =	0.43	L/d
Site Area =	4	acres
Area Use Factor (AUF) =	0.01038961	unitless
Exposure Frequency (EF) =	1	unitless

Table E-7
Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the Red-Tailed Hawk
Locomotive Building Area
Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Surface Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF	EED Surface Water	EED Sediment	EED Soil	EED Fish	EED Aq. Invert.	EED Terr. Invert.	EED Aq. Plants	EED Terr. Plants	EED Mammals	EED Birds	Total EED	TRV NOAEL	HQ NOAEL	TRV LOAEL	HQ LOAEL
							----------Unitless----------								mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d
Metals																													
Aluminum	2.15E+01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	7.80E+02							2.46E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.46E-03	1.10E+02	2.24E-05	1.10E+03	2.24E-06
Arsenic	6.69E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.74E+02							7.66E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.66E-07	5.14E+00	1.49E-07	1.28E+01	5.97E-08
Barium	1.12E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.46E+02							1.28E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.28E-05	2.08E+01	6.16E-07	4.17E+01	3.07E-07
Beryllium	1.10E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	3.10E+02							1.26E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.26E-07	NA	NA	NA	NA
Cadmium	0.00E+00	mg/L	1.46E+00	mg/kg	5.24E-01	mg/kg	1.00E+00		6.00E-01	9.45E+00	5.24E-01	8.34E-01	4.00E-01	4.00E-01	0.00E+00	0.00E+00	1.20E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.82E-05	5.76E-06	2.52E-05	1.45E+00	1.74E-05	2.00E+01	1.26E-06
Copper	2.41E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.21E+03							2.75E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.75E-06	4.70E+01	5.86E-08	6.17E+01	4.46E-08
Lead	9.79E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.38E+01							1.12E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.12E-06	3.85E+00	2.91E-07	3.85E+01	2.91E-08
Manganese	1.71E+00	mg/L	3.98E+03	mg/kg	0.00E+00	mg/kg	1.00E+00	2.47E+02	6.00E-03		7.90E-02	7.90E-02			1.96E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.96E-04	9.77E+02	2.01E-07	9.77E+03	2.01E-08
Nickel	5.73E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	7.24E+02							6.56E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.56E-06	7.74E+01	8.48E-08	1.07E+02	6.13E-08
Selenium	4.40E-03	mg/L	2.50E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.45E+02	5.39E+00		5.59E-01	NA			5.04E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	0.00E+00	0.00E+00	5.04E-07	4.40E-01	1.15E-06	1.50E+00	3.36E-07
Thallium	0.00E+00	mg/L	1.90E+00	mg/kg	0.00E+00	mg/kg	1.00E+00		5.39E+00		2.20E-03	2.20E-03			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.50E-01	0.00E+00	3.50E+00	0.00E+00
Vanadium	3.70E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	4.46E+02							4.23E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.23E-06	1.14E+01	3.72E-07	1.14E+02	3.72E-08
Zinc	1.44E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.22E+03							1.65E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.65E-05	1.45E+01	1.14E-06	1.31E+02	1.26E-07
Nitroaromatics																													
4-Amino-2,6-dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	5.27E-01	mg/kg	1.00E+00			1.00E-01	3.35E+00	3.35E+00	7.24E-08	7.24E-08	0.00E+00	0.00E+00	1.21E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.32E-12	1.05E-12	1.21E-06	7.00E-01	1.72E-06	1.78E+01	6.78E-08
2-Amino-4,6-dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	2.94E-01	mg/kg	1.00E+00			1.00E-01	3.35E+00	3.35E+00	7.24E-08	7.24E-08	0.00E+00	0.00E+00	6.73E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.85E-12	5.85E-13	6.74E-07	7.00E-01	9.62E-07	1.78E+01	3.78E-08
Semivolatile Organics																													
2,4-Dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	1.44E+00	mg/kg	1.00E+00			1.00E-01	4.44E-01	4.44E-01	8.14E-08	8.14E-08	0.00E+00	0.00E+00	3.30E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.02E-11	3.22E-12	3.30E-06	7.00E-01	4.71E-06	1.78E+01	1.85E-07
2,6-Dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	2.04E-01	mg/kg	1.00E+00			1.00E-01	3.74E-01	3.74E-01	6.34E-08	6.34E-08	0.00E+00	0.00E+00	4.67E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.13E-12	3.56E-13	4.67E-07	7.00E-01	6.68E-07	1.78E+01	2.63E-08
2-Methylnaphthalene	0.00E+00	mg/L	0.00E+00	mg/kg	2.89E+00	mg/kg	1.00E+00			1.40E+00		2.70E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.63E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.63E-06	2.28E+01	2.91E-07	2.28E+02	2.91E-08
Dibenzofuran	0.00E+00	mg/L	0.00E+00	mg/kg	7.55E-01	mg/kg	1.00E+00			1.44E+01	8.40E-02	8.40E-02	1.10E+00	1.10E+00	0.00E+00	0.00E+00	1.73E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.23E-05	2.28E-05	9.69E-05	NA	NA	NA	NA
Fluoranthene	0.00E+00	mg/L	0.00E+00	mg/kg	4.69E-01	mg/kg	1.00E+00			2.10E-01	5.00E-01	5.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.07E-06	3.95E+01	2.72E-08	3.95E+02	2.72E-09
Pyrene	0.00E+00	mg/L	0.00E+00	mg/kg	4.79E-01	mg/kg	1.00E+00			4.50E-01	7.20E-01	7.20E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.10E-06	3.95E+01	2.78E-08	3.95E+02	2.78E-09
Volatile Organics																													
1,2,4-Trimethylbenzene	0.00E+00	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00			1.44E+01	3.07E-01	3.07E-01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	NA	NA	NA
Acetone	0.00E+00	mg/L	6.46E-02	mg/kg	0.00E+00	mg/kg	1.00E+00		0.00E+00		9.00E-01	9.00E-01			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.01E+02	0.00E+00	2.00E+03	0.00E+00

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi \, x Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
HQ = Hazard Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box):
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or N See appropriate text tables for equations.
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Terrestrial plant diet fraction =	0	unitless
Aquatic plant diet fraction =	0	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	0	unitless
Mammal diet fraction =	0.76	unitless
Bird diet fraction =	0.24	unitless
Soil ingestion rate =	0.00114	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.057	kg/d
Body weight =	0.957	kg
Home range =	2080	acres
Water intake rate =	0.057	L/d
Site Area =	4	acres
Area Use Factor (AUF) =	0.00192308	unitless
Exposure Frequency (EF) =	1	unitless

Table E-8
Chemicals of Potential Concern
Exposure Doses and Hazard Quotients for the Muskrat
Locomotive Building Area
Plum Brook Ordnance Works
Sandusky, Ohio

Chemical	Surface Water Exposure Point Concentration	Units	Sediment Exposure Point Concentration	Units	Surface Soil Exposure Point Concentration	Units	Soil BAF	Fish BAF	Aq. Invert. BAF	Terr. Invert. BAF	Aq. Plant BAF	Terr. Plant BAF	Mammal BAF	Bird BAF	EED Surface Water	EED Sediment	EED Soil	EED Fish	EED Aq. Invert.	EED Terr. Invert.	EED Aq. Plants	EED Terr. Plants	EED Mammals	EED Birds	Total EED	TRV NOAEL	HQ NOAEL	TRV LOAEL	HQ LOAEL
							----------Unitless----------								mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d	mg/kg-d
Metals																													
Aluminum	2.15E+01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	7.80E+02							2.01E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.01E+00	1.93E+00	1.04E+00	1.93E+01	1.04E-01
Arsenic	6.69E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.74E+02							6.27E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.27E-04	1.26E-01	4.97E-03	1.26E+00	4.97E-04
Barium	1.12E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.46E+02							1.05E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.05E-02	5.10E+00	2.06E-03	1.98E+01	5.30E-04
Beryllium	1.10E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	3.10E+02							1.03E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.03E-04	6.60E-01	1.56E-04	3.30E+00	3.12E-05
Cadmium	0.00E+00	mg/L	1.46E+00	mg/kg	5.24E-01	mg/kg	1.00E+00		6.00E-01	9.45E+00	5.24E-01	8.34E-01	4.00E-01	4.00E-01	0.00E+00	0.00E+00	2.29E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.29E-01	1.00E+00	2.29E-01	1.00E+01	2.29E-02
Copper	2.41E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.21E+03							2.25E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.25E-03	1.17E+01	1.93E-04	1.51E+01	1.49E-04
Lead	9.79E-03	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.38E+01							9.17E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.17E-04	8.00E+00	1.15E-04	8.00E+01	1.15E-05
Manganese	1.71E+00	mg/L	3.98E+03	mg/kg	0.00E+00	mg/kg	1.00E+00	2.47E+02	6.00E-03		7.90E-02	7.90E-02			1.61E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.43E+01	0.00E+00	0.00E+00	0.00E+00	9.45E+01	8.80E+01	1.07E+00	2.84E+02	3.33E-01
Nickel	5.73E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	7.24E+02							5.37E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.37E-03	4.00E+01	1.34E-04	8.00E+01	6.71E-05
Selenium	4.40E-03	mg/L	2.50E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	6.45E+02	5.39E+00		5.59E-01	NA			4.12E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.18E-01	NA	0.00E+00	0.00E+00	4.18E-01	2.00E-01	2.09E+00	3.30E-01	1.27E+00
Thallium	0.00E+00	mg/L	1.90E+00	mg/kg	0.00E+00	mg/kg	1.00E+00		5.39E+00		2.20E-03	2.20E-03			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.25E-03	0.00E+00	0.00E+00	0.00E+00	1.25E-03	7.40E-03	1.69E-01	7.40E-02	1.69E-02
Vanadium	3.70E-02	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	4.46E+02							3.46E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.46E-03	2.10E-01	1.65E-02	2.10E+00	1.65E-03
Zinc	1.44E-01	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00	1.22E+03							1.35E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.35E-02	1.60E+02	8.43E-05	3.20E+02	4.21E-05
Nitroaromatics																													
4-Amino-2,6-dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	5.27E-01	mg/kg	1.00E+00			1.00E-01	3.35E+00	3.35E+00	7.24E-08	7.24E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.00E+00	0.00E+00	4.80E+01	0.00E+00
2-Amino-4,6-dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	2.94E-01	mg/kg	1.00E+00			1.00E-01	3.35E+00	3.35E+00	7.24E-08	7.24E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.00E+00	0.00E+00	4.80E+01	0.00E+00
Semivolatile Organics																													
2,4-Dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	1.44E+00	mg/kg	1.00E+00			1.00E-01	4.44E-01	4.44E-01	8.14E-08	8.14E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E-01	0.00E+00	1.50E+00	0.00E+00
2,6-Dinitrotoluene	0.00E+00	mg/L	0.00E+00	mg/kg	2.04E-01	mg/kg	1.00E+00			1.00E-01	3.74E-01	3.74E-01	6.34E-08	6.34E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.00E-01	0.00E+00	1.50E+00	0.00E+00
2-Methylnaphthalene	0.00E+00	mg/L	0.00E+00	mg/kg	2.89E+00	mg/kg	1.00E+00			1.40E+00		2.70E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.45E+00	0.00E+00	2.45E+01	0.00E+00
Dibenzofuran	0.00E+00	mg/L	0.00E+00	mg/kg	7.55E-01	mg/kg	1.00E+00			1.44E+01	8.40E-02	8.40E-02	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	NA	NA	NA
Fluoranthene	0.00E+00	mg/L	0.00E+00	mg/kg	4.69E-01	mg/kg	1.00E+00			2.10E-01	5.00E-01	5.00E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	0.00E+00	1.00E+01	0.00E+00
Pyrene	0.00E+00	mg/L	0.00E+00	mg/kg	4.79E-01	mg/kg	1.00E+00			4.50E-01	7.20E-01	7.20E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E+00	0.00E+00	1.00E+01	0.00E+00
Volatile Organics																													
1,2,4-Trimethylbenzene	0.00E+00	mg/L	0.00E+00	mg/kg	0.00E+00	mg/kg	1.00E+00			1.44E+01	3.07E-01	3.07E-01	1.10E+00	1.10E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	NA	NA	NA	NA
Acetone	0.00E+00	mg/L	6.46E-02	mg/kg	0.00E+00	mg/kg	1.00E+00		0.00E+00		9.00E-01	9.00E-01			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.74E-02	0.00E+00	0.00E+00	0.00E+00	1.74E-02	1.00E+02	1.74E-04	5.00E+02	3.49E-05

Intake Equation:

$$Ej = \left(\frac{A}{HR} \left[\sum_{i=1}^{m} \left(\frac{IRi \, x Cij}{BW} \right) \right] \right)$$

Where:
Ej = Total Exposure to Chemical
A = Site Area
HR = Home Range
m = Total number of ingested media
i = counter
IRi = Consumption Rate for Medium
Cij = Chemical concentration (j) in medium (I) (mg/kg or mg/L)
BW = Body Weight

Notes:
BAF = Bioaccumulation Factor (may be BCF if this is the only value available)
EED = Estimated Exposure Dose
HQ = Hazard Quotient.
L = LOAEL based; N = NOAEL based
LOAEL = Lowest Observed Adverse Effect Level
NOAEL = No Observed Adverse Effect Level
NA = Not applicable/Not available
BAF (or BCF) values from appropriate text tables (BCF = bioconcentration factor)
Some BAF (or BCF) values based on media regression equations (value in box):
LOAEL and NOAEL values from appropriate toxicity summary tables in the text.
UF = Uncertainty Factor for toxicity factor extrapolation, and Adjusted LOAEL or N See appropriate text tables for equations.
A "0" entry in the exposure concentration column indicates this chemical not selected as a COPEC for this medium.
Receptor diet data and home range data from appropriate text table.
Exposure point concentrations (EPCs) from appropriate text tables.

Species-Specific Factors

Terrestrial plant diet fraction =	0	unitless
Aquatic plant diet fraction =	1	unitless
Plant root diet fraction =	0	unitless
Fish diet fraction =	0	unitless
Aq. Invert diet fraction =	0	unitless
Terr. Invert diet fraction =	0	unitless
Mammal diet fraction =	0	unitless
Bird diet fraction =	0	unitless
Soil ingestion rate =	0	kg/d
Sediment ingestion rate =	0	kg/d
Food ingestion rate =	0.352	kg/d
Body weight =	1.174	kg
Home range =	0.3	acres
Water intake rate =	0.11	L/d
Site Area =	4	acres
Area Use Factor (AUF) =	1	unitless
Exposure Frequency (EF) =	1	unitless