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Region 2 RAC2
Remedial Action Contract

Final Screening Level Ecological Risk Assessment

Matteo & Sons, Inc. Site

Remedial Investigation/Feasibility Study

Thorofare, New Jersey

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565354

CDM Smith

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Acronyms and Abbreviations

BAF	bioaccumulation factor
BSAF	biota sediment accumulation factor
BTAG	Biological Technical Assistance Group
BW	body weight
CDM Smith	CDM Federal Programs Corporation
CF	concentration in food item
COPC	chemical of potential concern
CS	concentration in soil/sediment
CSM	conceptual site model
CW	concentration in water
DEQ	Department of Environmental Quality
Eco-SSL	ecological soil screening level
EPA	United States Environmental Protection Agency
ERA	ecological risk assessment
ERAGS	Ecological Risk Assessment Guidance for Superfund
ERT	Environmental Response Team
ESL	ecological screening level
FIR	food ingestion rate
g/g bw/day	grams per gram of body weight per day
HQ	hazard quotient
kg	kilogram
kg/day	kilograms per day
L/day	liters per day
LBG	The Louis Berger Group, Inc.
LEL	lowest-effects level
LOAEL	lowest-observed-adverse-effect-level
mg/kg	milligrams per kilogram
mg/kg bw/day	milligrams per kilogram of body weight per day
ng/kg	nanograms per kilogram
NHP	Natural Heritage Program
NJ	New Jersey
NJDEP	New Jersey Department of Environmental Protection
NOAEL	no-observed-adverse-effect-level
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
pg/g	picograms per gram
PRM	Potomac-Raritan-Magothy
RAC	Remedial Action Contract
RCRA	Resource Conservation and Recovery Act
RI/FS	remedial investigation/feasibility study
SEL	severe-effects level

SFF	site foraging factor
SIR	sediment /soil ingestion rate
SLERA	screening level ecological risk assessment
SMDP	scientific management decision point
SVOC	semi-volatile organic compound
TAL	Target Analyte List
TCDD	tetrachlorodibenzodioxin
TCL	Target Compound List
TEF	toxicity equivalence factor
TEQ	toxicity equivalent
the site	Matteo & Sons, Inc. site
TRV	toxicity reference value
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
USFWS	United States Fish and Wildlife Service
VOC	volatile organic compound
WHO	World Health Organization
WIR	water ingestion rate

Executive Summary

CDM Federal Programs Corporation (CDM Smith) received Work Assignment Number 032-RICO-02KD under the Remedial Action Contract (RAC) 2 program to provide technical services to complete a Remedial Investigation/Feasibility Study (RI/FS) for the Matteo & Sons, Inc. site (the site) for the United States Environmental Protection Agency (EPA), Region 2. The site is located in Thorofare, West Deptford Township, Gloucester County, New Jersey.

The overall purpose of the work assignment is to evaluate the nature and extent of contamination at the site and to develop and evaluate remedial alternatives, as appropriate. This Screening Level Ecological Risk Assessment (SLERA), as part of the RI/FS, provides a preliminary evaluation of ecological risks from contaminants to environments present within the study area.

The objective of this SLERA is to evaluate the potential for risk at the site. Conservative assumptions were used to identify exposure pathways and, where possible, quantify potential ecological risks. This report is prepared in accordance with the following documents:

- Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final (EPA 1997)
- Guidelines for Ecological Risk Assessment (EPA 1998)

Site Background

According to public records, between 1907 and 1947, the Matteo Property was owned by Samuel and Bertha Wilkins who used a portion of the property for farming activities, while the remainder of the property was covered by woodlands. The Matteo family acquired the property in 1947. In 1968, the New Jersey Department of Environmental Protection (NJDEP) identified an inactive incinerator at the property. In 1971, NJDEP approved Matteo's request to operate the incinerator to burn copper wire and Matteo submitted a plan to operate a "sweating fire box" to melt lead battery terminals for lead reclamation. This lead melting operation continued until 1985. In 1972, NJDEP observed landfilling of crushed battery casings in an area of wetlands adjacent to Hessian Run. This operation was apparently performed in conjunction with the lead melting operation, as there were several reports of battery casing incineration and subsequent onsite ash disposal. In addition to the incineration and landfilling operations, drums of waste were found scattered throughout the property.

Subsequently, several investigations lead by the responsible party under oversight of NJDEP were conducted at the Matteo property and the adjacent manufactured home community, Willow Woods. Included in these investigations was a 2003 aquatic biota study conducted by NJDEP. Data presented in the aquatic biota report was used in a desktop ecological risk assessment (ERA) conducted by EPA/Environmental Response Team (ERT).

Between May and July 2006, James Matteo and Sons, Inc. conducted soil removal activities, fence installation activities, and installation of crushed aggregate in accordance with the Administrative Settlement Agreement and Order of Consent (CERCLA Docket No. 02-2006-2013). The soil removal included excavation, removal and off-site disposal of lead contaminated surface soil from the Matteo

and Willow Woods properties utilizing the NJDEP residential cleanup standard of 400 parts per million (ppm) (Berner Construction 2006a). The fence installation included placing a chain-link fence along the southern property line, along the northern property boundary at the alternative entrance on Crown Point Road, and improvements to the existing fence at the scrap metal processing areas to restrict unauthorized access to the site. In addition, four inches of recycled crushed aggregate and/or recycled asphalt product were placed over the entire unpaved area of the active scrapyard.

Site Description

The Matteo Study Area is located at 1708 U.S. Highway 130 (Crown Point Road) in Thorofare, West Deptford Township, Gloucester County, New Jersey. The study area consists of the Matteo property, nearby properties (Willow Woods, Billy O Tire and others) and portions of Hessian Run and Woodbury Creek. The study area has been divided into several areas based on site physical features, historical information, and the locations of samples collected during the RI and previous investigations. These areas are described below.

- Matteo property (82.5 acres) –The Matteo property (which was once a farm) includes the contiguous upland areas and adjacent mudflats located between the confluence of Woodbury Creek, Hessian Run, and U.S. Highway 130. The property consists of three tax parcels as identified on the West Deptford Township Tax Map. The main portion of the Matteo property on Lot 2, Block 128 and Lot 2, Block 325 includes 80.2 acres of land and tidal mudflats. The third parcel (approximately 2.3 acres) at Lot 2.01, Block 128 is a rental home owned by Matteo. Additionally, two utility lines (Colonial Oil and Public Service Electric & Gas) are located on the northwestern portion of the property. The Matteo property has been subdivided into four general areas: the scrapyard area, the open field/waste disposal area, the rental home area and the tidal mudflats.
    - Scrapyard area – The scrapyard area (approximately 10 acres) is the southeastern portion of the Matteo property actively supporting the scrap metal recycling business, which remains active. The scrapyard area is largely paved or covered with crushed stone.
    - Open field/waste disposal area – The remaining upland portion (approximately 53 acres) of the western Matteo property is comprised primarily of heavily vegetated, undeveloped land. Within this area there are several distinct waste disposal areas that were delineated during previous NJDEP RI investigations.
    - Rental home area – This 2.3 acre property with a rental home owned by the Matteos is separated from the remainder of the Matteo property by a chain link fence and gate.
    - Tidal mudflats – The Matteo property also includes approximately 17.2 acres of tidal mudflats within Hessian Run that are below water at high tide.
- Willow Woods property (14.5 acres) – Willow Woods is a manufactured home community adjacent to the southwestern border of the Matteo property. The Willow Woods property is bounded by the Matteo property, U.S. Highway 130, and Woodbury Creek. The 14.5 acre parcel is on Lot 7, Block 325 in West Deptford Township.

- Other Nearby Properties – Monitoring wells or potable wells located on several nearby properties were sampled during this and previous investigations. This includes properties in West Deptford Township on Lots 7.02 and 8 on Block 325 (Billy O Tire property) and several properties on the eastern side of U.S Highway 130 (US 130); lots 2, 4.01, 13 and 14.01 on Block 130 also in West Deptford Township. The Billy O Tire property is an abandoned tire dealer adjacent to the southern border of the Matteo property, between the Matteo and Willow Woods properties. The properties east of US 130 consist of a variety of residential and commercial properties.

- Hessian Run – Hessian Run is a tributary of Woodbury Creek and eventually the Delaware River; this water body is north of the Matteo property with its furthest upstream reaches just east of U.S. Highway 130. Hessian Run is made up primarily of extensive tidal flats (mud flats) with small shallow channels (less than 2 to 3 feet below sea level) extending through the flats.

- Woodbury Creek – Woodbury Creek is a primary tributary of the Delaware River which is south of the Matteo property. The creek has deep narrow channels (up to 12 feet below sea level) and extensive tidal flats along its northern and southern shores.

Site Habitats and Presence of Threatened and Endangered Species

Undeveloped/inactive portions of the site are characterized by three habitats, upland forest intermixed with scrub/shrub, open field/meadow, and tidal wetlands. All at some point in time have undergone some type of disturbances related to previous/current site operations and historical agricultural use. Site terrestrial environments are essentially a small island of fragmented habitat bounded on all sides by the active portion of the site (scrapyard and offices), Willow Woods manufactured home community, Route 130, and Hessian Run/Woodbury Creek. In addition, a considerable portion of the site is surrounded by fencing.

Where intact, forest habitat consists of a mixed oak community. Trees sizes are variable, with older, larger specimens along site borders where presumably, disturbance activities have been minimal. Open field/meadow habitats consist mostly of grasses, forbs, and vegetative species indicative of disturbed areas. Undisturbed, viable habitat in all areas is scant and usage by wildlife is expected to be limited.

The United States Fish and Wildlife Service (USFWS) reported the historical occurrence of swamp pink (*Helonias bullata*) within West Deptford Township. Further review of swamp pink habitat requirements and those present on site indicate that suitable habitat is not present to support swamp pink.

The NJDEP Natural Heritage Program (NHP) reported that a review of their records for the area of the site indicated the occurrence of the great blue heron (*Ardea herodias*), a species of special concern. No other species or communities of concern were noted on or within ¼ miles of the site.

Assessment and Measurement Endpoints

A total of eleven assessment endpoints were identified and evaluated in the SLERA, as listed below.

- Assessment Endpoint 1: Survival, growth, and reproduction of terrestrial organisms

Measurement Endpoint: Evaluate the toxicity of chemicals in soil by comparing maximum-detected concentrations to soil-specific ecological screening levels (ESLs).

- Assessment Endpoint 2: Survival, growth, and reproduction of aquatic organisms

  Measurement Endpoint: Evaluate the toxicity of chemicals in sediment, surface water, sediment porewater, and seeps by comparing maximum-detected concentrations to sediment- and surface water-specific ESLs.

- Assessment Endpoint 3: Survival, growth, and reproduction of piscivorous birds

  Measurement Endpoint: Evaluate risk from dietary exposure to chemicals detected in sediment and surface water via food chain model using the selected receptor species, the bald eagle (*Haliaeetus leucocephalus*) and great blue heron (*Ardea herodias*). The estimated daily exposure doses are compared with literature-based dietary toxicity reference values (TRVs) that are associated with adverse effects in birds.

- Assessment Endpoint 4: Survival, growth, and reproduction of piscivorous mammals

  Measurement Endpoint: Evaluate risk from dietary exposure to chemicals detected in sediment and surface water via food chain model using the selected receptor species, the mink (*Mustela vison*). The estimated daily exposure doses are compared with literature-based dietary TRVs that are associated with adverse effects in mammals.

- Assessment Endpoint 5: Survival, growth, and reproduction of herbivorous mammals

  Measurement Endpoint: Evaluate risk from dietary exposure to chemicals detected in sediment and surface water via food chain model using the selected receptor species, the muskrat (*Ondatra zibethicus*). The estimated daily exposure doses are compared with literature-based dietary TRVs that have been associated with adverse effects in mammals.

- Assessment Endpoint 6: Survival, growth, and reproduction of omnivorous birds

  Measurement Endpoint: Evaluate risk from dietary exposure to chemicals detected in sediment and surface water via food chain model using the selected receptor species, the wood duck (*Aix sponsa*). The estimated daily exposure doses are compared with literature-based dietary TRVs that have been associated with adverse effects in birds.

- Assessment Endpoint 7: Survival, growth, and reproduction of omnivorous mammals

  Measurement Endpoint: Evaluate risk from dietary exposure to chemicals detected in sediment and surface water via food chain model using the selected receptor species, the raccoon (*Procyon lotor*). The estimated daily exposure doses are compared with literature-based dietary TRVs that have been associated with adverse effects in mammals.

- Assessment Endpoint 8: Survival, growth, and reproduction of insectivorous birds

  Measurement Endpoint: Evaluate risk from dietary exposure to chemicals detected in soil and surface water via food chain model using the selected receptor species, the American robin

(*Turdus migratorius*). The estimated daily exposure doses are compared with literature-based dietary TRVs that have been associated with adverse effects in birds.

- Assessment Endpoint 9: Survival, growth, and reproduction of invertivorous mammals

  Measurement Endpoint: Evaluate risk from dietary exposure to chemicals detected in soil and surface water via food chain model using the selected receptor species, the short-tailed shrew (*Blarina brevicauda*). The estimated daily exposure doses are compared with literature-based dietary TRVs that have been associated with adverse effects in mammals.

- Assessment Endpoint 10: Survival, growth, and reproduction of carnivorous birds

  Measurement Endpoint: Evaluate risk from dietary exposure to chemicals detected in soil and surface water via food chain model using the selected receptor species, the red-tailed hawk (*Buteo jamaicensis*). The estimated daily exposure doses are compared with literature-based dietary TRVs that have been associated with adverse effects in birds.
- Assessment Endpoint 11: Survival, growth, and reproduction of carnivorous mammals

  Measurement Endpoint: Evaluate risk from dietary exposure to chemicals detected in soil and surface water via food chain model using the selected receptor species, the red fox (*Vulpes vulpes*). The estimated daily exposure doses are compared with literature-based dietary TRVs that have been associated with adverse effects in mammals.

Data Used in the Screening Level Ecological Risk Assessment

The SLERA evaluated exposure to chemicals through direct contact and dietary exposure with site media. All data used in the SLERA was collected in support of the RI. For this SLERA, a single maximum value for each medium type evaluated was selected as exposure point concentrations. Media evaluated consist of site sediment, surface water, soil, sediment porewater, and seep water.

Summary of SLERA Results

Risks were evaluated through a comparison of maximum concentrations of chemicals in site media to their respective ESLs, and through food chain exposure models.

Risk via Direct Exposure

Assessment endpoints 1 and 2 were addressed through a comparison of site media chemistry results to ESLs. Assessment endpoint 1 focuses on receptors in the terrestrial environments of the site, while assessment endpoint 2 evaluates risks to receptors in the aquatic environment.

For assessment endpoint 1, *Survival, growth, and reproduction of terrestrial organisms*, risk to ecological receptors may occur from exposure to the following chemicals:

- SVOCs: benzo(a)anthracene
- Pesticides: 4,4'-DDE, 4,4'-DDT, dieldrin, and endrin
- PCB Aroclors: Aroclor 1248, 1254, and 1260
- Dioxins/Furans: dioxins/furans (based on total TEQs)

- Inorganics: antimony, cadmium, chromium, copper, lead, manganese, mercury, nickel, vanadium, and zinc

For assessment endpoint 2, *Survival, growth, and reproduction of aquatic organisms*, risks noted for each media evaluated follow:

Sediment
Risks to ecological receptors may occur from exposure the following chemicals:

- PCB Aroclors: Aroclors 1248, 1254, and 1268
- PCB Congeners: dioxin-like congeners (PCB 77, 105, 118, 126, 156, 167, and 169) and the total sum of all detected congeners
- Dioxins/Furans: dioxins/furans (based on total TEQs)
- Inorganics: antimony, arsenic, barium, cadmium, chromium, copper, cyanide, iron, lead, manganese, mercury, nickel, selenium, silver, and zinc

Surface Water
Risks to ecological receptors may occur from exposure the following chemicals:

- SVOCs: benzo(a)anthracene, benzo(a)pyrene, and bis(2-ethylhexyl)phthalate
- Pesticides: 4,4'-DDD and gamma-chlordane
- Inorganics (total): aluminum, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, silver, vanadium, and zinc
- Inorganics (dissolved): iron and manganese

Sediment Porewater
Risks to ecological receptors may occur from exposure to the following chemicals:

- Pesticides: 4,4'-DDE
- PCB Aroclors: Aroclor 1254
- Inorganics (total): aluminum, barium, beryllium, cadmium, chromium, cobalt, copper, cyanide, iron, lead, manganese, nickel, vanadium, and zinc
- Inorganics (dissolved): aluminum, barium, cadmium, chromium, iron, lead, manganese, vanadium, and zinc

Seep Water
Risks to ecological receptors may occur from exposure the following chemicals:

- PCB Aroclors: Aroclor 1254

- Inorganics (total): aluminum, barium, beryllium, cadmium, chromium, cobalt, copper, cyanide, iron, lead, manganese, nickel, vanadium, and zinc
- Inorganics (dissolved): aluminum, cadmium, copper, iron, lead, manganese, nickel, and zinc

Risk via Dietary Exposure

Assessment endpoints 3 through 11 were addressed through food chain exposure models using ten receptors representative of avian and mammalian communities assumed to utilize the site. Results of the models are as follows:

Assessment endpoint 3, Survival, growth, and reproduction of piscivorous birds, was addressed through a food chain exposure model using the bald eagle and great blue heron.

Results of both models indicate risk from exposure to lead. Results of the models also indicate the potential for risk from exposure to zinc; the potential for risk from exposure to selenium was also noted in the great blue heron model.

Assessment endpoint 4, Survival, growth, and reproduction of piscivorous mammals, was addressed through a food chain exposure model using the mink. Results of the model indicate risk from exposure to arsenic, lead, selenium, and total PCB congeners. Results of the model also indicate the potential for risk from exposure to copper, zinc, Aroclor 1248, total PCB congeners, and dioxins/furans (based on total TEQs).

Assessment endpoint 5, Survival, growth, and reproduction of herbivorous mammals, was addressed through a food chain exposure model using the muskrat. Results of the model indicate risk from exposure to arsenic and lead.

Assessment endpoint 6, Survival, growth, and reproduction of omnivorous birds, was addressed through a food chain exposure model using the wood duck. Results of the model indicate risk from exposure to lead. Results of the model also indicate the potential for risk from exposure to zinc.

Assessment endpoint 7, Survival, growth, and reproduction of omnivorous mammals, was addressed through a food chain exposure model using the raccoon. Results of the model indicate the potential for risk from exposure to arsenic and lead.

Assessment endpoint 8, Survival, growth, and reproduction of insectivorous, was addressed through a food chain exposure model using the American robin. Results of the model indicate risk from exposure to copper, lead, zinc, 4,4'-DDE, 4,4'-DDT, gamma-chlordane, dieldrin, endrin, and Aroclors 1248, 1254 and 1260. Results of the model also indicate the potential for risk from exposure to cadmium, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene chrysene, delta-BHC, and dioxins/furans.

Assessment endpoint 9, Survival, growth, and reproduction of invertivorous mammals, was addressed through a food chain exposure model using the short-tailed shrew. Results of the model indicate risk from exposure to lead, zinc, gamma-chlordane, endrin, Aroclors 1248 and 1260, and dioxins/furans. Results of the model also indicate the potential for risk from exposure to arsenic, cadmium, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dieldrin, and Aroclor 1254.

Assessment endpoint 10, Survival, growth, and reproduction of carnivorous birds, was addressed through a food chain exposure model using the red-tailed hawk. Results of the model indicate risk from exposure to lead and 4,4'-DDT. Results of the model also indicate the potential for risk from exposure to zinc, 4,4'-DDE and Aroclors 1248 and 1260.

Assessment endpoint 11, Survival, growth, and reproduction of carnivorous mammals, was addressed through a food chain exposure model using the red fox. Results of the model indicate risk from exposure to lead and Aroclor 1248. Results of the model also indicate the potential for risk from exposure to arsenic, dieldrin, Aroclor 1254, Aroclor 1260, and dioxins/furans.

Conclusions

Results of this SLERA have determined that chemicals detected in all site media are at levels that may cause adverse effects to ecological receptors.

For those receptors in direct exposure with site soil, risk drivers primarily include metals, such as but not limited to cadmium, copper, lead, mercury, and zinc, dioxins/furans, and to a lesser extent based on frequency of detection, pesticides, and Aroclors.

Risk drivers for receptors in direct exposure with site sediment consist of metals, such as but not limited to arsenic, cadmium, copper, lead and zinc, Aroclors, dioxin-like PCB congeners, and dioxins/furans.

For those receptors in direct exposure with site surface water, sediment porewater, and seep water, risk drivers primarily consist of metals. Risks from exposure to pesticides and Aroclor 1254 were also noted.

Risks from dietary exposure to chemicals in sediment to upper trophic level consumers such as birds and mammals were noted with lead as the primary risk driver. Of the six modeled receptors, only the raccoon, representative of omnivorous mammals, showed the potential for risk from exposure to lead in sediment.

Results of the models also indicated risk from exposure to arsenic, selenium, and total PCB congeners in sediment to piscivorous mammals; arsenic also posed a risk to herbivorous mammals.

Risks to terrestrial receptors via dietary exposure of chemicals in soil were also noted. Similar to sediment, lead was the primary risk driver as all four of the models indicated risk from exposure to lead. Based on the food chain exposure models, insectivorous birds and mammals are the most prone to risk from chemicals in soil when compared to carnivorous birds and mammals. This is primarily due to higher soil ingestion rates, a result of feeding habitats, and consumption of soil invertebrates. When combined, risk drivers to insectivorous birds and mammals in soil are copper, lead, zinc, 4,4'-DDE, 4,4'-DDT, gamma-chlordane, dieldrin, endrin, Aroclors, and dioxins/furans; however, between each taxa, birds are at risk from more chemicals than mammals.

Based on the red-tailed hawk and red fox food chain models, risk to carnivorous birds and mammals were noted from dietary exposure to lead, 4,4'-DDT, and Aroclor 1248. Aroclor 1248 was only detected in 1 out of 25 soil samples.

In conclusion, this SLERA has determined that chemicals present in site media may pose a risk to ecological receptors utilizing the site. Risk drivers consist of several chemicals; however, lead appears to be the most prominent risk driver in all site media from both direct exposure and dietary exposure.

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Section 1

Introduction

CDM Federal Programs Corporation (CDM Smith) received Work Assignment Number 032-RICO-02KD under the Remedial Action Contract (RAC) 2 program to provide technical services to complete a Remedial Investigation/Feasibility Study (RI/FS) for the Matteo & Sons, Inc. site (the site) for the United States Environmental Protection Agency (EPA), Region 2. The site is located in Thorofare, West Deptford Township, Gloucester County, New Jersey (Figure 1-1).

The overall purpose of the work assignment is to evaluate the nature and extent of contamination at the site and to develop and evaluate remedial alternatives, as appropriate. This Screening Level Ecological Risk Assessment (SLERA), as part of the RI/FS, provides a preliminary evaluation of ecological risks from contaminants to environments present within the study area.

1.1 Objectives

The objective of this SLERA is to evaluate the potential for risk at the site. Conservative assumptions are used to identify exposure pathways and, where possible, quantify potential ecological risks. This report is prepared in accordance with the following documents:

- Ecological Risk Assessment Guidance for Superfund (ERAGS): Process for Designing and Conducting Ecological Risk Assessments, Interim Final (EPA 1997)
- Guidelines for Ecological Risk Assessment (EPA 1998)

The SLERA consists of Steps 1 and 2 of a recommended eight step process for conducting ecological risk assessments at Superfund sites (EPA 1997). Step 1 of the Ecological Risk Assessment Guidance (ERAGS), includes a screening level problem formulation and ecological effects evaluation. Descriptions are developed of:

- Environmental setting
- Contaminants known or suspected to exist at the site and the maximum concentrations present in each medium
- Contaminant fate and transport mechanisms that might exist
- Categories of receptors that may be affected
- Potentially complete exposure pathways

In Step 2 of the ERAGS, the screening level preliminary exposure estimate and risk calculations, risk is estimated by comparing maximum documented exposure concentrations with the ecotoxicity screening values or dietary toxicity reference values (TRVs) identified in Step 1. The process concludes with a scientific management decision point (SMDP), which determines that:

- Ecological threats are negligible.
- Ecological risk assessment should continue to determine whether a risk exists.
- There is a potential for adverse ecological effects, and a baseline ecological risk assessment incorporating more site-specific information, is needed.

Per EPA's ERAGS (1997), a SMDP will be made by risk managers.

1.2 Report Organization

This SLERA is composed of eight sections and two appendices including:

Section 1 Introduction – provides an overview of the objectives and organization of the report.

Section 2 Problem Formulation – presents the environmental setting, conceptual site model (CSM), assessment and measurement endpoints, risk questions, and an overview of data evaluated in the SLERA.

Section 3 Exposure Assessment – presents the pathways and media through which receptors may be exposed to site contaminants.

Section 4 Effects Assessment – presents the literature based- and chemical-specific ecological screening levels (ESLs) for detected chemicals.

Section 5 Risk Characterization – presents the process for selecting chemicals of potential concern (COPCs), and integrates information from the exposure and effects assessments.

Section 6 Uncertainty Assessment – discusses the uncertainties associated with the assumptions used in this SLERA.

Section 7 Summary and Conclusions – summarizes the significant findings of the SLERA and makes conclusions based on the results.

Section 8 References – provides a list of references cited.

Tables and figures are presented at the end of the text. In addition, Appendix A presents letters received from the EPA and the New Jersey Department of Environmental Protection (NJDEP) regarding federal and state-listed threatened and endangered species at or in the vicinity of the site. A copy of an ecological risk assessment (ERA) previously performed for the EPA/Environmental Response Team (ERT) is provided in Appendix B. Dry weight to wet weight conversions for chemicals evaluated in food chain exposure models are presented in Appendix C; food chain models are provided in Appendix D.

Section 2

Problem Formulation

The problem formulation contains a description of the environmental setting, CSM, assessment and measurement endpoints, risk questions, and an overview of data evaluated.

2.1 Environmental Setting

This subsection describes the site location and description, site history, site geology and hydrogeology, ecological habitat and biota, and threatened and endangered species that may occur at or in the vicinity of the site.

2.1.1 Site Location and Description

The Matteo Study Area is located at 1708 U.S. Highway 130 (Crown Point Road) in Thorofare, West Deptford Township, Gloucester County, New Jersey (Figure 1-1). The study area consists of the Matteo property, nearby properties (Willow Woods, Billy O Tire and others) and portions of Hessian Run and Woodbury Creek. The study area has been divided into several areas based on site physical features, historical information, and the locations of samples collected during the RI and previous investigations. These areas are described below:

- Matteo property (82.5 acres) –The Matteo property (which was once a farm) includes the contiguous upland areas and adjacent mudflats located between the confluence of Woodbury Creek, Hessian Run, and U.S. Highway 130. The property consists of three tax parcels as identified on the West Deptford Township Tax Map. The main portion of the Matteo property on Lot 2, Block 128 and Lot 2, Block 325 includes 80.2 acres of land and tidal mudflats. The third parcel (approximately 2.3 acres) at Lot 2.01, Block 128 is a rental home owned by Matteo. Additionally, two utility lines (Colonial Oil and Public Service Electric & Gas) are located on the northwestern portion of the property. The Matteo property has been subdivided into four general areas: the scrapyard area, the open field/waste disposal area, the rental home area and the tidal mudflats.
    - Scrapyard area – The scrapyard area (approximately 10 acres) is the southeastern portion of the Matteo property actively supporting the scrap metal recycling business, which remains active. The scrapyard area is largely paved or covered with crushed stone.
    - Open field/waste disposal area – The remaining upland portion (approximately 53 acres) of the western Matteo property is comprised primarily of heavily vegetated, undeveloped land. Within this area there are several distinct waste disposal areas that were delineated during previous NJDEP RI investigations.
    - Rental home area – This 2.3 acre property with a rental home owned by the Matteos is separated from the remainder of the Matteo property by a chain link fence and gate.
    - Tidal mudflats – The Matteo property also includes approximately 17.2 acres of tidal mudflats within Hessian Run that are below water at high tide.

- Willow Woods property (14.5 acres) – Willow Woods is a manufactured home community adjacent to the southwestern border of the Matteo property. The Willow Woods property is bounded by the Matteo property, U.S. Highway 130, and Woodbury Creek. The 14.5 acre parcel is on Lot 7, Block 325 in West Deptford Township.

- Other Nearby Properties – Monitoring wells or potable wells located on several nearby properties were sampled during this and previous investigations. This includes properties in West Deptford Township on Lots 7.02 and 8 on Block 325 (Billy O Tire property) and several properties on the eastern side of U.S Highway 130 (US 130); lots 2, 4.01, 13 and 14.01 on Block 130 also in West Deptford Township. The Billy O Tire property is an abandoned tire dealer adjacent to the southern border of the Matteo property, between the Matteo and Willow Woods properties. The properties east of US 130 consist of a variety of residential and commercial properties.

- Hessian Run – Hessian Run is a tributary of Woodbury Creek and eventually the Delaware River; this water body is north of the Matteo property with its furthest upstream reaches just east of U.S. Highway 130. Hessian Run is made up primarily of extensive tidal flats (mud flats) with small shallow channels (less than 2 to 3 feet below sea level) extending through the flats.

- Woodbury Creek – Woodbury Creek is a primary tributary of the Delaware River which is south of the Matteo property. The creek has deep narrow channels (up to 12 feet below sea level) and extensive tidal flats along its northern and southern shores.

2.1.2 Site History

According to public records, between 1907 and 1947, the Matteo property was owned by Samuel and Bertha Wilkins, who used a portion of the property for farming activities, while the remainder of the property was covered by woodlands. The Matteo family acquired the property in 1947. In 1968, NJDEP identified an inactive incinerator at the property. In 1971, NJDEP approved Matteo's request to operate the incinerator to burn copper wire and Matteo submitted a plan to operate a "sweating fire box" to melt lead battery terminals for lead reclamation. This lead melting operation continued until 1985. In 1972, NJDEP observed landfilling of crushed battery casings in an area of wetlands adjacent to Hessian Run. This operation was apparently performed in conjunction with the lead melting operation, as there were several reports of battery casing incineration and subsequent onsite ash disposal. In addition to the incineration and landfilling operations, drums of waste were found scattered throughout the property.

Subsequently, several investigations lead by the responsible party under oversight of NJDEP and EPA were conducted at the Matteo property and the adjacent manufactured home community, Willow Woods. Included in these investigations was a 2003 aquatic biota study conducted by NJDEP. Data presented in the aquatic biota report was used in a desktop ERA conducted by EPA/ERT (Section 2.6).

Between May and July 2006, James Matteo and Sons, Inc. conducted soil removal activities, fence installation activities, and installation of crushed aggregate in accordance with the Administrative Settlement Agreement and Order of Consent (CERCLA Docket No. 02-2006-2013). The soil removal included excavation, removal and off-site disposal of surface lead contaminated soil from the Matteo and Willow Woods properties utilizing the NJDEP residential cleanup standard of 400 parts per million

(ppm) (Berner Construction 2006a). The fence installation included placing a chain-link fence along the southern property line, along the northern property boundary at the alternative entrance on Crown Point Road, and improvements to the existing fence at the scrap metal processing areas to restrict unauthorized access to the property In addition, four inches of recycled crushed aggregate and/or recycled asphalt product were placed over the entire unpaved area of the active portion of the scrapyard (Berner Construction 2006b).

2.1.3 Site Geology and Hydrogeology

This section provides a brief summary of the lithologic and hydrogeologic characteristics of the Matteo Study Area. A more detailed description of site geology and hydrogeology can be found in the RI report (CDM Smith 2012).

2.1.3.1 Site Geology

The site is covered by a mantle of Quaternary age (Pleistocene) deposits of the Cape May formation (Stanford 2004). Some Quaternary-age (Holocene) alluvium may also be present adjacent to and within the creeks. The Cape May Formation typically consists of yellow or brown medium to coarse-grained quartzose sand with some gravel and trace yellow, brown, black or grey clay. The materials are usually poorly sorted, sand grains are subangular, and is approximately 15 to 20 feet thick at the eastern side of the Matteo property, and approximately 40 feet thick on the western side.

Beneath this mantle of Quaternary deposits, are the deposits of the Upper Cretaceous-aged Merchantville and Magothy Formations; the contact between the two runs through the Matteo property (Owens, et al 1995). The southern and eastern portions of the property are underlain by the Merchantville Formation.

On the eastern and southern portions of the Matteo property, the Merchantville Formation is approximately 20 feet thick and is generally observed as dark grayish green clays and silts. The Merchantville thins and pinches out in the western portion of the property.

The Potomac-Raritan-Magothy (PRM) Formations underlie the Merchantville/Cape May Formations, and are generally observed as light gray sand with clay and silt lenses. On the western portion of the Matteo property where the Merchantville pinches out, the Cape May Formation and the PRM are in direct hydraulic contact.

2.1.3.2 Site Hydrogeology

There are two flow systems present at the site, a shallow perched flow system and a deep regional flow system.

The shallow perched flow system is observed in the Cape May Formation, which is a minor aquifer in Gloucester County. Changes in elevation in the shallow groundwater between low tide and high tide are minimal, generally less than 0.1 foot indicating no significant tidal influence. The extent of this perched water zone mirrors the extent of the Merchantville formation.

The regional aquifer in the area consists primarily of the Upper Cretaceous Magothy and Raritan Formations of the PRM aquifer. The PRM aquifer system is described as a single hydrologic unit because over large areas the formations are indistinguishable and interconnected. The upper aquifer of the PRM system is reported to be at least 100 feet thick in the Matteo Study Area. On the eastern

portion of the Matteo property the regional potentiometric surface is separated from the shallow perched groundwater system by the Merchantville formation.

In the eastern portion of the scrapyard and along the northern slope of the Matteo property, the perched groundwater flows north to Hessian Run. The remainder of the perched groundwater flows northwest towards the center of the open field/ waste disposal area where the Merchantville formation is not present and a direct connection between the sands of the Cape May Formation (shallow zone) and the sands of the Magothy Formation (the deep zone) is observed. Consistent with regional observations, data indicate the deeper groundwater flows to the southeast, similar to the regional flow.

2.1.4 Site Habitats

Undeveloped/inactive portions of the site are characterized by three habitats, upland forest intermixed with scrub/shrub, open field/meadow, and tidal wetlands. All at some point in time have undergone some type of disturbances related to previous/current site operations and historical agricultural use (Section 2.1.2). Site terrestrial environments are essentially a small island of fragmented habitat bounded on all sides by the active portion of the site (scrapyard and offices), Willow Woods manufactured home community, Route 130, and Hessian Run/Woodbury Creek. In addition, a considerable portion of the site is surrounded by fencing (Section 2.1.2).

Where intact, forest habitat consists of a mixed oak community. Trees sizes are variable, with older, larger specimens along site borders where presumably, disturbance activities have been minimal. Open field/meadow habitats consist mostly of grasses, forbs, and vegetative species indicative of disturbed areas (Lockheed-Martin 2005). Undisturbed, viable habitat in all areas is scant and usage by wildlife is expected to be limited.

2.1.5 Threatened, Endangered Species/Sensitive Environments

Information regarding threatened and endangered species and ecologically sensitive environments that may exist at or in the vicinity of the Matteo property was requested from the USFWS through EPA, and NJDEP. Correspondence received from both agencies is presented in Appendix A.

2.1.5.1 Federally-Listed Species

The USFWS reported the historical occurrence of swamp pink (*Helonias bullata*) within West Deptford Township. Further review of swamp pink habitat requirements and those present on site indicate that suitable habitat is not present to support swamp pink.

2.1.5.2 State-Listed Species

The NJDEP Natural Heritage Program (NHP) reported that a review of their records for the area of the site indicated the occurrence of the great blue heron (*Ardea herodias*), a species of special concern. No other species or communities of concern were noted on or within ¼ miles of the site.

2.2 Conceptual Site Model

The CSM depicts the fate and transport of chemicals from source(s) to exposure media (surface water, sediment, soil, food, etc) and illustrates the exposure routes for ecological receptors. Development of the CSM includes identification of the sources of contamination, and potential exposure pathways (Figure 2-1).

2.2.1 Sources of Contamination

For this SLERA, sources of contamination consist of chemicals present in soil and battery casing material, the result of spills/releases and disposal practices associated with past site operations. Contamination originating from these sources may have, or continues to migrate to surrounding areas via overland flow during rain events, erosion, weathering, and to a lesser extent wind dispersion.

2.2.2 Exposure Pathways

An exposure pathway is the means by which chemicals are transported from a source to ecological receptors. The CSM developed for the site (Figure 2-1) depicts the conceptual flow diagram of chemicals to ecological receptors. Contaminants present in site media may migrate via the following pathways.

- Adsorption to surface soil particles and transport by wind as fugitive dust
- Adsorption to soil particles and transported by erosion, overland sheet flow and surface water
- Exchange between surface water and sediment
- Biological removal (i.e., direct uptake from environmental media, bioaccumulation through ingestion of prey or media, and biomagnification through the food chain)

Chemicals with strong affinities for soils may be transported as sediment load in surface runoff and surface water flow, or on wind-derived fugitive particulates. Non-volatile chemicals with a lesser affinity for soils may also be transported via wind erosion. The predominant direction of storm water runoff and sheet flow at the site varies, but overland flow from the scrapyard and the open field is primarily north-northeast into Hessian Run.

Ecological receptors may be exposed to contaminants in soil via direct and/or secondary exposure pathways. Direct exposure pathways include soil ingestion, dermal absorption, and inhalation of contaminants adsorbed to fugitive dust. With the exception of soil invertebrates, exposure via dermal contact is expected to be limited. Mammals and birds are less susceptible to exposure via dermal contact with soils because their fur and feathers prevents skin from coming into direct contact with soil. However, soil ingestion may occur while grooming, preening, burrowing, or consuming plants, or invertebrates present in soil.

Exposure via inhalation of fugitive dust is limited to contaminants present in surface soils at those areas devoid of vegetation. The inherent moisture content of the soil also plays an important role in the amount of fugitive dust generated at a particular site. For these reasons, intake of contaminants via inhalation is expected to be minimal relative to other pathways.

Chemicals present in the sediment may result from erosion or weathering of battery casing material. Exposure via direct contact may occur, especially for benthic organisms and foraging birds and mammals. It is expected that most ecological receptors utilizing the site inadvertently ingest sediment during foraging.

Ecological receptors may be exposed to chemicals in surface water via direct contact and ingestion. While chemicals in soils may leach into groundwater, ecological receptors generally will not come into

direct contact with chemicals in groundwater since there is no direct exposure route. However, in areas of groundwater discharge to surface water, it is likely that ecological receptors would come into contact with contaminants present in groundwater.

Secondary exposure pathways involve chemicals that are transferred through different trophic levels of the food chain and may be bioaccumulated. This may include chemicals bioaccumulated from sediment/soil into plant tissues or organisms ingesting soil/sediment. These plants or animals may, in turn, be consumed by animals at higher trophic levels. Chemicals found in sediment and soil may bioaccumulate in food or prey items and then be passed up the food chain to impact organisms at higher trophic levels.

Potential primary exposure pathways for aquatic receptors include ingestion of and direct contact with sediment. Potential secondary exposure pathways for aquatic receptors are limited to incidental ingestion of sediment and ingestion of chemicals which have bioaccumulated into food or prey items.

Potential primary exposure pathways for terrestrial receptors at the site include the ingestion of and direct contact with soil. Potential secondary exposure pathways for terrestrial receptors are limited to incidental ingestion of soils and ingestion of contaminants which have bioaccumulated into food or prey items.

2.3 Assessment Endpoints

Assessment endpoints are explicit expressions of an environmental resource that is considered of value, operationally defined by an ecological entity and its attributes (EPA 1997). In SLERAs, assessment endpoints are usually considered to be any adverse effects from site contaminants to any ecological receptors at the site. It is not practical or possible to directly evaluate risks to all the individual components of the ecosystem on site, so assessment endpoints are used to focus on particular components that could be adversely affected by the chemicals associated with the site.

A review of the CSM provided information for the selection of assessment endpoints. Within the study area, terrestrial and aquatic ecosystems are present and have been potentially contaminated due to past operation and disposal practices (Section 2.1.2). Within each ecosystem are a number of biotic communities and habitats which inhabit or forage within these areas. Therefore, the assessment endpoints focused on these groups.

Assessment endpoints evaluated in this SLERA include:

- Assessment Endpoint 1: Survival, growth, and reproduction of terrestrial organisms
- Assessment Endpoint 2: Survival, growth, and reproduction of aquatic organisms
- Assessment Endpoint 3: Survival, growth, and reproduction of piscivorous birds
- Assessment Endpoint 4: Survival, growth, and reproduction of piscivorous mammals
- Assessment Endpoint 5: Survival, growth, and reproduction of herbivorous mammals
- Assessment Endpoint 6: Survival, growth, and reproduction of omnivorous birds

- Assessment Endpoint 7: Survival, growth, and reproduction of omnivorous mammals
- Assessment Endpoint 8: Survival, growth, and reproduction of insectivorous birds
- Assessment Endpoint 9: Survival, growth, and reproduction of insectivorous mammals
- Assessment Endpoint 10: Survival, growth, and reproduction of carnivorous birds
- Assessment Endpoint 11: Survival, growth, and reproduction of carnivorous mammals

2.4 Risk Questions

Risk questions summarize important components of the problem formulation phase of the SLERA and are based on the assessment endpoints. Risk questions are directly related to the testable hypotheses that can be accepted or rejected using the results of the SLERA. Selected risk questions to be answered in this SLERA include:

- May ecological receptors be exposed to chemicals present in site soil, sediment, surface water, sediment porewater, and seep water?
- Where present, are concentrations of chemicals in soil sufficient to cause adverse effects on the survival and/or growth of terrestrial organisms?
- Where present, are concentrations of chemicals in sediment sufficient to cause adverse effects on the survival and/or growth of aquatic organisms?
- Where present, are concentrations of chemicals in surface water sufficient to cause adverse effects on the survival and/or growth of aquatic organisms?
- Where present, are concentrations of chemicals in sediment porewater sufficient to cause adverse effects on the survival and/or growth of aquatic organisms?
- Where present, are concentrations of chemicals in seep water sufficient to cause adverse effects on the survival and/or growth of aquatic organisms?
- Are dietary exposure levels of chemicals sufficient to cause adverse effects on the growth, survival, and/or reproductive success of piscivorous bird communities utilizing the site?
- Are dietary exposure levels of chemicals sufficient to cause adverse effects on the growth, survival, and/or reproductive success of piscivorous mammal communities utilizing the site?
- Are dietary exposure levels of chemicals sufficient to cause adverse effects on the growth, survival, and/or reproductive success of herbivorous mammal communities utilizing the site?
- Are dietary exposure levels of chemicals sufficient to cause adverse effects on the growth, survival, and/or reproductive success of omnivorous bird communities utilizing the site?
- Are dietary exposure levels of chemicals sufficient to cause adverse effects on the growth, survival, and/or reproductive success of omnivorous mammal communities utilizing the site?

- Are dietary exposure levels of chemicals sufficient to cause adverse effects on the growth, survival, and/or reproductive success of insectivorous bird communities utilizing the site?
- Are dietary exposure levels of chemicals sufficient to cause adverse effects on the growth, survival, and/or reproductive success of insectivorous mammal communities utilizing the site?
- Are dietary exposure levels of chemicals sufficient to cause adverse effects on the growth, survival, and/or reproductive success of carnivorous bird communities utilizing the site?
- Are dietary exposure levels of chemicals sufficient to cause adverse effects on the growth, survival, and/or reproductive success of carnivorous mammal communities utilizing the site?

2.5 Measurement Endpoints

Measurement endpoints are chosen to link the existing site conditions to the goals established by the assessment endpoints and are useful for assessment endpoint evaluation. Measurement endpoints are quantitative expressions of observed or measured biological responses to contamination relevant to selected assessment endpoints. For a SLERA, ESLs are commonly used as measurement endpoints. For this SLERA, measurement endpoints are based on conservative ESLs from sources discussed in Section 4.1.

In addition, detected bioaccumulative chemicals are evaluated through use of food chain exposure models. These models are used to address assessment endpoints regarding the viability of higher trophic level receptors. Chemicals considered to be bioaccumulative are featured in Table 4-2 of *Bioaccumulative Testing and Interpretation for the Purpose of Sediment Quality Assessment, Status and Needs, EPA-823-R-00-001, February 2000*.

For this SLERA, the following assessment endpoints and measurement endpoints, presented below, were selected to evaluate whether site-related chemicals pose a risk to ecological receptors.

- Assessment Endpoint 1: Survival, growth, and reproduction of terrestrial organisms

  Measurement Endpoint: Evaluate the toxicity of chemicals in soil by comparing maximum-detected concentrations to soil-specific ESLs.

- Assessment Endpoint 2: Survival, growth, and reproduction of aquatic organisms

  Measurement Endpoint: Evaluate the toxicity of chemicals in sediment, surface water, sediment porewater, and seeps by comparing maximum-detected concentrations to sediment- and surface water-specific ESLs.

- Assessment Endpoint 3: Survival, growth, and reproduction of piscivorous birds

  Measurement Endpoint: Evaluate risk from dietary exposure to chemicals detected in sediment and surface water via food chain model using the selected receptor species, the bald eagle (*Haliaeetus leucocephalus*) and great blue heron (*Ardea herodias*). The estimated daily exposure doses are compared with literature-based dietary TRVs that are associated with adverse effects in birds.

- Assessment Endpoint 4: Survival, growth, and reproduction of piscivorous mammals

  Measurement Endpoint: Evaluate risk from dietary exposure to chemicals detected in sediment and surface water via food chain model using the selected receptor species, the mink (Mustela vison). The estimated daily exposure doses are compared with literature-based dietary TRVs that are associated with adverse effects in mammals.

- Assessment Endpoint 5: Survival, growth, and reproduction of herbivorous mammals

  Measurement Endpoint: Evaluate risk from dietary exposure to chemicals detected in sediment and surface water via food chain model using the selected receptor species, the muskrat (*Ondatra zibethicus*). The estimated daily exposure doses are compared with literature-based dietary TRVs that have been associated with adverse effects in mammals.

- Assessment Endpoint 6: Survival, growth, and reproduction of omnivorous birds

  Measurement Endpoint: Evaluate risk from dietary exposure to chemicals detected in sediment and surface water via food chain model using the selected receptor species, the wood duck (Aix sponsa). The estimated daily exposure doses are compared with literature-based dietary TRVs that have been associated with adverse effects in birds.

- Assessment Endpoint 7: Survival, growth, and reproduction of omnivorous mammals

  Measurement Endpoint: Evaluate risk from dietary exposure to chemicals detected in sediment and surface water via food chain model using the selected receptor species, the raccoon (*Procyon lotor*). The estimated daily exposure doses are compared with literature-based dietary TRVs that have been associated with adverse effects in mammals.

- Assessment Endpoint 8: Survival, growth, and reproduction of insectivorous birds

  Measurement Endpoint: Evaluate risk from dietary exposure to chemicals detected in soil and surface water via food chain model using the selected receptor species, the American robin (*Turdus migratorius*). The estimated daily exposure doses are compared with literature-based dietary TRVs that have been associated with adverse effects in birds.

- Assessment Endpoint 9: Survival, growth, and reproduction of insectivorous mammals

  Measurement Endpoint: Evaluate risk from dietary exposure to chemicals detected in soil and surface water via food chain model using the selected receptor species, the short-tailed shrew (*Blarina brevicauda*). The estimated daily exposure doses are compared with literature-based dietary TRVs that have been associated with adverse effects in mammals.

- Assessment Endpoint 10: Survival, growth, and reproduction of carnivorous birds

  Measurement Endpoint: Evaluate risk from dietary exposure to chemicals detected in soil and surface water via food chain model using the selected receptor species, the red-tailed hawk (*Buteo jamaicensis*). The estimated daily exposure doses are compared with literature-based dietary TRVs that have been associated with adverse effects in birds.

- Assessment Endpoint 11: Survival, growth, and reproduction of carnivorous mammals

  Measurement Endpoint: Evaluate risk from dietary exposure to chemicals detected in soil and surface water via food chain model using the selected receptor species, the red fox (*Vulpes vulpes*). The estimated daily exposure doses are compared with literature-based dietary TRVs that have been associated with adverse effects in mammals.

2.6 Previous Ecological Risk Assessment

The Louis Berger Group, Inc. (LBG), on behalf of the NJDEP, conducted an investigation in support of a RI which focused primarily on aquatic portions of the site; however, select upland areas of the site were also investigated (LBG 2004). Site-media consisting of sediment, surface water, soil, fish, mollusk, earthworms, and vegetation were collected and submitted for lead and PCB Aroclor analysis. Select sediment samples were also submitted for toxicity tests using the amphipod, *Hyalella azteca*, and the midge, *Chironomus tentans*. In addition, a survey of benthic macroinvertebrate and fish communities within Hessian Run and Woodbury Creek was also conducted. Subsequently, Lockheed-Martin, under contract to the EPA/ERT conducted a desk-top ERA for the site using the data collected during the LBG investigation (Lockheed-Martin 2005) (Appendix B).

In the ERA, a total of nine assessment endpoints were identified and evaluated as follows:

Assessment Endpoint No.1: Viable Tidal Flat Community Structure and Function. This was evaluated through a comparison of sediment and surface water chemistry results to ESLs, through sediment toxicity tests using the amphipod, *H. azteca*, and midge *C. tentans*, and an evaluation of benthic communities present on site.

Assessment Endpoint No. 2: Tidal Flat Nursery and Refuge Functioning. This was evaluated using the results of a fish community survey.

Assessment Endpoint No. 3: Viability and Function of the Piscivorous Bird Community. This was evaluated via food chain exposure models using the great blue heron and bald eagle which included the results of the chemical analysis of sediment, surface water, and fish tissue.

Assessment Endpoint No. 4: Viability and Function of the Piscivorous Mammal Community. This was evaluated via food chain exposure models using the mink which included the results of the chemical analysis of sediment, surface water, and fish tissue.

Assessment Endpoint No. 5: Viability and Function of the Omnivorous Bird Community. This was evaluated via food chain exposure models using the wood duck which included the results of the chemical analysis of sediment, surface water, clam, and plant tissue.

Assessment Endpoint No. 6: Viability and Function of the Omnivorous Mammal Community. This was evaluated via food chain exposure models using the raccoon which included the results of the chemical analysis of sediment, surface water, clam, and plant tissue.

Assessment Endpoint No. 7: Viability and Function of the Insectivorous Bird Community. This was evaluated via food chain exposure models using the American robin which included the results of the chemical analysis of soil, surface water, and earthworm tissue.

Assessment Endpoint No. 8: Viability and Function of the Insectivorous Mammal Community. This was evaluated via food chain exposure models using the short-tailed shrew which included the results of the chemical analysis of soil, surface water, and earthworm tissue.

Assessment Endpoint No. 9: Viability and Function of the Herbivorous Mammal Community. This was evaluated via food chain exposure models using the muskrat which included the results of the chemical analysis of sediment, surface water, and plant tissue.

Results of the ERA indicated that concentrations of lead in sediment and surface water were found in exceedance of its respective ESLs. Where detected, PCBs in sediment were at levels below severe-effects levels (SELs); however, most stations were found in exceedance of lowest-effects levels (LELs). Mortality observed in sediment toxicity assays for both test species did not correlate with concentrations of lead and PCBs. Benthic community diversity was lower at some locations adjacent to the site when compared to reference areas, and consisted of pollution tolerant species. Fish diversity was also slightly lower at some site locations when compared to reference areas.

Risks to insectivorous birds, insectivorous mammals, omnivorous birds, omnivorous mammals, and herbivorous mammals from exposure to lead were noted based on the American robin, short-tailed shrew, wood duck, raccoon, and muskrat models, respectively.

Risks to insectivorous mammals, herbivorous mammals, omnivorous mammals, and piscivorous mammals from exposure to PCBs were noted based on the short-tailed shrew, muskrat, raccoon, and mink models, respectively.

Risks from exposure to lead and PCBs to piscivorous mammals and birds were unable to be concluded based on the mink, blue heron and bald eagle models, respectively. Risks to omnivorous and insectivorous birds could not be concluded based on the wood duck and American robin models.

Results of the ERA concluded that a link between site contaminants and adverse effects to terrestrial and aquatic receptors/communities was noted, and that wildlife which utilize areas of highest site-related contamination for foraging were at risk (Lockheed-Martin 2005).

2.7 Data Used in the Screening Level Ecological Risk Assessment

This SLERA evaluates exposure to chemicals through direct and dietary exposure with site media. All data used in the SLERA were collected in support of the RI and consisted of sediment, soil, surface water, sediment porewater (porewater), and seep samples. Analytical results are presented in Appendices K through O of the RI report. For the evaluation of chemicals present in site media, a single maximum concentration of each chemical detected was evaluated. The number of samples evaluated by each medium along with a brief summary of analytical results is provided below. In addition, several data qualifiers were assigned to the data. These qualifiers are listed, when applicable, in the sections below. Definitions of data qualifiers can be found in the footnotes of Tables 2-1 through 2-5.

For this SLERA, EPA performed soil, sediment, surface water, sediment porewater, and seep water sampling from October 2011 to January 2012. Because organic data from soil samples were

determined to be of unknown quality, these results are not reported or used in this report. CDM Smith conducted additional soil sampling from the same locations from December 2014 to March 2015. These 2015 soil samples were analyzed for Target Compound List (TCL) volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, and PCB Aroclors.

2.7.1 Soil

Samples were analyzed for TCL VOCs, SVOCs, pesticides, PCBs Aroclors, dioxins/furans, and Target Analyte List (TAL) inorganics including mercury and cyanide. Minimum and maximum concentrations of contaminants detected, their frequency of detection, and location of the maximum detected values are presented in Table 2-1. Soil sample locations evaluated in this SLERA are provided on Figure 2-2.

VOCs: A total of seven samples analyzed for VOCs are evaluated in this SLERA. Three compounds, 1,1-dichloroethene, tetrachloroethene, and trichloroethene, were detected in one sample from location SB-111, at concentrations of 2.8J micrograms per kilogram (µg/kg), 27 J+ µg/kg, and 7 J+ µg/kg, respectively. No other VOCs were detected. The qualifier "J" indicates that the concentration of a chemical is estimated and "J+" indicates that the concentration of a chemical is estimated biased high.

SVOCs: A total of seven samples analyzed for SVOCs are evaluated in this SLERA. Twenty-seven SVOCs were detected. The most commonly detected SVOCs were the polycyclic aromatic hydrocarbons (PAHs). Benzo(a)anthracene, benzo(b)fluoranthene, chrysene, fluoranthene, and pyrene, which were detected in six out of seven samples. The maximum concentrations of these five compounds were 1,300 J+ µg/kg, 1,000 µg/kg, 980 J+ µg/kg, 210 µg/kg, and 540 J+ µg/kg, respectively.

Pesticides: A total of eight samples analyzed for pesticides are evaluated in this SLERA. Nine pesticides were detected as follows: 4,4'-DDT was detected in three samples, 4,4'-DDE, dieldrin, and heptachlor epoxide were detected in two samples, and beta-BHC, delta-BHC, endrin, gamma-chlordane, and heptachlor were detected in one sample. The maximum concentration of any pesticide detected was 4,4'-DDT at 250 J µg/kg.

PCB Aroclors: A total of 25 samples analyzed for PCB Aroclors are evaluated in this SLERA. Three Aroclors, 1248, 1254, and 1260, were detected at maximum concentrations of 3,400 J µg/kg, 1,200 J µg/kg, and 3,000 µg/kg, respectively. Aroclor 1248 was only detected in 1 out of 25 samples. No other PCB Aroclors were detected.

Dioxins/Furans: A total of seven samples analyzed for dioxins/furans are evaluated in this SLERA following the toxicity equivalents (TEQ) approach (Section 5.1). Total maximum TEQs of detected compounds was 54.1 nanograms per kilogram (ng/kg).

Inorganics: A total of 19 samples analyzed for TAL inorganics and cyanide are evaluated in this SLERA. All metals included in the full TAL suite were detected. Cyanide was only detected in one sample. Aluminum, arsenic, chromium, cobalt, copper, iron, lead, manganese, nickel, vanadium, and zinc were detected in every sample at maximum concentrations of 11,900 milligrams per kilogram (mg/kg), 8 J mg/kg, 39.9 J mg/kg, 4.4 mg/kg, 292 J mg/kg, 85,300 J mg/kg,10,100 J mg/kg, 427 J mg/kg,64.4 mg/kg, 146 mg/kg, and 13,400 mg/kg, respectively. With the exception of vanadium, maximum concentrations for the above metals were detected at either sample location SB-109 or SB-110. Both of these locations are situated next to each other and are down gradient of the scrapyard area.

2.7.2 Sediment

Samples were analyzed for PCB Aroclors, PCB congeners, dioxins/furans, and TAL inorganics including mercury and cyanide. Minimum and maximum concentrations of contaminants detected, their frequency of detection, and location of the maximum detected values are presented in Table 2-2. Sediment sample locations evaluated in this SLERA are provided on Figure 2-3.

PCB Aroclors: A total of 46 samples analyzed for PCB Aroclors are evaluated in this SLERA. Three Aroclors, 1248, 1254, and 1260 were detected in 13, 42, and 22 samples at maximum concentrations of 340 µg/kg, 670 J µg/kg, and 150 J µg/kg, respectively. No other PCB Aroclors were detected.

PCB Congeners: A total of four samples analyzed for PCB congeners are evaluated in this SLERA using the sum of maximum concentrations of individual compounds detected, and the maximum concentrations of dioxin-like compounds (Section 5.1). The sum of maximum concentrations for each detected congener was 2,372,089 picograms per gram (pg/g). Ten out of 12 dioxin-like congeners were detected and consisted of PCB 77, 105, 114, 118, 123, 126, 156, 167, 169, and 189. With the exception of PCBs 126 and 169, all were detected in every sample.

Dioxins/Furans: A total of four samples analyzed for dioxins/furans are evaluated in this SLERA following the TEQ approach (Section 5.1). Total maximum TEQ of detected compounds was 8 ng/kg.

Inorganics: A total of 60 samples analyzed for TAL inorganics and cyanide are evaluated in this SLERA. All metals included in the full TAL suite along with cyanide were detected. In general, mostly all metals included in the TAL suite occurred in over 83 percent of the samples. Aluminum, arsenic, chromium, copper, iron, lead, manganese, selenium, and zinc were detected in every sample at maximum concentrations of 22,800 J mg/kg, 42 J mg/kg, 229 J mg/kg, 158 mg/kg, 44,100 mg/kg, 6,430 J- mg/kg, 1,080 J+ mg/kg, 8.1 J mg/kg, and 900 J mg/kg, respectively. The qualifier “J-“ indicates that the concentrations of a chemical is estimated biased low. The majority of maximum metal concentrations were taken from samples collected from the T-14 and T-30 transects situated north of the site.

2.7.3 Surface Water

Samples were analyzed for TCL VOCs and SVOCs, pesticides, PCB Aroclors and TAL inorganics including mercury and cyanide. Samples were analyzed as both total and dissolved fractions for TAL inorganic analysis excluding cyanide in dissolved samples. Minimum and maximum concentrations of contaminants detected, their frequency of detection, and location of the maximum detected values are presented in Table 2-3. Surface water sample locations evaluated in this SLERA are provided on Figure 2-3.

VOCs: A total of 27 samples were analyzed for VOCs. No VOCs were detected in any sample.

SVOCs: A total of 27 samples analyzed for SVOCs are evaluated in this SLERA. Eight SVOCs were detected. The most commonly detected SVOC was bis(2-ethylhexyl)phthalate, which was detected in six samples. Remaining SVOCs detected consisted of the PAHs: benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, and indeno(1,2,3-cd)pyrene, and pentachlorophenol at maximum concentrations of 0.18 J micrograms per liter (µg/L), 0.32 J µg/L, 0.38 J µg/L, 0.15 J µg/L, 0.32 J µg/L, 0.15 J µg/L, and 3.8 J µg/L, respectively.

Pesticides: A total of 27 samples analyzed for pesticides are evaluated in this SLERA. Two pesticides, 4,4'-DDD and gamma-chlordane, were each detected in separate samples at concentrations of 0.055 J µg/L, and 0.027 J µg/L, respectively. No other pesticides were detected.

PCB Aroclors: A total of 27 samples were analyzed for PCB Aroclors. No PCB Aroclors were detected in any sample.

Inorganics: A total of 27 samples analyzed for TAL inorganics are evaluated in this SLERA. For total inorganics analysis, all metals included in the full TAL suite along with cyanide were detected. In general, mostly all metals included in the TAL suite occurred in over 40 percent of the samples with maximum concentrations of all analytes, except sodium, being detected in one sample, T1-SW-01. Barium, calcium, copper, lead, magnesium, manganese, sodium and zinc were detected in every sample at maximum concentrations of 1,380 µg/L, 40,300 µg/L, 150 µg/L, 654 µg/L, 17,900 µg/L, 1,270 µg/L, 21,900 µg/L, and 2,210 µg/L, respectively.

For dissolved metals analysis, fewer metals were detected. Barium, calcium, magnesium, manganese, potassium, sodium, and zinc were detected in every sample at maximum concentrations of 57.9 µg/L, 20,200 µg/L, 8,600 µg/L, 271 µg/L, 2,970 µg/L, 19,600 µg/L, and 23.3 J µg/L, respectively. Similar, to the total metals results, sample location T1-SW-01 had the most maximum concentrations of metal detected than any other sample.

2.7.4 Sediment Porewater

Samples were analyzed for TCL VOCs, SVOCs, pesticides, PCB Aroclors and TAL inorganics including mercury and cyanide. Samples were analyzed as both total and dissolved fractions for TAL inorganic analysis excluding cyanide in dissolved samples. Minimum and maximum concentrations of contaminants detected, their frequency of detection, and location of the maximum detected values are presented in Table 2-4.Sediment porewater sample locations evaluated in this SLERA are provided on Figure 2-4.

VOCs: A total of ten samples analyzed for VOCs are evaluated in this SLERA. Carbon disulfide was detected in one sample at an estimated concentration of 0.1 J µg/L. No other VOCs were detected in any sample.

SVOCs: A total of ten samples analyzed for SVOCs are evaluated in this SLERA. Four SVOCs, 4-methylphenol, acenaphthene, caprolactam, and phenol were detected in one sample. No other SVOCs were detected in any sample.

Pesticides: A total of ten samples analyzed for pesticides are evaluated in this SLERA. 4,4'-DDE was detected in one sample at an estimated concentration of 0.028 J µg/L. No other pesticides were detected in any sample.

PCB Aroclors: A total of ten samples analyzed for PCB Aroclors are evaluated in this SLERA. Aroclor 1254 was detected in two samples at concentrations of 0.39 µg/L and 1.1 µg/L. No other PCB Aroclors were detected in any sample.

Inorganics: A total of ten samples analyzed for TAL inorganics are evaluated in this SLERA. For total inorganics analysis, all metals included in the full TAL suite along with cyanide were detected with the

exception of silver and antimony. All analytes, except for cyanide, mercury, selenium, and thallium were detected in every sample. In general, sample location SGS-05 had the highest concentrations of metals detected.

For dissolved metals analysis, fewer metals were detected. In general, location SGS-06 had the highest concentrations of metals detected.

2.7.5 Seep Water

Samples were analyzed for TCL VOCs, SVOCs, pesticides, PCB Aroclors and TAL inorganics including mercury and cyanide. Samples were analyzed as both total and dissolved fractions for TAL inorganic analysis excluding cyanide in dissolved samples. Minimum and maximum concentrations of contaminants detected, their frequency of detection, and location of the maximum detected values are presented in Table 2-5. Seep sample locations evaluated in this SLERA are provided on Figure 2-4.

VOCs: A total of nine samples analyzed for VOCs are evaluated in this SLERA. Methyl tert-butyl ether was detected in one sample at a concentration of 0.98 µg/L. No other VOCs were detected in any sample.

SVOCs: A total of nine samples were analyzed for SVOCs. No SVOCs were detected in any sample.

Pesticides: A total of nine samples were analyzed for pesticides. No pesticides were detected in any sample.

PCB Aroclors: A total of nine samples analyzed for PCB Aroclors are evaluated in this SLERA. Aroclor 1254 was detected in six samples at concentrations ranging from 0.088 J µg/L to 0.62 J µg/L. No other PCB Aroclors were detected in any sample.

Inorganics: A total of nine samples analyzed for TAL inorganics are evaluated in this SLERA. For total inorganics analysis, all metals included in the full TAL suite along with cyanide were detected with the exception of silver. All analytes, except for antimony, beryllium, cadmium, cyanide, selenium, thallium, and vanadium were detected in every sample. In general, sample location SEEP-08 had the highest concentrations of metals detected.

For dissolved metals analysis, fewer metals were detected. In general, location SEEP-07 had the highest concentrations of metals detected.

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Section 3

Exposure Assessment

The objective of the exposure assessment is to determine the pathways and media through which ecological receptors may be exposed to site chemicals. Exposure scenarios are simplified descriptions of how potential receptors may come in contact with contaminants. Potential exposure pathways are dependent on habitats and receptors present on-site, the extent and magnitude of contamination, and environmental fate and transport of contaminants.

3.1 Potentially Affected Receptors/Exposure Scenarios

Areas evaluated in this SLERA consist of aquatic and terrestrial habitats present onsite and within Woodbury Creek and Hessian Run. The contamination of these habitats has been determined through previous investigations and review of the data collected in support of the RI. Based on habitats present, a number of organisms may inhabit or forage in these area and can potentially be exposed to contaminants present.

The aquatic habitats in the study area consist of Woodbury Creek and Hessian Run. Benthic and infaunal organisms inhabit the sediment and directly absorb contaminants through dermal contact with sediment particles and interstitial water, as well as through ingestion of contaminated food items and incidental ingestion of sediment. Direct contact with the whole sediment burden incorporates the contaminant fraction adsorbed to the solid phase as well as contaminants dissolved in the liquid interstitial phase.

The soil macroinvertebrate community is in constant association with soil and is therefore potentially exposed to contaminants through direct contact with the soil and soil interstitial water. Additional exposure may result from the ingestion of contaminated food items. Macroinvertebrates may also be indirectly affected by a reduction in ecosystem functions, such as nutrient cycling and energy transfer that are critical to growth and reproduction.

Terrestrial and wetland plant communities may potentially be exposed to contaminants through direct contact with soil, soil porewater, and surface water. Vegetation may also be indirectly affected by a reduction in ecosystem functions, such as nutrient cycling and energy transfer, which are critical to growth and reproduction. The presence of contaminated vegetation not only places plants at risk, but also affects organisms that utilize vegetation for food and habitat.

Mammals may also utilize the areas for food. Such mammals may feed on a variety of food items such as plants, fish, small mammals, or soil macroinvertebrates. Therefore, these mammals may potentially be exposed to contaminants through ingestion of contaminated food items. They may also be exposed through incidental ingestion of contaminated soil or sediment, direct contact with contaminated sediment or soil, or inhalation of contaminated dust.

Other organisms that are known to inhabit the study area include a variety of birds that live in surrounding areas. These birds may feed on a variety of food items such as fish, small mammals, or soil invertebrates. Therefore, these birds may potentially be exposed to contaminants through

ingestion of contaminated food items. They may also be exposed through incidental ingestion of contaminated soil or sediment, direct contact with contaminated sediment or soil, or inhalation of contaminated dust.

Potential complete exposure pathways include direct contact with contaminated media, ingestion of contaminated food items, incidental ingestion of soil or sediment, ingestion of surface water, dermal contact and inhalation. It should be noted that the dermal contact and inhalation pathways of exposure are difficult to evaluate because exposure through these routes is difficult to quantify. In addition, little information is available in the literature on contaminant effects to wildlife species through these pathways. However, these exposure pathways are either indirectly incorporated or are believed to be small when compared to the significance of the ingestion exposure pathways for contaminants which bioaccumulate or biomagnify.

Assessment and measurement endpoints were identified and focused on specific groups of organisms representative of communities potentially utilizing aquatic and terrestrial habitats found on site (Sections 2.3 and 2.5). For the purpose of this SLERA, maximum concentrations of contaminants detected in soil, sediment, surface water, sediment porewater, and seeps serve as exposure point concentrations and are evaluated via direct exposure (assessment endpoints 1 and 2), and where applicable via food chain exposure models (assessment endpoints 3 through 11).

3.2 Food Chain Exposure Models

Food chain modeling is reserved, and most appropriate for evaluating contaminants with the potential to bioaccumulate and adversely affect upper trophic level receptors (i.e., dose-based effects). Receptor species representative of organisms which are likely to be exposed to contaminants because of specific behaviors, patterns of habitat use, or feeding habits were selected for evaluation in this SLERA. The availability of appropriate exposure and toxicity information on which risk calculations were based was also an important consideration. Representative receptor species selected for this SLERA include the bald eagle, great blue heron, mink, muskrat, wood duck, raccoon, American robin, short-tailed shrew, red-tailed hawk, and red fox.

Exposure profiles for model receptor species are presented below. For each receptor, a conservative exposure profile was identified. Conservative exposure parameters include the lowest reported regional (when available) adult body weight, and highest sediment/soil and water ingestion rates. Home range, feeding territory and breeding territory size have been reported in the literature for the model species. However, for this SLERA, a site foraging factor (SFF) of 1.0 was utilized, as the conservative assumption was made that the receptor species spends all of its time, and acquires all of its food, from the site. Exposure profile input parameters are presented in Table 3-1.

3.2.1 Exposure Profile for Bald Eagle

Conservative exposure pathways are the highest ingestion rates or lowest body weight values located in the literature. Adult bald eagles weigh from 3.524 kilograms (kg) to 5.756 kg (EPA 1993). The lowest value of 3.524 kg (EPA 1993) was used as a conservative estimate of body weight.

Bald eagles are primarily carrion feeders eating dead or dying fish, but may also catch live fish if available. In general, they are opportunistic and will feed on whatever food source is plentiful or easy to scavenge and may include birds and mammals (EPA 1993). For this SLERA, the diet of the bald eagle

is assumed to consist only of fish. A food ingestion rate for the bald eagle was not located in the literature. A food ingestion rate was derived following the equation developed by Nagy (1987): food ingestion (kg/day) = 0.0582 x (body weight)$^{0.651}$. Using a body weight of 3.524 kg, a conservative food ingestion rate of 0.132 kg/day was calculated. The allometric equation developed by Calder and Braun (1983) was used to estimate a water ingestion rate for the bald eagle. Using the conservative body weight (BW) of 3.524 kg, a conservative water ingestion rate (WIR) of 0.137 L/day was calculated as follows: WIR = 0.059 * BW$^{0.67}$. This equation was used to estimate a WIR for all birds for which a species-specific WIR was unavailable. A sediment ingestion rate for the bald eagle, or other appropriate surrogate species was not located in the literature as based on raptor feeding habits ingestion of soil/sediment is expected to be negligible (Sample and Suter 1994). However, because prey species may contain sediment in their gastro-intestinal tracts, a sediment ingestion rate of 1% is assumed for this SLERA. To calculate a conservative estimate of soil ingestion in unit of kg/day, the sediment ingestion rate was multiplied by food ingestion rate, yielding a value of 0.0013 kg/day.

3.2.2 Exposure Profile for the Great Blue Heron

Conservative exposure pathways are the highest ingestion rates or lowest body weight values located in the literature. Adult great blue herons weigh from 2.204 kg to 2.576 kg (EPA 1993). The lowest regional value of 2.229 kg was used as a conservative estimate of body weight.

Fish are the preferred prey of the great blue heron; however, being opportunistic they will consume whatever food items are available, including amphibians, reptiles, crustaceans, insects, birds, and mammals (EPA 1993). For this SLERA, the diet of the great blue heron was assumed to consist entirely of fish. A food ingestion rate of 0.18 grams/gram (g/g) body weight (bw)/day was found for adult great blue herons (EPA 1993). Using the above body weight a conservative food ingestion rate of 0.401 kg/day was calculated. The allometric equation developed by Calder and Braun (1983) was used to estimate a water ingestion rate for the great blue heron. Using the conservative body weight of 2.229 kg, a conservative water ingestion rate of 0.101 L/day was calculated. An incidental sediment ingestion rate could not be identified for the great blue heron. For the purposes of this SLERA, a soil ingestion rate (substituting for sediment) of 3.3 percent as reported for the mallards (Beyer et al. 1994) was used. To evaluate this pathway the food ingestion rate of 0.401 kg/day was multiplied by the percent soil ingested by the mallard to yield a sediment ingestion rate of 0.0132 kg/day.

3.2.3 Exposure Profile for the Mink

Conservative exposure pathways are the highest ingestion rates or lowest body weight values located in the literature. Adult mink weigh from 0.550 kg to 1.734 kg (EPA 1993). The lowest regional value of 0.974 kg was used as a conservative estimate of body weight.

The diet of mink is governed by seasonal food availability (Barbour and Davis 1974) and may consist of crayfish, muskrats, frogs, fish, snakes, rodents, rabbits, and plants (Schwartz and Schwartz 1981; Jones and Birney 1988). For this SLERA, the diet of the mink was assumed to consist solely of fish. A food ingestion rate of 0.22 g/g bw/day was found for adult mink (EPA 1993). Using the above body weight a conservative food ingestion rate of 0.214 kg/day was calculated. The allometric equation developed by Calder and Braun (1983) was used to estimate a water ingestion rate for the mink. Using the conservative body weight of 0.974 kg, a conservative water ingestion rate of 0.097 L/day was calculated as follows: WIR = 0.099* BW$^{0.9}$. This equation is used to estimate a WIR for all mammals for

which a receptor-specific WIR was unavailable. Incidental sediment ingestion is expected to be negligible (Sample and Suter 1994); however, for the purpose of this SLERA a soil ingestion rate (substituting for sediment) of 9.4% as reported by Beyer et al. (1994) for the raccoon was used as it is assumed that both species exhibited similar foraging habits. To evaluate this pathway the food ingestion rate of 0.214 kg/day was multiplied by the percent soil ingested by the raccoon to yield a sediment ingestion rate of 0.02 kg/day.

3.2.4 Exposure Profile for the Muskrat

Conservative exposure pathways are the highest ingestion rates or lowest body weight values located in the literature. Adult muskrat weigh from 0.837 kg to 1.48 kg (EPA 1993). The lowest regional value of 1.35 kg (EPA 1993) was used as a conservative estimate of body weight.

In times of food scarcity muskrats may feed on animal matter, but are generally herbivorous (Davis and Schmidly 1994; Schwartz and Schwartz 1981). Food ingestion rates for the muskrat range from 0.26 to 0.34 g/g bw/day (EPA 1993). The highest value of 0.34 g/g bw/day was used as a conservative estimate of food ingestion. Using the above body weight a conservative food ingestion rate of 0.459 kg/day was calculated. The allometric equation developed by Calder and Braun (1983) was used to estimate a water ingestion rate for the muskrat. Using the conservative body weight of 1.35 kg, a conservative water ingestion rate of 0.130 L/day was calculated. A sediment ingestion rate for the muskrat was not located in the literature. As an alternate, a soil ingestion rate (substituting for sediment) of 9.4% (Beyer et al. 1994) for the raccoon was used, as foraging behavior is expected to be similar since it assumed both species forage primarily within the onsite tidal marsh. To calculate a conservative estimate of sediment ingestion in unit of kg/day, the soil ingestion rate was multiplied by food ingestion rate, yielding a value of 0.0431 kg/day.

3.2.5 Exposure Profile for the Wood Duck

Conservative exposure pathways are the highest ingestion rates or lowest body weight values located in the literature. Adult wood ducks weigh from 0.454 kg to 0.862 kg (Cornell University 2011). The lowest value of 0.454 kg was used as a conservative estimate of body weight.

The diet of the wood duck is variable, but plant matter makes up 80% or more of what this species consumes. Preferred diet consists of seeds, fruits, and insects (Cornell University 2011). For this SLERA, the diet of the wood duck was assumed to consist of 50% plants and 50% aquatic invertebrates (i.e., mollusks) as this species is representative of omnivorous birds. A food ingestion rate for the wood duck was not located in the literature. Using a body weight of 0.454 kg and the equation developed by Nagy (1987), a food ingestion rate of 0.035 kg/day was calculated. The allometric equation developed by Calder and Braun (1983) was used to estimate a water ingestion rate for the wood duck. Using the conservative body weight of 0.454 kg, a conservative water ingestion rate of 0.035 L/day was calculated. Beyer et al (1994) reported a soil ingestion rate by the wood duck to be 11% of the diet. To calculate a conservative rate of soil ingestion, this value was multiplied by the conservative food ingestion rate, yielding a value of 0.004 kg/day.

3.2.6 Exposure Profile for the Raccoon

Conservative exposure pathways are the highest ingestion rates or lowest body weight values located in the literature. Adult raccoon weigh from 5.1 kg to 8.8 kg (EPA 1993). The lowest value of 5.1 kg was used as a conservative estimate of body weight.

The diet of raccoon is governed by seasonal food availability; however, it consists primarily of fruits, nuts, and acorns, but may also include grains, insects, frogs, eggs, crayfish, and almost any animal or plant matter (EPA 1993). For this SLERA, the diet of the raccoon was assumed to consist of 50% plants and 50% aquatic invertebrates (i.e., mollusks) as this species is representative of omnivorous mammals. A food ingestion rate for the raccoon was not located in the literature. A food ingestion rate was derived following the equation developed by Nagy (1987): food ingestion (kg/day) = 0.0582 x (body weight)$^{0.651}$. Using a body weight of 5.1 kg, a conservative food ingestion rate of 0.168 kg/day was calculated. The allometric equation developed by Calder and Braun (1983) was used to estimate a water ingestion rate for the raccoon. Using the conservative body weight of 5.1 kg, a conservative water ingestion rate of 0.429 L/day was calculated. Beyer et al. (1994) reported a soil ingestion rate by the raccoon to be 9.4% of the diet. To calculate a conservative rate of soil ingestion, this value was multiplied by the conservative food ingestion rate, yielding a value of 0.0158 kg/day.

3.2.7 Exposure Profile for the American Robin

Conservative exposure pathways are the highest ingestion rates or lowest body weight values located in the literature. Adult American robins weigh from 0.055 to 0.103 kg (Eiserer 1976; Clench and Leberman 1978; Hazelton et al. 1984; Skorupa and Hothem 1985; Wheelwright 1986; Wheelwright 1988; Wauer 1999). The lowest regional value of 0.0635 kg (EPA 1993) was used as a conservative estimate of body weight.

The diet of the American robin primarily consists of fruit and invertebrates. Diet varies seasonally, and depends on habitat and time of day (Wheelwright 1988). The year-round diet is comprised of 37% invertebrates and 63% fruits (Martin et al. 1951; Eiserer 1976; Wheelwright 1988). For this SLERA, the diet of the American robin was assumed to consist only of invertebrates. Food ingestion rates for the American robin range from 0.89 to 1.96 g/g bw/day (EPA 1993). The highest value of 1.96 g/g bw/day was used as a conservative estimate of food ingestion. Using the above body weight a conservative food ingestion rate of 0.124 kg/day was calculated. The allometric equation developed by Calder and Braun (1983) was used to estimate a water ingestion rate for the American robin. Using the conservative body weight of 0.0635 kg, a conservative water ingestion rate of 0.0093 L/day was calculated. A soil ingestion rate for the American robin was not located in the literature. As an alternate, a value of 10.4% (Beyer et al. 1994) for the American woodcock was used as the diets of the woodcock and robin are similar. To calculate a conservative estimate of soil ingestion in units of kg/day, the soil ingestion rate was multiplied by food ingestion rate, yielding a value of 0.013 kg/day.

3.2.8 Exposure Profile for the Short-tailed Shrew

Conservative exposure pathways are the highest ingestion rates or lowest body weight values located in the literature. Adult short-tailed shrews weigh from 0.0125 kg to 0.0225 kg (EPA 1993). The lowest value of 0.0125 kg (EPA 1993) was used as a conservative estimate of body weight.

Short-tailed shrews prefer to eat animal matter; however, they are opportunistic omnivores and will consume whatever food items are available, including earthworms, slugs, snails, arthropods, fungi, roots, fruits, seeds, snakes, salamanders, small mammals, and young birds (Barbour and Davis 1974; Jones and Birney 1988; Schwartz and Schwartz 1981). For this SLERA the diet of the short-tailed shrew was assumed to consist only of invertebrates. A food ingestion rate of 0.62 g/g bw/day was found for adult short-tailed shrews (EPA 1993). Using the above body weight a conservative food ingestion rate of 0.00775 kg/day was calculated. A water ingestion rate of 0.223 g/g bw/day is reported for this species (EPA 1993). Using the above body weight a conservative water ingestion rate of 0.003 L/day was calculated. Connor (1993) reported soil ingestion by the short-tailed shrew to be 5.2% of the diet. To calculate a conservative rate of soil ingestion, this value was multiplied by the conservative food ingestion rate, yielding a value of 0.00040 kg/day.

3.2.9 Exposure Profile for the Red-tailed Hawk

Conservative exposure pathways are the highest ingestion rates or lowest body weight values located in the literature. Adult red-tailed hawks weigh from 0.957 kg to 1.235 kg (EPA 1993). The lowest regional value of 1.028 kg (EPA 1993) was used as a conservative estimate of body weight.

Red-tailed hawks are opportunistic and will feed on whatever prey species are most abundant. In general, small mammals such as mice, shrews, voles, and squirrels make up a considerable portion of the diet, but other prey such as birds, lizards, snakes and large insects may also be consumed (EPA 1993). For this SLERA, the diet of the red-tailed hawk is assumed to consist only of small mammals. Food ingestion rates for red-tailed hawks range from 0.086 to 0.11 g/g bw/day (EPA 1993). The highest value of 0.11 g/g bw/day was used as a conservative estimate of food ingestion. Using the above body weight a conservative food ingestion rate of 0.113 kg/day was calculated. The allometric equation developed by Calder and Braun (1983) was used to estimate a water ingestion rate for the red-tailed hawk. Using the conservative body weight of 1.028 kg, a conservative water ingestion rate of 0.060 L/day was calculated. The EPA (EPA 1999) reported soil ingestion by the red-tailed hawk to be 1% of the diet. To calculate a conservative rate of soil ingestion, this value was multiplied by the conservative food ingestion rate, yielding a value of 0.00113 kg/day.

3.2.10 Exposure Profile for the Red Fox

Conservative exposure pathways are the highest ingestion rates or lowest body weight values located in the literature. Adult red fox weigh from 3.27 kg to 7.04 kg (EPA 1993). The lowest value of 3.27 kg (EPA 1993) was used as a conservative estimate of body weight.

In general, red fox are primarily opportunistic carnivores, consuming a variety of food items such as small mammals, birds, eggs, carrion, invertebrates, snakes, and frogs (Barbour and Davis 1974; Merritt 1987). Some vegetable matter such as fruits and nuts are also consumed when in season (Jones and Birney 1988). For this SLERA, the diet of the red fox was assumed to consist only of small mammals. Food ingestion rates for the red fox range from 0.069 to 0.14 g/g bw/day (EPA 1993). The highest value of 0.14 g/g bw/day was used as a conservative estimate of food ingestion. Using the above body weight a conservative food ingestion rate of 0.458 kg/day was calculated. The allometric equation developed by Calder and Braun (1983) was used to estimate a water ingestion rate for the red fox. Using the conservative body weight of 3.27 kg, a conservative water ingestion rate of 0.278 L/day was calculated. Beyer et al. (1994) reported soil ingestion by the red fox to be 2.8% of the diet. To calculate

a conservative rate of soil ingestion, this value was multiplied by the conservative food ingestion rate, yielding a value of 0.013 kg/day.

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Section 4

Effects Assessment

The effects assessment evaluates the potential for site-related contaminants to cause adverse ecological effects, and establishes a relationship between exposure to a contaminant and the increased likelihood of adverse effects. It also presents the available types and sources of effects data which include media- and chemical-specific ESLs, and dose-based TRVs that serve as conservative effect concentrations.

4.1 Literature-Based Effects Data

This section of the SLERA describes the sources and types of effects data selected for use. For this SLERA, effects data are limited to ESLs and dose- based TRVs. This section describes and provides support for the sources and types of effects data (i.e., toxicity data) selected for use.

4.1.1 Ecological Screening Values

Medium-specific and chemical-specific ESLs were selected for this SLERA. These values were compared to concentrations of chemicals measured in site media to assess ecological risk. Screening values from the following references were applied in a hierarchical fashion to the maximum site specific chemical concentrations detected in soil, sediment, surface water, sediment porewater, and seep water as follows:

Soil

- EPA 2008a, 2007a through 2007i, 2006a, 2005a through 2005h, and 2003a and 2003b. Ecological Soil Screening Levels (Eco-SSLs); lowest available value used
- Oak Ridge National Laboratory, Preliminary Remediation Goals for Ecological Endpoints (Efroymson et al. 1997)
- EPA 2003c. Region 5 Resource Conservation and Recovery Act (RCRA) Ecological Screening Levels

Sediment

- NJDEP, Site Remediation Program. 2009. Ecological Screening Criteria
- EPA 2006b. Region 3 Biological Technical Assistance Group (BTAG) Sediment Screening Benchmarks
- Oregon Department of Environmental Quality (DEQ), Land Quality Division. 2007. Guidance for Assessing Bioaccumulative Chemicals of Concern in Sediment. April.

Surface Water, Sediment, Sediment Porewater, and Seeps

- NJDEP, Site Remediation Program. 2009. Ecological Screening Criteria
- EPA 2009b. National Recommended Water Quality Criteria

- EPA 2006b. Region 3 BTAG Surface Water Screening Benchmarks

In this SLERA, NJDEP values were examined first to determine if a screening value was available for a particular chemical. If a value was available, it was utilized. If not, values from secondary sources were used in the order they are listed above. The only exception was the dioxin/furan and PCB congener sediment data which was screened against the Oregon DEQ values. If a selected screening level was exceeded, or no screening level was located, contaminants were retained as COPCs.

4.1.2 Wildlife Toxicity Reference Values

For contaminants evaluated through food chain exposure models a literature search was conducted to locate TRVs. The values were selected to evaluate potential effects of estimated exposure doses received by select avian and mammalian modeled receptor species. The output of the food chain exposure model is a dose, expressed in milligrams of contaminant per kilogram of body weight per day (mg/kg bw/day) and is compared to a dose-based TRV. An attempt was made to select TRVs derived from test organisms which are closely related on a trophic level, and with respect to prey preferences to the model receptor.

For this SLERA, the lowest-observed-adverse-effect level (LOAEL) and no observed-adverse-effect level (NOAEL) were selected as the TRVs. The primary source for selected NOAEL and LOAEL-based TRVs is Toxicological Benchmarks for Wildlife: 1996 Revision (Sample et al. 1996); however, other sources were also utilized when needed. The TRVs used in the food chain exposure models for this SLERA are presented in Tables 4-1 and 4-2.

Section 5

Risk Characterization

The risk characterization integrates information from the exposure and effects assessments and estimates risk to representative ecological receptors. This SLERA relies on the hazard quotient (HQ) approach to evaluate risks.

5.1 Risk Characterizaton Methods

For this SLERA, the potential for risk is evaluated through a comparison of chemical concentrations in site media to their respective ESLs, and through food chain exposure models. Both means evaluate risks using the HQ approach as described in the following subsections.

Dioxin/furan, and when applicable, dioxin-like PCB congener data are evaluated utilizing the TEQ approach as specified in EPA document entitled *Framework for Application of the Toxicity Equivalence Methodology for Polychlorinated Dioxins, Furans, and Biphenyls in Ecological Risk Assessment* (EPA 2008b, https://www.epa.gov/sites/production/files/2013-09/documents/tefs-draft-052808-0804.pdf). Dioxins are generally found in mixtures containing several kinds of dioxins and dioxin-like compounds, each having its own degree of toxicity. The TEQ approach weighs the toxicity of less toxic compounds as fractions of the toxicity of the most toxic compound, 2,3,7,8-tetrachlorodibenzodioxin (TCDD). Each compound is assigned a specific toxicity equivalence factor (TEF). This factor indicates the degree of toxicity compared to 2,3,7,8-TCDD, which is given a reference value of 1.

The World Health Organization (WHO) has published TEFs for dioxin and dioxin-like compounds (WHO 2005). Included in this list are TEF values for 17 dioxin and furan compounds. To calculate the total 2,3,7,8-TCDD TEQ of a dioxin mixture used for comparison to ESLs, the concentrations of each dioxin and furan detected were multiplied by their highest respective TEFs and summed together (Table 5-1). The total maximum dioxin/furan TEF values are then used to evaluate risk through a comparison to ESLs as described below in Section 5.1.1.

For screening purposes, PCB congener sediment data are evaluated following two approaches. The first uses the sum of maximum concentrations of each individual congener detected and the total value is compared to an ESL for total PCBs. The second approach evaluates those congeners characterized as having dioxin-like effects by using the maximum concentrations of each compound detected and comparing it to their respective ESLs for dioxin-like compounds. Of the twelve dioxin-like congeners, only ten were detected and are presented on Table 2-2.

When evaluating dioxin/furans and PCB congeners sediment data in food chain models, maximum concentrations of each group of compounds (for which a TEF is assigned) are multiplied by their respective WHO TEFs for either birds or mammals. The resultant values are summed together and are evaluated as total 2,3,7,8-TCDD TEQs. Only PCB congeners characterized as having dioxin-like effects are included in the calculation of total TCDD TEQs. Those remaining PCB congeners lacking dioxin-like effects are summed together and are evaluated in the models as total PCB congeners. The same approach was used for evaluating dioxin/furan soil data in food chain models with the exception that

dioxin-like congener data were not included in the sum of TEQs as PCB congeners were not analyzed in soil samples.

5.1.1 Direct Exposure

Potential risks to ecological receptors are evaluated using the HQ approach. This process involves comparing the maximum chemical concentrations measured in site media to their respective ESLs. By nature these values are conservative, and in this way avoid the potential for underestimating risk. This method compares the maximum exposure concentration for a specific chemical to their screening benchmark counterpart and is expressed as a ratio per the following formula:

$$\textit{Hazard Quotient} = \frac{\textit{Maximum Detected Concentration of a Chemical}}{\textit{ESL}}$$

If resultant HQs are greater than unity (1.0), risk is implied. A HQ less than one suggests that there is a high degree of confidence that minimal risk exists, and therefore, are considered insignificant. Higher HQs are not necessarily indicative of more severe effects.

5.1.2 Dietary Exposure

Chemicals detected in sediment and soil that are considered bioaccumulative, regardless of frequency of detection, are evaluated through food chain exposure models. Contaminants were identified as bioaccumulative, as per Table 4-2 in *Bioaccumulative Testing and Interpretation for the Purpose of Sediment Quality Assessment, Status and Needs, EPA-823-R-00-001, February 2000* (EPA 2000).

For those contaminants evaluated through food chain exposure models the HQ method was also employed. Hazard quotient modeling involves calculating potential risks to target receptors based on life history characteristics of selected receptors, the exposure concentration of the chemicals, and literature-based toxicological effects associated with the modeled dose. The dose represents the intake rate of a contaminant. For this SLERA, the dose is a function of the daily food ingestion rate for the target receptor being modeled, the amount of contaminant present in soil or sediment and hypothetical prey (e.g., earthworms, fish), and the incidental ingestion of soil or sediment.

For each model receptor evaluated by CDM Smith, the dose was calculated using conservative life history and exposure parameters. These included the lowest reported regional (when available) adult body weight and highest ingestion rates. Home range, feeding territory and breeding territory sizes are reported in the literature for several species. However, for this SLERA, a SFF of 1.0 (100% utilization) was used which assumed that each modeled receptor spends all of its time, and acquires all of its food from the site.

Site-specific representative prey tissue data were not collected; therefore, use of bioaccumulation factors (BAFs) and sediment to biota bioaccumulation factors (BSAFs) were utilized to estimate concentrations of contaminants in prey species (e.g., fish and invertebrates) of select modeled receptors (Table 5-2). The BAFs and BSAFs were applied to the maximum soil and sediment concentrations to predict the tissue burden at a hypothetical concentration. The resultant BAF and BSAF-based values were then used in conjunction with the sediment or soil data to determine the total dose of which the receptor species will be exposed. Since TRVs are generally reported as wet

weight concentrations, sediment or soil concentrations were entered into the models as wet weights (Appendix C).

Dose was calculated as follows:

$$\text{Total dose} = \{\sum[(SIR \times Cs) + (FIR \times CF) + (WIR \times Cw)] \times SFF\}/BW$$

where:

SIR = sediment or soil ingestion rate
CS = maximum contaminant concentration in sediment or soil
FIR = food ingestion rate
CF = BSAF or BAF-based maximum contaminant concentration in prey item
WIR = water ingestion rate
Cw = maximum concentration in surface water
SFF = site foraging factor
BW = body weight

The resultant dose is then compared to the appropriate TRVs and is expressed as a ratio per the following formula:

$$\textit{Hazard Quotient} = \frac{\textit{Exposure Concentration (i.e., Total Dose)}}{\textit{NOAEL or LOAEL-based Dietary TRV}}$$

5.2 Identification of Chemicals of Potential Concern

Each of the following subsections presents risks based on direct contact and food chain exposure. Chemicals with maximum detected concentrations above their respective ESLs, or dosed-based TRVs are identified as COPCs. In general, benchmarks for calcium, magnesium, potassium, and sodium are lacking. However, these elements are not considered in the evaluation of risk because they are ubiquitous, occur naturally in high concentrations, are essential nutrients, and are unlikely to pose risk. In addition, tissue concentrations of these elements are regulated by living organisms; even at relatively high levels of exposure, internal concentrations generally do not become sufficiently high to cause toxic effects.

5.2.1 Direct Exposure

Chemicals with maximum detected values above their selected ESLs (i.e., HQ > 1.0) are identified as COPCs, as are detected chemicals for which screening-level benchmarks could not be identified. The HQs and identified COPCs, and the rationale for their selection, are presented below (Tables 2-1 through 2-5).

5.2.1.1 Soil

Chemicals with maximum concentrations above their respective ESLs (HQs >1.0):

- **SVOCs:** benzo(a)anthracene
- **Pesticides:** 4,4'-DDE, 4,4'-DDT, dieldrin, and endrin
- **PCB Aroclors:** Aroclors 1248, 1254, and 1260

- **Dioxins/Furans:** dioxins/furans (based on total TEQs)
- **Inorganics:** antimony, cadmium, chromium, copper, lead, manganese, mercury, nickel, vanadium, and zinc

Chemicals detected with no corresponding ESLs:

- **SVOCs:** 1,1'biphenyl, benzaldehyde, carbazole, and dibenzofuran
- **Inorganics:** aluminum and iron

5.2.1.2 Sediment

Chemicals with maximum concentrations above their respective ESLs (HQs >1.0):

- **PCB Aroclors:** Aroclors 1248, 1254, and 1268
- **PCB Congeners:** dioxin-like congeners (PCB 77, 105, , 118, 126, 156, 167, and 169) and total sum of all detected congeners
- **Dioxins/Furans:** dioxins/furans (based on total TEQs)
- **Inorganics:** antimony, arsenic, barium, cadmium, chromium, copper, cyanide, iron, lead, manganese, mercury, nickel, selenium, silver, and zinc

Chemicals detected with no corresponding ESLs:

- **Inorganics:** beryllium, thallium, and vanadium

5.2.1.3 Surface Water

Chemicals with maximum concentrations above their respective ESLs (HQs >1.0):

- **SVOCs:** benzo(a)anthracene, benzo(a)pyrene, and bis(2-ethylhexyl)phthalate
- **Pesticides:** 4,4'-DDD and gamma-chlordane
- **Inorganics (total):** aluminum, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, silver, vanadium, and zinc
- **Inorganics (dissolved):** iron and manganese

Chemicals detected with no corresponding ESLs:

- **SVOCs:** benzo(k)fluoranthene and chrysene

5.2.1.4 Sediment Porewater

Chemicals with maximum concentrations above their respective ESLs (HQs >1.0):

- **Pesticides:** 4,4'-DDE
- **PCB Aroclors:** Aroclor 1254

- **Inorganics (total):** aluminum, barium, beryllium, cadmium, chromium, cobalt, copper, cyanide, iron, lead, manganese, nickel, vanadium, and zinc
- **Inorganics (dissolved):** aluminum, barium, cadmium, chromium, iron, lead, manganese, vanadium, and zinc

Chemicals detected with no corresponding ESLs:

- **SVOCs:** caprolactam

5.2.1.5 Seep Water

Chemicals with maximum concentrations above their respective ESLs (HQs >1.0):

- **PCB Aroclors:** Aroclor 1254
- **Inorganics (total):** aluminum, barium, beryllium, cadmium, chromium, cobalt, copper, cyanide, iron, lead, manganese, nickel, vanadium, and zinc
- **Inorganics (dissolved):** aluminum, cadmium, copper, iron, lead, manganese, nickel, and zinc

5.2.2 Food Chain Exposure Model Risks

The following sections summarize the results of the food chain exposure models for each receptor. Ten species representing avian and mammalian communities are assumed to inhabit the site and accumulate chemical residues through ingestion of prey items and incidental ingestion of soil or sediment. NOAEL-based HQs below 1.0 suggest a lack of risk. LOAEL-based HQs greater than 1.0 suggest risk. When NOAEL-based HQs are greater than 1.0, but LOAEL-based HQs are not, this suggests the potential for risk. This potential increases as the dose approaches the LOAEL.

Food chain exposure models were run following the methods in Section 5.1.2 and are presented in Appendix D. Results are summarized in the following subsections and are presented in Tables 5-3 and 5-4.

5.2.2.1 Bald Eagle

A food chain exposure model using the bald eagle was conducted following the methodology discussed in Section 5.1.2. Results of the model indicate risk from exposure to lead as both the NOAEL and LOAEL-based HQ is greater than 1.0 (Table 5-3). In addition, the model indicates the potential for risk from exposure to zinc as the NOAEL-based HQ is greater than 1.0, but the LOAEL-based value is less than 1.0 (Table 5-3).

5.2.2.2 Great Blue Heron

A food chain exposure model using the great blue heron was conducted following the methodology discussed in Section 5.1.2. Results of the model indicate risk from exposure to lead as both the NOAEL and LOAEL-based HQ is greater than 1.0 (Table 5-3). In addition, the model indicates the potential for risk from exposure to selenium and zinc as NOAEL-based HQs are greater than 1.0, but the LOAEL-based values are less than 1.0 (Table 5-3).

5.2.2.3 Mink

A food chain exposure model using the mink was conducted following the methodology discussed in Section 5.1.2. Results of the model indicate risk from exposure to arsenic, lead, selenium, and total PCB congeners as both the NOAEL and LOAEL-based HQs are greater than 1.0 (Table 5-3). In addition, the model indicates the potential for risk from exposure to copper, zinc, Aroclor 1248, and dioxins/furans evaluated as total 2,3,7,8-TCDD TEQs as NOAEL-based HQs are greater than 1.0, but the LOAEL-based values are less than 1.0 (Table 5-3).

5.2.2.4 Muskrat

A food chain exposure model using the muskrat was conducted following the methodology discussed in Section 5.1.2. Results of the model indicate risk from exposure to arsenic and lead as both NOAEL and LOAEL-based HQs are greater than 1.0 (Table 5-3).

5.2.2.5 Wood Duck

A food chain exposure model using the wood duck was conducted following the methodology discussed in Section 5.1.2. Results of the model indicate risk from exposure to lead as both the NOAEL and LOAEL-based HQ is greater than 1.0 (Table 5-3). In addition, the model indicates the potential for risk from exposure to zinc as the NOAEL-based HQ is greater than 1.0, but the LOAEL-based value is less than 1.0 (Table 5-3).

5.2.2.6 Raccoon

A food chain exposure model using the raccoon was conducted following the methodology discussed in Section 5.1.2. Results of the model indicate the potential for risk from exposure to arsenic and lead as NOAEL-based HQs are greater than 1.0, but the LOAEL-based values are less than 1.0 (Table 5-3).

5.2.2.7 American Robin

A food chain exposure model using the American robin was conducted following the methodology discussed in Section 5.1.2. Results of the model indicate risk from exposure to copper, lead, zinc, 4,4'-DDE, 4,4'-DDT, gamma-chlordane, dieldrin, endrin, and Aroclors 1248, 1254, and 1260 as both NOAEL and LOAEL-based HQs are either equal to or greater than 1.0 (Table 5-4).

In addition, the model indicates the potential for risk from exposure to cadmium, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, delta-BHC, and dioxins/furans evaluated as total 2,3,7,8-TCDD TEQs as the NOAEL-based HQs are greater than 1.0, but the LOAEL-based values are less than 1.0 (Table 5-4).

5.2.2.8 Short-tailed Shrew

A food chain exposure model using the short-tailed shrew was conducted following the methodology discussed in Section 5.1.2. Results of the model indicate risk from exposure to lead, zinc, gamma-chlordane, endrin, Aroclors 1248 and 1260, and dioxins/furans evaluated as total 2,3,7,8-TCDD TEQs as both the NOAEL and LOAEL-based HQs are greater than 1.0 (Table 5-4).

In addition, the model indicates the potential for risk from exposure to arsenic, cadmium, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dieldrin, and Aroclor 1254 as the NOAEL-based HQs are greater than 1.0, but the LOAEL-based values are less than 1.0 (Table 5-4).

5.2.2.9 Red-tailed Hawk

A food chain exposure model using the red-tailed hawk was conducted following the methodology discussed in Section 5.1.2. Results of the model indicate risk from exposure to lead and 4,4'-DDT as both the NOAEL and LOAEL-based HQs are greater than 1.0 (Table 5-4). In addition, the model indicates the potential for risk from exposure to zinc, 4,4'-DDE and Aroclors 1248 and 1260 as the NOAEL-based HQs are greater than 1.0, but the LOAEL-based values are less than 1.0 (Table 5-4).

5.2.2.10 Red Fox

A food chain exposure model using the red fox was conducted following the methodology discussed in Section 5.1.2. Results of the model indicate risk from exposure to lead and Aroclor 1248 as the NOAEL and LOAEL based HQs are either equal to or greater than 1.0 (Table 5-4). In addition, the model indicates the potential for risk from exposure to arsenic, dieldrin, Aroclors 1254 and 1260, and dioxins/furans evaluated as total 2,3,7,8-TCDD TEQs as the NOAEL-based HQs are either equal to or greater than 1.0, but the LOAEL-based values are less than 1.0 (Table 5-4).

5.3 Risk Summary

This section of the SLERA discusses the potential ecological significance of the estimated risks and provides answers to risk questions identified in Section 2. Ecological significance considers the limitations and uncertainties (see Section 6) with the quantitative HQ risk estimates. An important first step to understand the results of this SLERA is to answer the risk questions initially presented in Section 2, Problem Formulation.

The following risk questions were identified as important to the SLERA. The results of the SLERA are used to respond to these questions and to help form conclusions. The risk questions and associated responses are presented below.

- *May ecological receptors be exposed to chemicals present in site soil, sediment, surface water, sediment porewater, and seep water?*

  Response: Yes. Several chemicals were detected in all site media sampled (Section 2.7).

- *Where present, are concentrations of chemicals in soil sufficient to cause adverse effects on the survival and/or growth of terrestrial organisms?*

  Response: Yes. Several chemicals were detected in site soil at concentrations in exceedance of their respective ESLs (Section 5.2.1.1 and Table 2-1).

- *Where present, are concentrations of chemicals in sediment sufficient to cause adverse effects on the survival and/or growth of aquatic organisms?*

  Response: Yes. Concentrations of several chemicals were detected in site sediment at concentrations in exceedance of their respective ESLs (Section 5.2.1.2 and Table 2-2).

- *Where present, are concentrations of chemicals in surface water sufficient to cause adverse effects on the survival and/or growth of aquatic organisms?*

Response: Yes. Concentrations of several chemicals were detected in site surface water at concentrations in exceedance of their respective ESLs (Section 5.2.1.3 and Table 2-3).

- *Where present, are concentrations of chemicals in sediment porewater sufficient to cause adverse effects on the survival and/or growth of aquatic organisms?*

  Response: Yes. Concentrations of several chemicals were detected in site sediment porewater at concentrations in exceedance of their respective ESLs (Section 5.2.1.4 and Table 2-4).

- *Where present, are concentrations of chemicals in seep water sufficient to cause adverse effects on the survival and/or growth of aquatic organisms?*

  Response: Yes. Concentrations of several chemicals were detected in seep water at concentrations in exceedance of their respective ESLs (Section 5.2.1.5 and Table 2-5).

- *Are dietary exposure levels of chemicals sufficient to cause adverse effects on the growth, survival, and/or reproductive success of piscivorous bird communities utilizing the site?*

  Response: Yes. Results of the bald eagle and great blue heron models indicate risk from exposure to lead as both the NOAEL and LOAEL-based HQs are greater than 1.0 (Sections 5.2.2.1, 5.2.2.2, and Table 5-3).

  In addition, both models indicate the potential for risk from exposure to zinc; the potential for risk from exposure to selenium was also noted in the great blue heron model as NOAEL-based HQs are greater than 1.0, but LOAEL-based values are less than 1.0 (Sections 5.2.2.1, 5.2.2.2 and Table 5-3).

- *Are dietary exposure levels of chemicals sufficient to cause adverse effects on the growth, survival, and/or reproductive success of piscivorous mammal communities utilizing the site?*

  Response: Yes. Results of the mink model indicate risk from exposure to arsenic, lead, selenium, and total PCB congeners in sediment as both the NOAEL and LOAEL-based HQs are greater than 1.0 (Section 5.2.2.3 and Table 5-3).

  In addition, the model indicates the potential for risk from exposure to copper, zinc, Aroclor 1248, and dioxins/furans (based on total TEQs) in sediment as the resultant NOAEL-based HQs are greater than 1.0, but the LOAEL-based values are less than 1.0 (Section 5.2.2.3 and Table 5-3).

- *Are dietary exposure levels of chemicals sufficient to cause adverse effects on the growth, survival, and/or reproductive success of herbivorous mammal communities utilizing the site?*

  Response: Yes. Results of the muskrat model indicate risk from exposure to arsenic and lead in sediment as both NOAEL and LOAEL-based HQs are greater than 1.0 (Section 5.2.2.4 and Table 5-3).

- *Are dietary exposure levels of chemicals sufficient to cause adverse effects on the growth, survival, and/or reproductive success of omnivorous bird communities utilizing the site?*

Response: Yes. Results of the wood duck model indicate risk from exposure to lead in sediment as both the NOAEL and LOAEL-based HQ is greater than 1.0 (Section 5.2.2.5 and Table 5-3).

In addition, the model indicates the potential for risk from exposure to zinc as the resultant NOAEL-based HQ is greater than 1.0, but the LOAEL-based value is less than 1.0 (Section 5.2.2.5 and Table 5-3).

- *Are dietary exposure levels of chemicals sufficient to cause adverse effects on the growth, survival, and/or reproductive success of omnivorous mammal communities utilizing the site?*

  Response: Possible. Results of the raccoon model indicate the potential for risk from exposure to arsenic, lead, and Aroclor 1248 in sediment as the resultant NOAEL-based HQs are greater than 1.0, but the LOAEL-based values are less than 1.0 (Section 5.2.2.6 and Table 5-3).

- *Are dietary exposure levels of chemicals sufficient to cause adverse effects on the growth, survival, and/or reproductive success of insectivorous bird communities utilizing the site?*

  Response: Yes. Results of the American robin model indicate risk from exposure to copper, lead, zinc, 4,4'-DDE, 4,4'-DDT, gamma-chlordane, dieldrin, endrin, and Aroclors 1248, 1254, and 1260 in soil as resultant NOAEL and LOAEL-based HQs are either equal to or greater than 1.0 (Section 5.2.2.7 and Table 5-4).

  In addition, the model indicates the potential for risk from exposure to cadmium, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, delta-BHC, and dioxins/furans as NOAEL-based HQs are greater than 1.0, but the LOAEL-based values are less than 1.0 (Section 5.2.2.7 and Table 5-4).

- *Are dietary exposure levels of chemicals sufficient to cause adverse effects on the growth, survival, and/or reproductive success of insectivorous mammal communities utilizing the site?*

  Response: Yes. Results of the short-tailed shrew model indicate risk from exposure to lead, zinc, gamma-chlordane, endrin, Aroclors 1248 and 1260, and dioxins/furans in soil as resultant the NOAEL and LOAEL-based HQs are greater than 1.0 (Section 5.2.2.8 and Table 5-4).

  In addition, the model indicates the potential for risk from exposure to arsenic, cadmium, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dieldrin, and Aroclor 1254 as NOAEL-based HQs are greater than 1.0, but the LOAEL-based values are less than 1.0 (Section 5.2.2.8 and Table 5-4).

- *Are dietary exposure levels of chemicals sufficient to cause adverse effects on the growth, survival, and/or reproductive success of carnivorous bird communities utilizing the site?*

  Response: Yes. Results of the red-tailed hawk model indicate risk from exposure to lead and 4,4'-DDT as the NOAEL and LOAEL-based HQs are greater than 1.0 (Section 5.2.2.9 and Table 5-4). In addition, the model indicates the potential for risk from exposure to zinc, 4,4'-DDE, Aroclors 1248, and 1260 as the NOAEL-based HQs are greater than 1.0, but the LOAEL-based values are less than 1.0 (Section 5.2.2.9 and Table 5-4).

- *Are dietary exposure levels of chemicals sufficient to cause adverse effects on the growth, survival, and/or reproductive success of carnivorous mammal communities utilizing the site?*

  Response: Yes. Results of the red fox model indicate risk from exposure to lead and Aroclor 1248 in soil as both the NOAEL and LOAEL-based HQs are either equal to or greater than 1.0 (Section 5.2.2.10 and Table 5-4). However, Aroclor 1248 was only detected in 1 out of 25 soil samples (Table 2-1). In addition, the model indicates the potential for risk from exposure to arsenic, dieldrin, Aroclors 1254 and 1260, and dioxin/furans as the NOAEL-based HQs are either equal to or greater than 1.0, but the LOAEL-based values are less than 1.0 (Section 5.2.2.10 and Table 5-4).

Section 6

Uncertainty Assessment

The potential risks due to chemicals in site media to ecological communities or populations at the site were evaluated by comparing maximum exposure concentrations to ecological screening values, an approach which provides the lowest level at which harmful effects would be predicted to occur, and through use of food chain exposure models. Inherent in these methods is some degree of uncertainty, introduced during various steps in the evaluation. The sources of this uncertainty are discussed below, as well as whether the assumptions used are likely to over- or under-represent ecological risks from chemicals at the site. In general, because this SLERA used conservative assumptions, risks are likely overestimated.

The main sources of uncertainty include natural variability, error, and insufficient knowledge. Natural variability is an inherent characteristic of ecological systems, their stressors, and their combined behavior in the environment. Biotic and abiotic parameters in these systems may vary to such a degree that the exposure and response of similar assessment endpoints in the same system may differ temporally and spatially. Factors that contribute to temporal and spatial variability include differences in individual organism behavior (within and between species), changes in the weather or ambient temperature, unanticipated interference from other stressors, interactions with other species in the community, differences between microenvironments, and numerous other factors.

6.1 Problem Formulation

Sources of uncertainty within the problem formulation phase of the SLERA relate to the selection of assessment endpoints and assumptions within the CSM.

The CSM presents the pathways by which contaminants are released from source areas to expose receptors. However, some exposure pathways are difficult to evaluate or cannot be quantitatively evaluated based on available information. For example, within this SLERA the inhalation exposure pathway was not addressed. It was assumed this exposure pathway is not significant when compared to contaminant exposure via direct contact and incidental ingestion. This may result in underestimating potential risk.

Target receptors were selected to represent a variety of organisms with similar feeding and behavioral strategies and to assist in the evaluation of measurement endpoints. However, species-specific exposure within similar feeding groups may vary and result in differing risk potential. Target receptors were selected with the intent of optimizing exposure and assuming they spend their entire lives restricted to the area of contamination. The assumption that target receptors spend their entire life at the site or a particular area is highly conservative and most likely over-estimates risk.

6.2 Exposure Assessment

All exposure assessments have a degree of uncertainty due to necessary simplifications and assumptions, which must be made as part of the evaluation. Major sources of uncertainty in the exposure assessment are discussed below.

Concentrations used to represent exposure point concentrations and characterizations of the distributions of chemicals can be a source of uncertainty. These issues relate to the adequate characterization of the nature and extent of chemical contamination. It is assumed that sufficient samples have been collected from site media and appropriately analyzed to adequately describe the nature and extent of chemical contamination resulting from the release of site-related chemicals.

When potential levels of uncertainty could adversely affect the results of the assessment, conservative approaches are taken that may result in over-protection of sensitive receptors. Such an approach is prudent where uncertainties are high and is in line with regulatory guidance for conducting SLERAs. For example, maximum detected concentrations of chemicals are used to assess potential risk at the SLERA stage, and this approach likely overestimated the average concentrations to which receptors may be exposed.

In this SLERA, it was assumed that COPCs in environmental media were 100% bioavailable. This is a conservative assumption that will overestimate risk. Bioavailability can be affected by factors including chemical speciation, sorption onto soils or sediment, complexation, aging, competition with environmental ligands, or precipitation in anoxic environments in the presence of sulfides (Chapman et al. 2003). Soil and sediment particle size can also influence exposure concentrations and bioavailability; soil/sediment comprised of fine particles will tend to have higher chemical concentrations than coarser textured ones due to the larger surface area and increased number of potential adsorption sites.

6.3 Effects Assessment

Uncertainties associated with the effects assessment relate to estimations of ESLs and TRVs, the use of conservative assumptions, and the degree of interaction between site contaminants. The major uncertainty in the effects assessment and potential impact on the SLERA is evaluated in this section.

The applicability of literature-derived data depends upon types of results presented and methods used to arrive at these results. Test endpoints produced by laboratory and field tests may be reported as formally defined toxicological endpoints or as less stringently defined measures of mortality or sublethal effects; variations in format introduce a source of uncertainty when used to derive a single acceptable level value. Thus, seemingly equivalent values may, in fact, be significantly different due to differences in test protocols, test conditions, or responses of individual organisms.

Uncertainties can be introduced by use of unrealistic assumptions in the conceptual model. Conservative assumptions are generally made in light of the uncertainty associated with the risk assessment process. This minimizes the possibility of concluding that no risk is present when a threat actually does exist (e.g., minimizes false negatives). However, the accuracy with which risk was predicted is not known. The use of conservative assumptions likely overestimates risk.

The recommended dose-based NOAELs and LOAELs presented in Sample et al. (1996) for avian and mammalian receptors were derived from an extensive literature review by the authors. These well-accepted values are therefore considered appropriate dose-based TRVs for the receptors modeled in this SLERA. The same assumption applies to TRVs from other sources that were reviewed when no values were available in the Sample et al. (1996) document.

6.4 Risk Characterization

By definition, uncertainties in risk characterization are influenced by uncertainties in exposure assessment and effects assessment. The adequate sampling and analysis of study area media minimize the uncertainties in the exposure assessment of these media. Descriptions of the magnitude and distribution of chemicals at the site are considered to be generally representative of current conditions. Since only the maximum-detected concentrations are used at this stage of the ecological risk assessment, the resulting HQs probably overestimate risks.

The frequency of a specific chemical detected above its criteria was not taken into consideration as part of the COPC identification process. In several instances, chemicals were retained as COPCs; however, they were often detected in a fraction of the samples and in several cases were only found in one.

Effects data can also contribute to overall uncertainty in risk characterization. Confidence in the ability of selected ESLs to assess ecological risks varies for each data value selected. While all values used in this SLERA are associated with some degree of uncertainty, it is the general trend described by the comparisons between exposure concentrations and effects concentrations, and the overall confidence in such comparisons, that are most important. Available information suggests that the ESLs selected for use in this SLERA are generally similar to others, are commonly accepted, and adequate for estimating risk using conservative assumptions.

This SLERA utilized simplifying assumptions in the food chain models, since it is difficult to mimic a complete diet. Thus, for the purpose of the models, receptor species are assumed to only consume a single food item. The exception was for modeled omnivorous receptors, the wood duck and raccoon, which were assumed to consume vegetation and mollusks. This is a conservative approach as all modeled receptors are expected to opportunistically consume a wide range of prey/food items, for example, the American robin. A considerable portion of the American robin's diet consists of fruit, especially outside of the breeding season. The assumption that the American robin's diet is comprised solely of soil invertebrates is a highly conservative and unrealistic assumption.

Ecological screening levels and TRVs for certain contaminants were not always available. When applicable, surrogate values were used. In general, these values were those published for a specific parent compound, metabolite or isomer. For example, soil ESLs for alpha- and gamma-chlordane could not be located. Instead, a value for chlordane was utilized.

Fish, soil invertebrate, small mammal, mollusk, and plant tissue were not collected in support of this SLERA. Instead, BSAFs and BAFs were used to derive hypothetical tissue burden concentrations. Use of these values in the absence of site-specific data is not representative of site conditions and may over- or under-estimate concentrations of contaminants in prey species when compared to those found on site. Use of these values in calculating dose introduces more uncertainties into already highly conservative food chain exposure models and may over- or under-estimate risk.

In addition, if a specific BSAF or BAF was not located, a default value of "1" was used. This is also a conservative approach that most likely over estimates risk.

No evaluation on the effects of contaminants in site media to individual tissues or organs of ecological receptors was conducted as part of this SLERA. Risk may be underestimated.

Finally, the risk characterization method itself can contribute to uncertainty. Hazard quotients depend on a single value for both exposure concentration and effects concentration. Selecting a single ESL or TRV, only after consulting multiple sources to ensure some degree of consistency, minimizes the uncertainty associated with any single value. Incorporating site observations into final conclusions also reduces the dependence on strict quantitative risk estimates that, in some cases, can be highly uncertain.

Section 7

Summary and Conclusions

This section of the SLERA provides a summary of the responses to risk questions presented in Section 2.4 of the Problem Formulation. More specifically, those chemicals which pose a risk based on a particular assessment endpoint. Risks were evaluated through a comparison of maximum concentrations of chemicals in site media to their respective ESLs, and through food chain exposure models.

7.1 Direct Exposure

Assessment endpoints 1 and 2 were addressed through a comparison of site media chemistry results to ESLs. Assessment endpoint 1 focuses on receptors in the terrestrial environments of the site, while assessment endpoint 2 evaluates risks to receptors in the aquatic environment.

7.1.1 Assessment Endpoint 1

Assessment endpoint 1, *Survival, growth, and reproduction of terrestrial organisms*, was addressed through a comparison of soil chemistry results to ESLs. Based on this comparison, risk to ecological receptors may occur from exposure to the following chemicals:

- SVOCs: benzo(a)anthracene
- Pesticides: 4,4'-DDE, 4,4'-DDT, dieldrin, and endrin
- PCB Aroclors: Aroclors 1248, 1254, and 1260
- Dioxins/Furans: dioxins/furans (based on total TEQs)
- Inorganics: antimony, cadmium, chromium, copper, lead, manganese, mercury, nickel, vanadium, and zinc

Due to a lack of ESLs, risk from exposure to the SVOCs 1,1' biphenyl, benzaldehyde, carbazole, and dibenzofuran, and aluminum and iron were not evaluated. Risk from exposure to these chemicals is inconclusive.

7.1.2 Assessment Endpoint 2

Assessment Endpoint 2, *Survival, growth, and reproduction of aquatic organisms*, was addressed through a comparison on sediment, surface water, sediment porewater, and seep water chemistry results to ESLs. Results are presented below.

7.1.2.1 Sediment

Risks to ecological receptors may occur from exposure the following chemicals:

- PCB Aroclors: Aroclors 1248, 1254, and 1268

- PCB Congeners: dioxin-like congeners (PCB 77, 105, 118, 126, 156, 167, and 169) and total sum of all detected congeners
- Dioxins/Furans: dioxins/furans (based on total TEQs)
- Inorganics: antimony, arsenic, barium, cadmium, chromium, copper, cyanide, iron, lead, manganese, mercury, nickel, selenium, silver, and zinc

Due to a lack of ESLs, risk from exposure to beryllium, thallium, and vanadium were not evaluated. Risk from exposure to these chemicals is inconclusive.

7.1.2.2 Surface Water

Risks to ecological receptors may occur from exposure the following chemicals:

- SVOCs: benzo(a)anthracene, benzo(a)pyrene, and bis(2-ethylhexyl)phthalate
- Pesticides: 4,4'-DDD and gamma-chlordane
- Inorganics (total): aluminum, barium, beryllium, cadmium, chromium, cobalt, copper, iron, lead, manganese, nickel, silver, vanadium, and zinc
- Inorganics (dissolved): iron and manganese

Due to a lack of ESLs, risk from exposure to the SVOCs benzo(k)fluoranthene and chrysene were not evaluated. Risk from exposure to these chemicals is inconclusive.

7.1.2.3 Sediment Porewater

Risks to ecological receptors may occur from exposure the following chemicals:

- Pesticides: 4,4'-DDE
- PCB Aroclors: Aroclor 1254
- Inorganics (total): aluminum, barium, beryllium, cadmium, chromium, cobalt, copper, cyanide, iron, lead, manganese, nickel, vanadium, and zinc
- Inorganics (dissolved): aluminum, barium, cadmium, chromium, iron, lead, manganese, vanadium, and zinc

Due to a lack of ESLs, risk from exposure to the SVOC caprolactam was not evaluated. Risk from exposure to this chemical is inconclusive.

7.1.2.4 Seep Water

Risks to ecological receptors may occur from exposure the following chemicals:

- PCB Aroclors: Aroclor 1254
- Inorganics (total): aluminum, barium, beryllium, cadmium, chromium, cobalt, copper, cyanide, iron, lead, manganese, nickel, vanadium, and zinc

- Inorganics (dissolved): aluminum, cadmium, copper, iron, lead, manganese, nickel, and zinc

7.2 Dietary Exposure

Assessment endpoints 3 through 11 were addressed through food chain exposure models using ten receptors representative of avian and mammalian communities assumed to utilize the site. NOAEL-based HQs below 1.0 suggest a lack of risk. LOAEL-based HQs greater than 1.0 suggest risk. When NOAEL-based HQs are greater than 1.0, but LOAEL-based HQs are not, this suggests the potential for risk. This potential increases as the dose approaches the LOAEL. Results of the models are discussed in the following sections.

7.2.1 Assessment Endpoint 3

Assessment endpoint 3, *Survival, growth, and reproduction of piscivorous birds*, was addressed through a food chain exposure model using the bald eagle and great blue heron. Results of both models indicate risk from exposure to lead.

Results of the models also indicate the potential for risk from exposure to zinc; the potential for risk from exposure to selenium was also noted in the great blue heron model.

7.2.2 Assessment Endpoint 4

Assessment endpoint 4, *Survival, growth, and reproduction of piscivorous mammals*, was addressed through a food chain exposure model using the mink.

Results of the model indicate risk from exposure to arsenic, lead, selenium, and total PCB congeners. Results of the model also indicate the potential for risk from exposure to copper, zinc, Aroclor 1248, and dioxins/furans (based on total TEQs).

7.2.3 Assessment Endpoint 5

Assessment endpoint 5, *Survival, growth, and reproduction of herbivorous mammals*, was addressed through a food chain exposure models using the muskrat.

Results of the model indicate risk from exposure to arsenic and lead.

7.2.4 Assessment Endpoint 6

Assessment endpoint 6, *Survival, growth, and reproduction of omnivorous birds*, was addressed through a food chain exposure model using the wood duck.

Results of the model indicate risk from exposure to lead. Results of the model also indicate the potential for risk from exposure to zinc.

7.2.5 Assessment Endpoint 7

Assessment endpoint 7, *Survival, growth, and reproduction of omnivorous mammals*, was addressed through a food chain exposure model using the raccoon.

Results of the model indicate the potential for risk from exposure to arsenic and lead.

7.2.6 Assessment Endpoint 8

Assessment endpoint 8, *Survival, growth, and reproduction of insectivorous birds*, was addressed through a food chain exposure model using the American robin.

Results of the model indicate risk from exposure to copper, lead, zinc, 4,4'-DDE, 4,4'-DDT, gamma-chlordane, dieldrin, endrin, and Aroclors 1248, 1254, and 1260. Results of the model also indicate the potential for risk from exposure to cadmium, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, delta-BHC, and dioxins/furans.

7.2.7 Assessment Endpoint 9

Assessment endpoint 9, *Survival, growth, and reproduction of insectivorous mammals*, was addressed through a food chain exposure model using the short-tailed shrew.

Results of the model indicate risk from exposure to lead, zinc, gamma-chlordane, endrin, Aroclors 1248 and 1260, and dioxins/furans. Results of the model also indicate the potential for risk from exposure to arsenic, cadmium, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dieldrin, and Aroclor 1254.

7.2.8 Assessment Endpoint 10

Assessment endpoint 10, *Survival, growth, and reproduction of carnivorous birds*, was addressed through a food chain exposure model using the red-tailed hawk.

Results of the model indicate risk from exposure to lead and 4,4'DDT. Results of the model also indicate the potential for risk from exposure to zinc, 4,4'-DDE, and Aroclors 1248 and 1260.

7.2.9 Assessment Endpoint 11

Assessment endpoint 11, *Survival, growth, and reproduction of carnivorous mammals*, was addressed through a food chain exposure model using the red fox.

Results of the model indicate risk from exposure to lead and Aroclor 1248. However, Aroclor 1248 was only detected in 1 out of 25 soil samples. Results of the model also indicate the potential for risk from exposure to arsenic, dieldrin, Aroclors 1254 and 1260, and dioxins/furans.

7.3 Conclusions

Results of this SLERA have determined that chemicals detected in all site media are at levels that may cause adverse effects to ecological receptors.

For those receptors in direct exposure with site soil, risk drivers primarily include several metals such as but not limited to cadmium, copper, lead, mercury, and zinc; dioxins/furans, and to a lesser extent based on frequency of detection, pesticides and PCB Aroclors.

Risk drivers for receptors in direct exposure with site sediment consists of several metals such as but not limited to arsenic, cadmium, copper, lead, and zinc; PCB Aroclors, dioxin-like PCB congeners, and dioxins/furans.

For those receptors in direct exposure with site surface water, sediment porewater, and seep water, risk drivers primarily consist of metals. Risks from exposure to pesticides and Aroclor 1254 were also noted.

Risks from dietary exposure to chemicals in sediment to upper trophic level consumers such as birds and mammals were noted with lead as the primary risk driver. Of the six modeled receptors, only the raccoon, representative of omnivorous mammals, showed the potential for risk from exposure to lead in sediment. Results of the models also indicated risk from exposure to arsenic, selenium, and total PCB congeners in sediment to piscivorous mammals; arsenic also posed a risk to herbivorous mammals.

Risks to terrestrial receptors via dietary exposure of chemicals in soil were also noted. Similar to sediment, lead was the primary risk driver as all four of the models indicated risk from exposure to lead. Based on the food chain exposure models, insectivorous birds and mammals are the most prone to risk from chemicals in soil when compared to carnivorous birds and mammals. This is primarily due to higher soil ingestion rates, a result of feeding habitats, and consumption of soil invertebrates. When combined, risk drivers to insectivorous birds and mammals in soil are copper, lead, zinc, 4,4'-DDE, 4,4'-DDT, gamma-chlordane, endrin, dieldrin, Aroclors, and dioxins/furans; however, between each taxa, birds are at risk from more chemicals than mammals.

Based on the red-tailed hawk and red fox food chain models, risk to carnivorous birds and mammals were noted from dietary exposure to lead, 4,4'-DDT, and Aroclor 1248.

In conclusion, this SLERA has determined that chemicals present in site media may pose a risk to ecological receptors utilizing the site. Risk drivers consist of several chemicals; however, lead appears to be the most prominent risk driver in all site media from both direct exposure and dietary exposure.

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Section 8

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Tables

Table 2-1
Comparison of Chemicals Detected in Soil to Ecological Screening Levels
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	CAS No.	Minimum Concentration Detected	Maximum Concentration Detected	Location of Maximum Concentration	Frequency of Detection	Screening Value	Hazard Quotient	COPC	Rationale
Volatile Organic Compounds (µg/kg)									
1,1-Dichloroethene	75-35-4	2.8 J	2.8 J	SB-111	1 / 7	8,280 C	0.0003	No	BSL
Tetrachloroethene	127-18-4	27 J+	27 J+	SB-111	1 / 7	9,920 C	0.003	No	BSL
Trichloroethene	79-01-6	7 J+	7 J+	SB-111	1 / 7	12,400.00 C	0.0006	No	BSL
Semi-Volatile Organic Compounds (µg/kg)									
1,1'-Biphenyl	92-52-4	36 J	150 J	SB-111	2 / 7	NL	NC	Yes	NV
2-Methylnaphthalene	91-57-6	68 J	170	SB-111	2 / 7	3,240 C	0.05	No	BSL
Acenaphthene	83-32-9	36 J	62 J	SB-110	2 / 7	29,000 A,a	0.002	No	BSL
Acenaphthylene	208-96-8	160 J	160 J	SB-117	1 / 7	682,000 C	0.0002	No	BSL
Acetophenone	98-86-2	120 J	400	SB-111	2 / 7	300,000 C	0.001	No	BSL
Anthracene	120-12-7	66 J	150 J	SB-117	3 / 7	29,000 A,a	0.005	No	BSL
Benzaldehyde	100-52-7	42 J	320 J+	SB-111	3 / 7	NL	NC	Yes	NV
Benzo(a)anthracene	56-55-3	19 J	1,300 J+	SB-111	6 / 7	1,100 A,b	1.2	Yes	ASL
Benzo(a)pyrene	50-32-8	35 J	440	SB-117	3 / 7	1,100 A,b	0.4	No	BSL
Benzo(b)fluoranthene	205-99-2	23 J	1,000	SB-111	6 / 7	59,800 C	0.02	No	BSL
Benzo(g,h,i)perylene	191-24-2	26 J	370	SB-117	4 / 7	1,100 A,b	0.3	No	BSL
Benzo(k)fluoranthene	207-08-9	71 J	700	SB-111	2 / 7	148,000 C	0.005	No	BSL
bis(2-Ethylhexyl)phthalate	117-81-7	100 J	420	SB-110	3 / 7	925 C	0.5	No	BSL
Butylbenzylphthalate	85-68-7	48 J	48 J	SB-110	1 / 7	239 C	0.2	No	BSL
Carbazole	86-74-8	77 J	77	SB-117	1 / 7	NL	NC	Yes	NV
Chrysene	218-01-9	27 J	980 J+	SB-111	6 / 7	1,100 A,b	0.9	No	BSL
Dibenzo(a,h)anthracene	53-70-3	40 J	140 J	SB-117	2 / 7	1,100 A,b	0.1	No	BSL
Dibenzofuran	132-64-9	27 J	54 J	SB-110	2 / 7	NL	NC	Yes	NV
Di-n-butylphthalate	84-74-2	52 J	190 J	SB-117	2 / 7	200,000 C	0.001	No	BSL
Fluoranthene	206-44-0	28 J	210	SB-110	6 / 7	1,100 A,b	0.2	No	BSL
Fluorene	86-73-7	48 J	210	SB-111	3 / 7	29,000 A,a	0.007	No	BSL
Indeno(1,2,3-cd)pyrene	193-39-5	51 J	340	SB-117	3 / 7	1,100 A,b	0.3	No	BSL
Naphthalene	91-20-3	61 J	190	SB-111	2 / 7	29,000 A,a	0.01	No	BSL
n-Nitrosodiphenylamine	86-30-6	200	200	SB-111	1 / 7	545 C	0.4	No	BSL
Phenanthrene	85-01-8	51 J	1,000	SB-111	4 / 7	29,000 A,a	0.03	No	BSL
Phenol	108-95-2	140 J	140 J	SB-111	1 / 7	30,000 B	0.005	No	BSL
Pyrene	129-00-0	27 J	540 J+	SB-111	6 / 7	1,100 A,b	0.5	No	BSL

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Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	CAS No.	Minimum Concentration Detected	Maximum Concentration Detected	Location of Maximum Concentration	Frequency of Detection	Screening Value	Hazard Quotient	COPC	Rationale
Pesticides (µg/kg)									
4,4'-DDE	72-55-9	26 NJ	42 NJ	SB-110	2 / 8	21 A	2	Yes	ASL
4.4'-DDT	50-29-3	4.6 NJ	250 J	SB-110	3 / 8	21 A	12	Yes	ASL
beta-BHC	319-85-7	2.9 NJ	2.9 NJ	SB-111	1 / 8	3.98 C	0.7	No	BSL
delta-BHC	319-86-8	72 J	72 J	SB-110	1 / 8	9940 C	0.01	No	BSL
Dieldrin	60-57-1	12 J	32 NJ	SB-110	2 / 8	4.9 A	7	Yes	ASL
Endrin	72-20-8	12 J	12 J	SB-110	1 / 8	10.1 C	1.2	Yes	ASL
gamma-Chlordane	5103-74-2	54 J	54 J	SB-111	1 / 8	224 C,c	0.2	No	BSL
Heptachlor	76-44-8	5.6 NJ	5.6 NJ	SB-110	1 / 8	5.98 C	0.9	No	BSL
Heptachlor Epoxide	1024-57-3	15	120 J	SB-110	2 / 8	152 C	0.8	No	BSL
PCB Aroclors (µg/kg)									
Aroclor 1248	12672-29-6	3,400 J	3,400 J	SB-110	1 / 25	371 B,d	9.16	Yes	ASL
Aroclor 1254	11097-69-1	35 J	1,200 J	SS-106	11 / 25	371 B,d	3.2	Yes	ASL
Aroclor 1260	11096-82-5	28 J	3,000	SB-110	14 / 25	371 B,d	8.09	Yes	ASL
Dioxins/Furans (ng/kg)									
TOTAL 2,3,7,8-TCDD TEQ[f]	NA	NA	54.1	NA	NA	0.199 C	272	Yes	ASL
Inorganics (mg/kg)									
Aluminum	7429-90-5	1,250	11,900	SB-109	19 / 19	NL	NC	Yes	NV
Antimony	7440-36-0	0.22 J	18.6	SB-110	11 / 19	0.27 A	69	Yes	ASL
Arsenic	7440-38-2	1.3	8 J	SB-109	19 / 19	18 A	0.44	No	BSL
Barium	7440-39-3	9.2	149 J	SB-109	12 / 19	330 A	0.45	No	BSL
Beryllium	7440-41-7	0.19 J	0.31 J	SB-117	3 / 19	21 A	0.01	No	BSL
Cadmium	7440-43-9	0.14 J	9.5	SB-109	7 / 19	0.36 A	26	Yes	ASL
Calcium	7440-70-2	167 J	8,910	SB-109	15 / 19	NL	NC	No	EN
Chromium	7440-47-3	2.5 J	39.9 J	SB-109	19 / 19	26 A,e	1.5	Yes	ASL
Cobalt	7440-48-4	0.37 J	4.4	SB-110	19 / 19	13 A	0.34	No	BSL
Copper	7440-50-8	2.8 J	292 J	SB-109	19 / 19	28 A	10	Yes	ASL
Cyanide	57-12-5	0.85	0.85	SB-116	1 / 19	1.33 C	0.64	No	BSL
Iron	7439-89-6	2,280 J	85,300 J	SB-109	19 / 19	NL	NC	Yes	NV
Lead	7439-92-1	7.3 J	10,100 J	SB-110	19 / 19	11 A	918	Yes	ASL
Magnesium	7439-95-4	169 J	829	SB-109	18 / 19	NL	NC	No	EN
Manganese	7439-96-5	16.2	427 J	SB-109	19 / 19	220 A	1.9	Yes	ASL
Mercury	7439-97-6	0.079 J	0.23	SB-109	6 / 19	0.00051 B	451	Yes	ASL
Nickel	7440-02-0	1.1 J	64.4	SB-110	19 / 19	38 A	1.7	Yes	ASL
Potassium	7440-09-7	214 J	325 J	SS-116	2 / 19	NL	NC	No	EN
Silver	7440-22-4	0.14 J	0.91	SB-109	5 / 19	4.2 A	0.22	No	BSL
Sodium	7440-23-5	277 J	277 J	SB-109	1 / 19	NL	NC	No	EN

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Table 2-1
Comparison of Chemicals Detected in Soil to Ecological Screening Levels
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	CAS No.	Minimum Concentration Detected	Maximum Concentration Detected	Location of Maximum Concentration	Frequency of Detection	Screening Value	Hazard Quotient	COPC	Rationale
Vanadium	7440-62-2	3.9	146	SB-117	19 / 19	7.8 A	19	Yes	ASL
Zinc	7440-66-6	9.3 J	13,400	SB-109	19 / 19	46 A	291	Yes	ASL

Notes:

A - EPA Ecological Soil Screening Levels (EcoSSLs). http://www.epa.gov/ecotox/ecossl/ . Values selected are the lowest of the soil screening values for plants, avian, invertebrate, and mammalian receptors.
B - Efroymson, R.A., G.W. Suter II, B.E. Sample, and D.S. Jones. 1997. Preliminary Remediation Goals (PRGs) for Ecological Endpoints
Prepared for the U.S. Department of Energy, Office of Environmental Management Contract No. DE-AC05-84OR21401
C - EPA 2003. EPA Region 5 Resource Conservation and Recovery Act (RCRA) Ecological Screening Levels
a - value for low molecular weight PAHs
b - value for high molecular weight PAHs
c - value for chlordane
d - value for PCBs
e - value for trivalent chromium
f - dioxins/furans evaluated via comparison of the sum of 2,3,7,8-TCDD TEQs to an ecological screening level for 2,3,7,8-TCDD
ASL - above screening level
BSL - below screening level
CAS - Chemical Abstracts Service
COPC - chemical of potential concern
EN - essential nutrient
J - estimated
NA - not applicable; only summaries of maximum values detected are used in the calculation of the exposure point concentration
NC - no hazard quotient calculated
NJ - estimated; tentatively identified
NL - not listed
NV - chemical detected, but no screening value located
mg/kg - milligrams per kilogram
TCDD - tetrachlorodibenzodioxin
TEQ - toxicity equivalent
µg/kg - micrograms per kilogram

Table 2-2
Comparison of Chemicals Detected in Sediment to Ecological Screening Levels
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	CAS No.	Minimum Concentration Detected	Maximum Concentration Detected	Location of Maximum Concentration	Frequency of Detection	Screening Value	Hazard Quotient	COPC	Rationale
PCB Aroclors (µg/kg)									
Aroclor 1248	12672-29-6	10	340	SD-T14-F	13 / 46	30 A	11	Yes	ASL
Aroclor 1254	11097-69-1	2.1 J	670 J	SD-T14-F	42 / 46	60 A	11	Yes	ASL
Aroclor 1268	11100-14-4	4.9 NJ	150 J	SD-T17-B	22 / 46	59.8 B,a	2.5	Yes	ASL
Dioxin-Like PCB Congeners (pg/g)									
2,3,3',4,4',5,5'-Heptachlorobiphenyl (189)	39635-31-9	4.29	587	SD-T14-E	4 / 4	6,600 C	0.09	No	BSL
2,3,3',4,4',5-Hexachlorobiphenyl (156)	38380-08-4	39.1 C	9,800 C	SD-T14-E	4 / 4	1,200 C	8.2	Yes	ASL
2,3,3',4,4'-Pentachlorobiphenyl (105)	32598-14-4	61.6	18,400 D	SD-T14-E	4 / 4	940 C	20	Yes	ASL
2,3',4,4',5,5'-Hexachlorobiphenyl (167)	52663-72-6	16.3	3,390	SD-T14-E	4 / 4	1,200 C	2.8	Yes	ASL
2,3,4,4',5-Pentachlorobiphenyl (114)	74472-37-0	2.63	977 D	SD-T14-E	4 / 4	980 C	0.99	No	BSL
2,3',4,4',5-Pentachlorobiphenyl (118)	31508-00-6	161	70,400 D	SD-T14-E	4 / 4	1,200 C	59	Yes	ASL
2',3,4,4',5-Pentachlorobiphenyl (123)	65510-44-3	3.68	762 D	SD-T14-E	4 / 4	1,200 C	0.64	No	BSL
3,3',4,4',5,5'-Hexachlorobiphenyl (169)	32774-16-6	50	50	SD-ST4	1 / 4	1.2 C	42	Yes	ASL
3,3',4,4',5-Pentachlorobiphenyl (126)	57465-28-8	2.47	64.9	SD-ST4	3 / 4	0.28 C	232	Yes	ASL
3,3',4,4'-Tetrachlorobiphenyl (77)	32598-13-3	9.49	1,780 D	SD-T14-E	4 / 4	8 C	223	Yes	ASL
Total PCB Congeners (pg/g)	NA	NA	2,372,089	NA	NA	59,800 B,a	40	Yes	ASL
Dioxins/Furans (ng/kg)									
TOTAL 2,3,7,8-TCDD TEQ[b]	NA	NA	8.0	NA	NA	0.12 A	67	Yes	ASL
Inorganics (mg/kg)									
Aluminum	7429-90-5	189	22,800 J	SD-T1-D	60 / 60	25,500 A	0.89	No	BSL
Antimony	7440-36-0	0.041 J	10.4	SD-T14-E	54 / 60	3 A	3.5	Yes	ASL
Arsenic	7440-38-2	0.29 J	42 J	SD-T25-E	60 / 60	6 A	7.0	Yes	ASL
Barium	7440-39-3	3.1	251 J	SD-T30-A	59 / 60	48 A	5.2	Yes	ASL
Beryllium	7440-41-7	0.15 J	3.6 J	SD-T1-D	59 / 60	NL	NC	Yes	NV
Cadmium	7440-43-9	0.017 J	8.6 J	SD-T30-A	59 / 60	0.6 A	14	Yes	ASL
Calcium	7440-70-2	354 J	6,640 J	SD-T22-D	54 / 60	NL	NC	No	EN
Chromium	7440-47-3	1.5	229 J	SD-T30-E	60 / 60	26 A	8.8	Yes	ASL
Cobalt	7440-48-4	0.75 J	28 J	SD-T1-D	52 / 60	50 A	0.56	No	BSL
Copper	7440-50-8	0.55 J	158	SD-T14-F	60 / 60	16 A	9.9	Yes	ASL
Cyanide	57-12-5	0.07 J	2.6 J	SD-T17-A	16 / 60	0.0001 A	26,000	Yes	ASL
Iron	7439-89-6	621	44,100	SD-T14-E	60 / 60	20,000 B	2.2	Yes	ASL
Lead	7439-92-1	2.4 J	6,430 J-	SD-T14-E	60 / 60	31 A	207	Yes	ASL
Magnesium	7439-95-4	775	5,040 J	SD-T4-G	50 / 60	NL	NC	No	EN
Manganese	7439-96-5	11.8	1,080 J+	SD-T14-E	60 / 60	630 A	1.7	Yes	ASL
Mercury	7439-97-6	0.02 J	0.97 J	SD-T14-H	51 / 60	0.2 A	4.9	Yes	ASL

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Table 2-2
Comparison of Chemicals Detected in Sediment to Ecological Screening Levels
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	CAS No.	Minimum Concentration Detected	Maximum Concentration Detected	Location of Maximum Concentration	Frequency of Detection	Screening Value	Hazard Quotient	COPC	Rationale
Nickel	7440-02-0	0.55 J	62.7 J	SD-T30-A	59 / 60	16 A	3.9	Yes	ASL
Potassium	7440-09-7	610	2,030 J	SD-T4-G	43 / 60	NL	NC	No	EN
Selenium	7782-49-2	0.032 J	8.1 J	SD-T30-A	60 / 60	2 B	4.1	Yes	ASL
Silver	7440-22-4	0.3	4.6 J	SD-T30-A	40 / 60	0.5 A	9.2	Yes	ASL
Sodium	7440-23-5	39.1 J	571 J	SD-T2-A	39 / 60	NL	NC	No	EN
Thallium	7440-28-0	0.019 J	0.36 J	SD-T1-D	53 / 60	NL	NC	Yes	NV
Vanadium	7440-62-2	6.3 J	212 J	SD-T30-A	59 / 60	NL	NC	Yes	NV
Zinc	7440-66-6	9.3	900 J	SD-T4-E	60 / 60	120 A	7.5	Yes	ASL

Notes:
A - NJDEP Ecological Evaluation Technical Guidance. (http://www.nj.gov/dep/srp/guidance/index.html). August 2011.
NJDEP Ecological Screening Criteria. (webpage http://www.state.nj.us/dep/srp/regs/sediment/table_01.htm). March 2009.
B - EPA Freshwater Sediment Screening Benchmarks . August 2006. http://www.epa.gov/reg3hscd/risk/eco/btag/sbv/fwsed/screenbench.htm.
C - Oregon Department of Environmental Quality, Land Quality Division. 2007. Guidance for Assessing Bioaccumulative Chemicals of Concern in Sediment. April.
a - value for total PCBs
b - dioxins/furans evaluated via comparison of the sum of 2,3,7,8-TCDD TEQs to an ecological screening level for 2,3,7,8-TCDD
ASL - above screening level
BSL - below screening level
C - Identified co-eluting congeners
CAS - Chemical Abstracts Service
COPC - chemical of potential concern
D - Dilution
EN - essential nutrient
J - estimated
J+ - estimated biased low
J- - estimated biased high
NA - not applicable; only summaries of maximum values detected are used in the calculation of the exposure point concentration
NC - no hazard quotient calculated
NJ - estimated;tentatively identified
NL - not listed
NV - chemical detected, but no screening value located
mg/kg - milligram per kilogram
ng/kg - nanograms per kilogram
pg/g - picogram per gram
TCDD - tetrachlorodibenzodioxin
TEQ - toxicity equivalent
µg/kg - microgram per kilogram

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Table 2-3
Comparison of Chemicals Detected in Surface Water to Ecological Screening Levels
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	CAS No.	Minimum Concentration Detected	Maximum Concentration Detected	Location of Maximum Concentration	Frequency of Detection	Screening Value	Hazard Quotient	COPC	Rationale
Semi-Volatile Organic Compounds (µg/L)									
Benzo(a)anthracene	56-55-3	0.1	0.18 J	T1-SW-01	2 / 27	0.025 A	7.2	Yes	ASL
Benzo(a)pyrene	50-32-8	0.2	0.32 J	T1-SW-01	2 / 27	0.014 A	23	Yes	ASL
Benzo(b)fluoranthene	205-99-2	0.23	0.38 J	T1-SW-01	2 / 27	9.07 A	0.04	No	BSL
Benzo(k)fluoranthene	207-08-9	0.091	0.15 J	T1-SW-01	2 / 27	NL	NC	Yes	NV
Bis(2-ethylhexyl)phthalate	117-81-7	1.2	2.4	T4-SW-02	6 / 27	0.3 A	8.0	Yes	ASL
Chrysene	218-01-9	0.17	0.32 J	T1-SW-01	2 / 27	NL	NC	Yes	NV
Indeno(1,2,3-cd)pyrene	193-39-5	0.097	0.15 J	T1-SW-01	2 / 27	4.31 A	0.03	No	BSL
Pentachlorophenol	87-86-5	0.82 J	3.8 J	T33-SW-01	4 / 27	15 B	0.25	No	BSL
Pesticides (µg/L)									
4,4'-DDD	72-54-8	0.055 J	0.055 J	T2-SW-01	1 / 27	0.001 A,a	55	Yes	ASL
Gamma-chlordane	5103-74-2	0.027 J	0.027 J	T11-SW-01	1 / 27	0.0043 A,b	6.3	Yes	ASL
Total Inorganics (µg/L)									
Aluminum	7429-90-5	55.2	28,300	T1-SW-01	11 / 27	87 C	325	Yes	ASL
Antimony	7440-36-0	0.51	7.1	T1-SW-01	2 / 27	80 A	0.09	No	BSL
Arsenic	7440-38-2	0.23 J	46.6	T1-SW-01	26 / 27	150 A	0.31	No	BSL
Barium	7440-39-3	21.8	1,380	T1-SW-01	27 / 27	220 A	6.3	Yes	ASL
Beryllium	7440-41-7	0.045 J	11.4	T1-SW-01	3 / 27	3.6 A	3.2	Yes	ASL
Cadmium	7440-43-9	0.033 J	12.7	T1-SW-01	12 / 27	0.134 A,c	95	Yes	ASL
Calcium	7440-70-2	9,740	40,300	T1-SW-01	27 / 27	116,000 C	0.35	No	EN, BSL
Chromium	7440-47-3	1.2 J	76.7 J	T1-SW-01	11 / 27	42 A	1.8	Yes	ASL
Cobalt	7440-48-4	0.26	67.5	T1-SW-01	22 / 27	24 A	2.8	Yes	ASL
Copper	7440-50-8	1.8	150	T1-SW-01	27 / 27	6.2 A,c	24	Yes	ASL
Cyanide	57-12-5	3.2 J	3.5 J	T1-SW-01	2 / 27	5.2 A	0.67	No	BSL
Iron	7439-89-6	176	220,000	T1-SW-01	19 / 27	1,000 B	220	Yes	ASL
Lead	7439-92-1	1.3	654	T1-SW-01	27 / 27	5.4 A	121	Yes	ASL
Magnesium	7439-95-4	4,760	17,900	T1-SW-01	27 / 27	82,000 C	0.22	No	EN, BSL
Manganese	7439-96-5	34.2	1,270	T1-SW-01	27 / 27	120 C	11	Yes	ASL
Mercury	7439-97-6	0.61	0.68	T1-SW-01	2 / 27	0.77 A	0.88	No	BSL
Nickel	7440-02-0	1.3 J	229 J	T1-SW-01	19 / 27	32.5 A,c	7.0	Yes	ASL
Potassium	7440-09-7	1,700	5,400	T1-SW-01	19 / 27	53,000 C	0.10	No	EN, BSL
Selenium	7782-49-2	0.19 J	3.2	T1-SW-01	22 / 27	5 A	0.64	No	BSL
Silver	7440-22-4	1	1	T1-SW-01	1 / 27	0.12 A	8.3	Yes	ASL
Sodium	7440-23-5	11,500	21,900	T33-SW-01	27 / 27	680,000 C	0.03	No	EN, BSL
Thallium	7440-28-0	0.53	0.53	T1-SW-01	1 / 27	10 A	0.05	No	BSL
Vanadium	7440-62-2	1.6	155	T1-SW-01	3 / 27	12 A	13	Yes	ASL
Zinc	7440-66-6	7	2,210	T1-SW-01	27 / 27	83.9 A,c	26	Yes	ASL

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Table 2-3
Comparison of Chemicals Detected in Surface Water to Ecological Screening Levels
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	CAS No.	Minimum Concentration Detected	Maximum Concentration Detected	Location of Maximum Concentration	Frequency of Detection	Screening Value	Hazard Quotient	COPC	Rationale
Dissolved Inorganics (µg/L)									
Aluminum	7429-90-5	5.7 J	39.1	T22-SW-01	19 / 27	87 C	0.45	No	BSL
Arsenic	7440-38-2	0.083 J	1.5	T1-SW-01	25 / 27	150 A	0.01	No	BSL
Barium	7440-39-3	21.3	57.9	T1-SW-01	27 / 27	220 A	0.26	No	BSL
Calcium	7440-70-2	8,750	20,200	T4-SW-01	27 / 27	116,000 C	0.17	No	EN, BSL
Chromium	7440-47-3	3.7	25.4 J	T32-SW-01	5 / 27	42 A	0.60	No	BSL
Cobalt	7440-48-4	2.9	5.4 J	T14-SW-02	3 / 27	24 A	0.23	No	BSL
Copper	7440-50-8	1.4	5.2 J	T14-SW-02	16 / 27	5.8 A,d	0.90	No	BSL
Iron	7439-89-6	77.3	12,000	T1-SW-01	22 / 27	1,000 B	12	Yes	ASL
Lead	7439-92-1	0.28	2 J	T16-SW-02	11 / 27	5.4 A	0.37	No	BSL
Magnesium	7439-95-4	4,600	8,600	T1-SW-01	27 / 27	82,000 C	0.10	No	EN, BSL
Manganese	7439-96-5	15.1	271	T1-SW-01	27 / 27	120 C	2.3	Yes	ASL
Nickel	7440-02-0	1.3 J	5.7	T2-SW-01	16 / 27	30.5 A,d	0.19	No	BSL
Potassium	7440-09-7	1,700	2,970	T1-SW-01	27 / 27	53,000 C	0.06	No	EN, BSL
Selenium	7782-49-2	0.16 J	0.5 J	T14-SW-03	21 / 27	5 A	0.10	No	BSL
Sodium	7440-23-5	12,500	19,600	T33-SW-01	27 / 27	680,000 C	0.03	No	EN, BSL
Zinc	7440-66-6	4.2 J	23.3 J	T31-SW-01	27 / 27	78.5 A,d	0.30	No	BSL

Notes:
A - NJDEP Surface Water Quality Standards. (web page http://www.nj.gov/dep/rules/rules/njac7_9b.pdf). April 2011
B - EPA 2009. National Recommended Water Quality Criteria. Criteria based on Freshwater Criterion Continuous Concentrations.
http://www.epa.gov/waterscience/criteria/wqctable/. Note several values for metals were adjusted based on site specific water hardness.
C -EPA 2006. EPA Region 3 Biological Technical Assistance Group Freshwater Screening Benchmarks,
Mid-Atlantic Risk Assessment: Ecological Risk Assessment, http://www.epa.gov/reg3hwmd/risk/eco/index.htm
a - value for DDT
b - value for chlordane
c - dissolved criteria corrected for site-specific hardness geometric mean of 69.8 milligrams per liter
d - dissolved criteria corrected for site-specific hardness geometric mean of 64.5 milligrams per liter
ASL - above screening level
BSL - below screening level
CAS - Chemical Abstracts Service
COPC - chemical of potential concern
EN - essential nutrient
J - estimated
NC - no hazard quotient calculated
NL - not listed
NV - chemical detected, but no screening value located
µg/L - micrograms per liter

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Table 2-4
Comparison of Chemicals Detected In Sediment Porewater to Ecological Screening Levels
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	CAS No.	Minimum Concentration Detected	Maximum Concentration Detected	Location of Maximum Concentration	Frequency of Detection	Screening Value	Hazard Quotient	COPC	Rationale
Volatile Organic Compounds (µg/L)									
Carbon disulfide	75-15-0	0.1 J	0.1 J	SGS-10	1 / 10	0.92 C	0.11	No	BSL
Semi-Volatile Organic Compounds (µg/L)									
4-Methylphenol	106-44-5	1.2 J	1.2 J	SGS-03	1 / 10	543 C	0.002	No	BSL
Acenaphthene	83-32-9	0.57 J	0.57 J	SGS-04	1 / 10	38 A	0.015	No	BSL
Caprolactam	105-60-2	1.8 J	1.8 J	SGS-09	1 / 10	NL	NC	Yes	NV
Phenol	108-95-2	17	17	SGS-03	1 / 10	180 A	0.09	No	BSL
Pesticides (µg/L)									
4,4'-DDE	72-55-9	0.028 J	0.028 J	SGS-10	1 / 10	0.001 A,a	28	Yes	ASL
PCB Aroclors (µg/L)									
Aroclor 1254	11097-69-1	0.39	1.1	SGS-04	2 / 10	0.014 A,b	79	Yes	ASL
Total Inorganics (µg/L)									
Aluminum	7429-90-5	1,390 J	79,100 J	SGS-05	10 / 10	87 C	909	Yes	ASL
Arsenic	7440-38-2	11.7 J	45.1 J	SGS-05	10 / 10	150 A	0.30	No	BSL
Barium	7440-39-3	112 J	3,960 J	SGS-05	10 / 10	220 A	18	Yes	ASL
Beryllium	7440-41-7	0.51 J	33.8	SGS-05	10 / 10	3.6 A	9.4	Yes	ASL
Cadmium	7440-43-9	0.81	33.6	SGS-05	10 / 10	0.224 A,c	150	Yes	ASL
Calcium	7440-70-2	21,600 J	115,000 J	SGS-05	10 / 10	116,000 C	0.99	No	EN, BSL
Chromium	7440-47-3	5.6 J	393 J	SGS-05	10 / 10	42 A	9.4	Yes	ASL
Cobalt	7440-48-4	1.4	167	SGS-05	10 / 10	24 A	7.0	Yes	ASL
Copper	7440-50-8	2.1	58.6	SGS-03	10 / 10	11.2 A,c	5	Yes	ASL
Cyanide	57-12-5	1.7 J	7 J	SGS-07	4 / 9	5.2 A	1.3	Yes	ASL
Iron	7439-89-6	10,300 J	703,000 J	SGS-05	10 / 10	1,000 B	703	Yes	ASL
Lead	7439-92-1	53.2 J	11,100 J	SGS-05	10 / 10	5.4 A	2,056	Yes	ASL
Magnesium	7439-95-4	6,970 J	32,700 J	SGS-05	10 / 10	82,000 C	0.40	No	EN, BSL
Manganese	7439-96-5	593 J	18,500 J	SGS-05	10 / 10	120 C	154	Yes	ASL
Mercury	7439-97-6	0.16 J	0.37 J	SGS-05	9 / 10	0.77 A	0.48	No	BSL
Nickel	7440-02-0	4.7 J	217 J	SGS-05	10 / 10	58.1 A,c	3.7	Yes	ASL
Potassium	7440-09-7	656 J	6,170 J	SGS-08	10 / 10	53,000 C	0.12	No	EN, BSL
Selenium	7782-49-2	3.1 J	3.1 J	SGS-05	1 / 10	5 A	0.62	No	BSL
Sodium	7440-23-5	19,000	56,200 J	SGS-07	10 / 10	680,000 C	0.08	No	EN, BSL
Thallium	7440-28-0	0.11 J	0.12 J	SGS-05	2 / 10	10 A	0.012	No	BSL
Vanadium	7440-62-2	21.8	882	SGS-05	10 / 10	12 A	74	Yes	ASL
Zinc	7440-66-6	129	6,740 J	SGS-05	10 / 10	150 A,c	45	Yes	ASL
Dissolved Inorganics (µg/L)									
Aluminum	7429-90-5	9.2 J	6,200	SGS-06	10 / 10	87 C	71	Yes	ASL
Arsenic	7440-38-2	6.3 J	20 J	SGS-01	10 / 10	150 A	0.13	No	BSL

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Table 2-4
Comparison of Chemicals Detected In Sediment Porewater to Ecological Screening Levels
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	CAS No.	Minimum Concentration Detected	Maximum Concentration Detected	Location of Maximum Concentration	Frequency of Detection	Screening Value	Hazard Quotient	COPC	Rationale
Barium	7440-39-3	31.4	549	SGS-06	10 / 10	220 A	2.5	Yes	ASL
Beryllium	7440-41-7	0.73 J	3.5	SGS-06	4 / 10	3.6 A	0.97	No	BSL
Cadmium	7440-43-9	0.23 J	0.76	SGS-01	4 / 10	0.19 A,d	4.0	Yes	ASL
Calcium	7440-70-2	19,700	49,700	SGS-08	10 / 10	116,000 C	0.43	No	EN, BSL
Chromium	7440-47-3	0.61 J	58.2	SGS-06	10 / 10	42 A	1.4	Yes	ASL
Cobalt	7440-48-4	0.54 J	8.5	SGS-06	10 / 10	24 A	0.35	No	BSL
Copper	7440-50-8	0.66 J	5.2	SGS-01	6 / 10	9.2 A,d	0.57	No	BSL
Iron	7439-89-6	2,900	74,600	SGS-06	10 / 10	1,000 B	75	Yes	ASL
Lead	7439-92-1	0.52 J	456	SGS-04	10 / 10	5.4 A	84	Yes	ASL
Magnesium	7439-95-4	6,990 J	11,100 J	SGS-06	10 / 10	82,000 C	0.14	No	EN, BSL
Manganese	7439-96-5	499	3020	SGS-09	10 / 10	120 C	25	Yes	ASL
Mercury	7439-97-6	0.17	0.46	SGS-10	10 / 10	0.77 A	0.60	No	BSL
Nickel	7440-02-0	1.4	14.9	SGS-06	10 / 10	48.1 A,d	0.31	No	BSL
Potassium	7440-09-7	816 J	6410	SGS-08	10 / 10	53,000 C	0.12	No	EN, BSL
Sodium	7440-23-5	18,300 J	55,300 J	SGS-07	10 / 10	680,000 C	0.08	No	EN, BSL
Vanadium	7440-62-2	1.3 J	99.8	SGS-06	9 / 10	12 A	8.3	Yes	ASL
Zinc	7440-66-6	3.3	379	SGS-06	10 / 10	124 A,d	3.1	Yes	ASL

Notes:
A - NJDEP Surface Water Quality Standards. (web page http://www.nj.gov/dep/rules/rules/njac7_9b.pdf). April 2011
B - EPA 2009. National Recommended Water Quality Criteria. Criteria based on Freshwater Criterion Continuous Concentrations.
http://www.epa.gov/waterscience/criteria/wqctable/. Note several values for metals were adjusted based on site specific water hardness.
C -EPA 2006. EPA Region 3 Biological Technical Assistance Group Freshwater Screening Benchmarks,
Mid-Atlantic Risk Assessment: Ecological Risk Assessment, http://www.epa.gov/reg3hwmd/risk/eco/index.htm
a - value for DDT
b - value for PCBs
c - dissolved criteria corrected for site-specific hardness geometric mean of 138.4 milligrams per liter
d - dissolved criteria corrected for site-specific hardness geometric mean of 110.8 milligrams per liter
ASL - above screening level
BSL - below screening level
CAS - Chemical Abstracts Service
COPC - chemical of potential concern
EN - essential nutrient
J - estimated
NC - no hazard quotient calculated
NL - not listed
NV - chemical detected, but no screening value located
µg/L - micrograms per liter

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Table 2-5
Comparison of Chemicals Detected in Seep Water to Ecological Screening Levels
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	CAS No.	Minimum Concentration Detected	Maximum Concentration Detected	Location of Maximum Concentration	Frequency of Detection	Screening Value	Hazard Quotient	COPC	Rationale
Volatile Organic Compounds (µg/L)									
Methyl tert-butyl ether	1634-04-4	0.98	0.98	SEEP-08	1 / 9	51000 A	0.00002	No	BSL
PCB Aroclors (µg/L)									
Aroclor 1254	11097-69-1	0.088 J	0.62 J	SEEP-08	6 / 9	0.014 Aa	44	Yes	ASL
Total Inorganics (µg/L)									
Aluminum	7429-90-5	98.1 J	71,600 J	SEEP-08	9 / 9	87 C	823	Yes	ASL
Antimony	7440-36-0	3.3	12.2	SEEP-07	5 / 9	80 A	0.15	No	BSL
Arsenic	7440-38-2	0.56 J	59.1 J	SEEP-08	9 / 9	150 A	0.39	No	BSL
Barium	7440-39-3	27.2	3,930	SEEP-08	9 / 9	220 A	18	Yes	ASL
Beryllium	7440-41-7	3.2	36.9	SEEP-08	4 / 9	3.6 A	10	Yes	ASL
Cadmium	7440-43-9	0.21 J	93.9	SEEP-08	8 / 9	0.2 Ab	470	Yes	ASL
Calcium	7440-70-2	15,800 J	199,000 J	SEEP-08	9 / 9	116,000 C	1.7	No	EN
Chromium	7440-47-3	0.5 J	221	SEEP-08	9 / 9	42	5.3	Yes	ASL
Cobalt	7440-48-4	0.33 J	261	SEEP-08	9 / 9	24	11	Yes	ASL
Copper	7440-50-8	2 J	564	SEEP-07	9 / 9	10 Ab	56	Yes	ASL
Cyanide	57-12-5	18	864	SEEP-07	4 / 9	5.2 A	166	Yes	ASL
Iron	7439-89-6	497 J	245,000 J	SEEP-08	9 / 9	1,000 B	245	Yes	ASL
Lead	7439-92-1	8.4 J	251,000 J	SEEP-08	9 / 9	5.4 A	46,481	Yes	ASL
Magnesium	7439-95-4	6,030	36,500	SEEP-08	9 / 9	82,000 C	0.45	No	EN, BSL
Manganese	7439-96-5	33.8 J	50,700 J	SEEP-08	9 / 9	120 C	423	Yes	ASL
Mercury	7439-97-6	0.19	0.3	SEEP-01	9 / 9	0.77 A	0.39	No	BSL
Nickel	7440-02-0	1.6	396	SEEP-08	9 / 9	52.3 Ab	7.6	Yes	ASL
Potassium	7440-09-7	1,990 J	14,700 J	SEEP-08	9 / 9	53,000 C	0.28	No	EN, BSL
Selenium	7782-49-2	1.3 J	2.2 J	SEEP-08	2 / 9	5 A	0.44	No	BSL
Sodium	7440-23-5	17,400	33,800	SEEP-08	9 / 9	680,000 C	0.05	No	EN, BSL
Thallium	7440-28-0	0.19 J	0.84	SEEP-08	4 / 9	10 A	0.084	No	BSL
Vanadium	7440-62-2	1.7 J	1,030	SEEP-08	8 / 9	12 A	86	Yes	ASL
Zinc	7440-66-6	17.2 J	25,700 J	SEEP-08	9 / 9	135 Ab	190	Yes	ASL
Dissolved Inorganics (µg/L)									
Aluminum	7429-90-5	32.2	987	SEEP-07	5 / 9	87 C	11	Yes	ASL
Antimony	7440-36-0	3.1	4.6	SEEP-10	5 / 9	80 A	0.06	No	BSL
Arsenic	7440-38-2	0.38 J	10.3 J	SEEP-07	9 / 9	150 A	0.07	No	BSL
Barium	7440-39-3	25.2	121	SEEP-08	9 / 9	220 A	0.55	No	BSL
Cadmium	7440-43-9	0.24 J	1.5	SEEP-07	7 / 9	0.15 Ac	10	Yes	ASL
Calcium	7440-70-2	16,900	39,700	SEEP-08	9 / 9	116,000 C	0.34	No	EN, BSL
Chromium	7440-47-3	0.68 J	3	SEEP-05	4 / 9	42	0.07	No	BSL
Cobalt	7440-48-4	0.38 J	4.4	SEEP-07	6 / 9	24	0.18	No	BSL
Copper	7440-50-8	1 J	25.9	SEEP-07	9 / 9	6.8 Ac	3.8	Yes	ASL
Iron	7439-89-6	41.8 J	3,110	SEEP-06	9 / 9	1,000 B	3.1	Yes	ASL
Lead	7439-92-1	0.99 J	802	SEEP-05	8 / 9	5.4 A	149	Yes	ASL
Magnesium	7439-95-4	3,580	9,020	SEEP-08	9 / 9	82,000 C	0.11	No	EN, BSL

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Table 2-5
Comparison of Chemicals Detected in Seep Water to Ecological Screening Levels
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	CAS No.	Minimum Concentration Detected	Maximum Concentration Detected	Location of Maximum Concentration	Frequency of Detection	Screening Value	Hazard Quotient	COPC	Rationale
Manganese	7439-96-5	12.1 J	1,050	SEEP-08	9 / 9	120 C	8.8	Yes	ASL
Mercury	7439-97-6	0.17	0.36	SEEP-07	9 / 9	0.77 A	0.47	No	BSL
Nickel	7440-02-0	1.2	36.6	SEEP-07	9 / 9	35.5 Ac	1.0	Yes	ASL
Potassium	7440-09-7	2,000	4,850	SEEP-07	9 / 9	53,000 C	0.09	No	EN, BSL
Sodium	7440-23-5	16,700	25,200	SEEP-08	9 / 9	680,000 C	0.04	No	EN, BSL
Vanadium	7440-62-2	3.1 J	4 J	SEEP-05	2 / 9	12 A	0.33	No	BSL
Zinc	7440-66-6	6.4	958	SEEP-07	9 / 9	91.7 Ac	10	Yes	ASL

Notes:
A - NJDEP Surface Water Quality Standards. (web page http://www.nj.gov/dep/rules/rules/njac7_9b.pdf). April 2011
B - EPA 2009. National Recommended Water Quality Criteria. Criteria based on Freshwater Criterion Continuous Concentrations.
http://www.epa.gov/waterscience/criteria/wqctable/. Note several values for metals were adjusted based on site specific water hardness.
C -EPA 2006. EPA Region 3 Biological Technical Assistance Group Freshwater Screening Benchmarks,
Mid-Atlantic Risk Assessment: Ecological Risk Assessment, http://www.epa.gov/reg3hwmd/risk/eco/index.htm
a - value for DDT
b - dissolved criteria corrected for site-specific hardness geometric mean of 122.2 milligrams per liter
c - dissolved criteria corrected for site-specific hardness geometric mean of 77.5 milligrams per liter
ASL - above screening level
BSL - below screening level
CAS - Chemical Abstracts Service
COPC - chemical of potential concern
EN - essential nutrient
J - estimated
NC - no hazard quotient calculated
NL - not listed
NV - chemical detected, but no screening value located
µg/L - micrograms per liter

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Table 3-1
SLERA Food Chain Exposure Model Input Parameters
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Modeled Receptor	Body Weight [1] (kg)	Ingestion Rates			Site Foraging Factor [9]
		Food (kg/day)	Soil/Sediment (kg/day) [5]	Water (L/day)	
Bald Eagle [3,6]	3.524	0.132	0.0013	0.137	1
Great Blue Heron [2,6]	2.229	0.401	0.0132	0.101	1
Mink [4,7]	0.974	0.214	0.02	0.097	1
Muskrat [2,7]	1.35	0.459	0.0431	0.130	1
Wood Duck [3,6]	0.454	0.035	0.0003	0.035	1
Raccoon [4,7]	5.1	0.168	0.0158	0.429	1
Short-tailed Shrew [2,8]	0.0125	0.00775	0.00040	0.003	1
American Robin [2,6]	0.0635	0.124	0.013	0.0093	0.58
Red-tailed Hawk [2,6]	1.028	0.113	0.00113	0.060	1
Red Fox [2,7]	3.27	0.458	0.013	0.288	1

Notes:

1 - Body weights are the lowest of literature values identified in Section 3.2 of SLERA

2 - Food ingestion rates (FIR) normalized to body weight from literature source identified in Section 3.2 of SLERA

3 - No FIR available; value derived following the Nagy (1987) equation for birds. FIR = 0.0582 x (body weight)$^{0.651}$

4 - No FIR rate available; value derived following the Nagy (1987) equation for mammals. FIR = 0.0687 x (body weight)$^{0.822}$

5 - Soil/sediment ingestion rates calculated using the values presented in Section 3.2 of the SLERA

6 - No water ingestion rate (WIR) available; value derived following the Calder and Braun (1983) equation for birds. WIR = 0.059 x (body weight)$^{0.67}$

7 - No WIR available; value derived following the Calder and Braun (1983) equation for mammals. WIR = 0.099 x (body weight)$^{0.9}$

8 - Water ingestion normalized to body weight using the value presented in Section 3.2 of SLERA

9 - Site foraging factor (SFF) seasonally adjusted for the American robin. Based on WEFH (EPA 1993) a residence time of seven months is assumed resulting in a SSF of 0.58 (7 months divided by 12 months)

kg - kilogram

kg/day - kilogram per day

L/day - liters per day

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Table 4-1
Avian Toxicity Reference Values
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Great Blue Heron		Bald Eagle		Wood Duck		American Robin		Red-tailed Hawk	
	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL
Arsenic	12.8 a	5.1 a	12.8 a	5.1 a	12.8 a	5.1 a	12.8 a	5.1 a	12.8 a	5.1 a
Cadmium	20 a	1.45 a	20 a	1.45 a	20 a	1.45 a	20 a	1.45 a	20 a	1.45 a
Copper	61.7 a	47 a	61.7 a	47 a	61.7 a	47 a	61.7 a	47 a	61.7 a	47 a
Lead	11.3 a	1.13 a	11.3 a	1.13 a	11.3 a	1.13 a	11.3 a	1.13 a	11.3 a	1.13 a
Nickel	107 a	77.4 a	107 a	77.4 a	107 a	77.4 a	107 a	77.4 a	107 a	77.4 a
Selenium	1 a	0.5 a	1 a	0.5 a	1 a	0.5 a	Not evaluated		Not evaluated	
Silver	60.5 j	20.2 j	60.5 j	20.2 j	60.5 j	20.2 j	60.5 j	20.2 j	60.5 j	20.2 j
Zinc	131 a	14.5 a	131 a	14.5 a	131 a	14.5 a	131 a	14.5 a	131 a	14.5 a
Acenaphthene	Not evaluated		Not evaluated		Not evaluated		4550 b,c	445 b,c	4550 b,c	445 b,c
Acenaphthylene	Not evaluated		Not evaluated		Not evaluated		4550 b,c	445 b,c	4550 b,c	445 b,c
Anthracene	Not evaluated		Not evaluated		Not evaluated		4550 b,c	445 b,c	4550 b,c	445 b,c
Benzo(a)anthracene	Not evaluated		Not evaluated		Not evaluated		20 b,d	2 b,d	20 b,d	2 b,d
Benzo(a)pyrene	Not evaluated		Not evaluated		Not evaluated		20 b,d	2 b,d	20 b,d	2 b,d
Benzo(b)fluoranthene	Not evaluated		Not evaluated		Not evaluated		20 b,d	2 b,d	20 b,d	2 b,d
Benzo(g,h,i)perylene	Not evaluated		Not evaluated		Not evaluated		20 b,d	2 b,d	20 b,d	2 b,d
Benzo(k)fluoranthene	Not evaluated		Not evaluated		Not evaluated		20 b,d	2 b,d	20 b,d	2 b,d
Chrysene	Not evaluated		Not evaluated		Not evaluated		20 b,d	2 b,d	20 b,d	2 b,d
Dibenzo(a,h)anthracene	Not evaluated		Not evaluated		Not evaluated		20 b,d	2 b,d	20 b,d	2 b,d
Fluoranthene	Not evaluated		Not evaluated		Not evaluated		20 b,d	2 b,d	20 b,d	2 b,d
Fluorene	Not evaluated		Not evaluated		Not evaluated		4550 b,c	445 b,c	4550 b,c	445 b,c
Indeno(1,2,3-cd)pyrene	Not evaluated		Not evaluated		Not evaluated		20 b,d	2 b,d	20 b,d	2 b,d
Phenanthrene	Not evaluated		Not evaluated		Not evaluated		4550 b,c	445 b,c	4550 b,c	445 b,c
Pyrene	Not evaluated		Not evaluated		Not evaluated		20 b,d	2 b,d	20 b,d	2 b,d
4,4-DDE	Not evaluated		Not evaluated		Not evaluated		0.028 a,g	0.003 a,g	0.028 a,g	0.003 a,g
4,4'-DDT	Not evaluated		Not evaluated		Not evaluated		0.028 a	0.003 a	0.028 a	0.003 a
beta-BHC	Not evaluated		Not evaluated		Not evaluated		2.25 a,l	0.56 a,l	2.25 a,l	0.56 a,l
delta-BHC	Not evaluated		Not evaluated		Not evaluated		2.25 a,l	0.56 a,l	2.25 a,l	0.56 a,l
gamma-chlordane	Not evaluated		Not evaluated		Not evaluated		10.7 a,e	2.1 a,e	10.7 a,e	2.1 a,e
Dieldrin	Not evaluated		Not evaluated		Not evaluated		0.77 a,m	0.077 a	0.77 a.m	0.077 a
Endrin	Not evaluated		Not evaluated		Not evaluated		0.1 a	0.01 a	0.1 a	0.01 a
Heptachlor	Not evaluated		Not evaluated		Not evaluated		650 n,m	65 n	650 n,m	65 n
Heptachlor Epoxide	Not evaluated		Not evaluated		Not evaluated		650 o	65 o	650 o	65 o
Aroclor-1248	1.8 a,f	0.18 a,f	1.8 a,f	0.18 a,f	1.8 a,f	0.18 a,f	1.8 a,f	0.18 a,f	1.8 a,f	0.18 a,f
Aroclor-1254	1.8 a	0.18 a	1.8 a	0.18 a	1.8 a	0.18 a	1.8 a	0.18 a	1.8 a	0.18 a
Aroclor-1260	Not evaluated		Not evaluated		Not evaluated		1.8 a,f	0.18 a,f	1.8 a,f	0.18 a,f
Aroclor-1268	1.8 a,f	0.18 a,f	1.8 a,f	0.18 a,f	1.8 a,f	0.18 a,f	Not evaluated		Not evaluated	

Table 4-1
Avian Toxicity Reference Values
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Great Blue Heron		Bald Eagle		Wood Duck		American Robin		Red-tailed Hawk	
	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL
Total 2,3,7,8-TCDD TEQs[1]	Not applicable		0.00014 a,k	0.000014 a,k	Not applicable		0.00014 a,k	0.000014 a,k	0.00014 a,k	0.000014 a,k
Total PCB congeners[2]	Not applicable		1.8 a,f	0.18 a,f	Not applicable		Not evaluated		Not evaluated	

Notes:
1 - Includes the total sum of dioxin/furan and dioxin-like PCB congeners toxic equivalents for sediment; PCB congeners not analyzed in soil samples
2 - Total sum of PCB congeners excludes those with dioxin-like effects which are evaluated along with dioxins/furans for sediment
LOAEL - lowest-observed-adverse-effect level
NOAEL - no-observed-adverse-effect level
TRV - toxicity reference value
a - TRVs taken from Sample, B.E., D.M. Opresko and G.W. Suter II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. ES/ER/TM-86/R3. Oak Ridge National Laboratoy, Oakridge, TN.
b - TRVs taken from Lockheed-Martin. 2002. Final Report, Atlantic Wood Industries, Ecological Risk Assessment, Portsmouth, Virginia. EPA Contract 68-C-99-223.
c - value for low molecular weight polyaromatic hydrocarbons (LMWPAHs)
d - value for high molecular weight PAHs
e - value for chlordane
f - value for Aroclor 1254
g - value for DDT and metabolites
h - no LOAEL located; value derived by multiplying the NOAEL by a factor of 10
i - value for endosulfan
j - TRVs taken from EPA. 2005. Ecological Soil Screening Levels (Eco-SSLs) for Silver. Washington, DC. US Environmental Protection Agency
k - value for 2,3,7,8-tetrachlorodibenzodioxin
l - value for BHC-mixed isomers
m - value for NOAEL x factor of ten
n - TRVs taken from EPA Region 6 Screening Level Ecological Risk Assessment Protocol Appendix E: Toxicity Reference Values. August 1999
o - value for heptachlor
Not evaluated - chemical not detected or analyzed in media (soil or sediment) evaluated using the designated receptor
Not applicable - chemical not evaluated in food chain models using the designated receptor

Table 4-2
Mammalian Toxicity Reference Values
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Mink		Muskrat		Raccoon		Short-tailed Shrew		Red Fox	
	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL
Arsenic	0.524 a	0.052 a	0.524 a[1]	0.052 a[1]	0.524 a[2]	0.052 a[2]	1.498 a	0.15 a	0.36 a	0.036 a
Cadmium	7.419 a	0.742 a	7.419 a[1]	0.742 a[1]	7.419 a[2]	0.742 a[2]	21.2 a	2.12 a	5.094 a	0.509 a
Copper	15.4 a	11.7 a	15.4 a[1]	11.7 a[1]	15.4 a[2]	11.7 a[2]	44 a	33.4 a	10.6 a	8.0 a
Lead	61.53 a	6.15 a	61.53 a[1]	6.15 a[1]	61.53 a[2]	6.15 a[2]	175.83 a	17.58 a	42.25 a	4.22 a
Nickel	61.53 a	30.77 a	61.53 a[1]	30.77 a[1]	61.53 a[2]	30.77 a[2]	175.83 a	87.91 a	42.25 a	21.12 a
Selenium	0.254 a	0.154 a	0.254 a[1]	0.154 a[1]	0.254 a[2]	0.154 a[2]	Not evaluated		Not evaluated	
Silver	6.02 b	0.6 b,c	6.02 b	0.6 b,c	6.02 b	0.6 b,c	6.02 b	0.6 b,c	6.02 b	0.6 b,c
Zinc	246.1 a	123.1 a	246.1 a[1]	123.1 a[1]	246.1 a[2]	123.1 a[2]	703.3 a	351.7 a	169 a	84.5 a
Acenaphthene	Not evaluated		Not evaluated		Not evaluated		656 e,f,h	65.6 e,f	656 e,f,h	65.6 e,f
Acenaphthylene	Not evaluated		Not evaluated		Not evaluated		656 e,f,h	65.6 e,f	656 e,f,h	65.6 e,f
Anthracene	Not evaluated		Not evaluated		Not evaluated		656 e,f,h	65.6 e,f	656 e,f,h	65.6 e,f
Benzo(a)anthracene	Not evaluated		Not evaluated		Not evaluated		6.15 e,g,h	0.615 e,g	6.15 e,g,h	0.615 e,g
Benzo(a)pyrene	Not evaluated		Not evaluated		Not evaluated		11.89 a	1.19 a	2.86 a	0.29 a
Benzo(b)fluoranthene	Not evaluated		Not evaluated		Not evaluated		6.15 e,g,h	0.615 e,g	6.15 e,g,h	0.615 e,g
Benzo(g,h,i)perylene	Not evaluated		Not evaluated		Not evaluated		6.15 e,g,h	0.615 e,g	6.15 e,g,h	0.615 e,g
Benzo(k)fluoranthene	Not evaluated		Not evaluated		Not evaluated		6.15 e,g,h	0.615 e,g	6.15 e,g,h	0.615 e,g
Chrysene	Not evaluated		Not evaluated		Not evaluated		6.15 e,g,h	0.615 e,g	6.15 e,g,h	0.615 e,g
Dibenzo(a,h)anthracene	Not evaluated		Not evaluated		Not evaluated		6.15 e,g,h	0.615 e,g	6.15 e,g,h	0.615 e,g
Fluoranthene	Not evaluated		Not evaluated		Not evaluated		6.15 e,g,h	0.615 e,g	6.15 e,g,h	0.615 e,g
Fluorene	Not evaluated		Not evaluated		Not evaluated		656 e,f,h	65.6 e,f	656 e,f,h	65.6 e,f
Indeno(1,2,3-cd)pyrene	Not evaluated		Not evaluated		Not evaluated		6.15 e,g,h	0.615 e,g	6.15 e,g,h	0.615 e,g
Phenanthrene	Not evaluated		Not evaluated		Not evaluated		656 e,f,h	65.6 e,f	656 e,f,h	65.6 e,f
Pyrene	Not evaluated		Not evaluated		Not evaluated		6.15 e,g,h	0.615 e,g	6.15 e,g,h	0.615 e,g
4,4-DDE	Not evaluated		Not evaluated		Not evaluated		8.79 a,j	1.76 a,j	2.11 a,j	0.42 a,j
4,4'-DDT	Not evaluated		Not evaluated		Not evaluated		8.79 a	1.76 a	2.11 a	0.42 a
beta-BHC	Not evaluated		Not evaluated		Not evaluated		4.4 a	1.95 a	1.06 a	0.21 a
delta-BHC	Not evaluated		Not evaluated		Not evaluated		7.03 a,m	3.52 a,m	0.1 a,m	0.01 a,m
gamma-chlordane	Not evaluated		Not evaluated		Not evaluated		10.9 a,i	5.5 a,i	2.6 a,i	1.3 a,i
Dieldrin	Not evaluated		Not evaluated		Not evaluated		0.44 a	0.044 a	0.106 a	0.011 a
Endrin	Not evaluated		Not evaluated		Not evaluated		1.094 a	0.109 a	0.263 a	0.026 a
Heptachlor	Not evaluated		Not evaluated		Not evaluated		2.857 a	0.2857 a	0.687 a	0.069 a
Heptachlor Epoxide	Not evaluated		Not evaluated		Not evaluated		1 a,n	0.1 a,n	1 a,n	0.1 a,n
Aroclor-1248	0.15 a	0.015 a	0.15 a[1]	0.015 a[1]	0.15 a[2]	0.015 a[2]	0.43 a	0.043 a	0.103 a	0.01 a
Aroclor-1254	0.69 a	0.14 a	0.69 a[1]	0.14 a[1]	0.69 a[2]	0.14 a[2]	0.668 a	0.067 a	0.474 a	0.096 a
Aroclor-1260	Not evaluated		Not evaluated		Not evaluated		0.668 a,o	0.067 a,o	0.474 a,o	0.096 a,o
Aroclor-1268	0.69 a,d	0.14 a,d	0.69 a,d[1]	0.14 a,d[1]	0.69 a,d[2]	0.14 a,d[2]	Not evaluated		Not evaluated	
Total 2,3,7,8-TCDD TEQs[1]	0.00000224 l	0.00000008 l	Not applicable		Not applicable		0.000022 a,k	0.0000022 a,k	0.0000053 a,k	0.0000005 a,k
Total PCB congeners[2]	0.69 a,d	0.14 a,d	Not applicable		Not applicable		Not evaluated		Not evaluated	

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Table 4-2
Mammalian Toxicity Reference Values
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Notes:
1 - Includes the total sum of dioxin/furan and dioxin-like PCB congeners toxic equivalents for sediment; PCB congeners not analyzed in soil samples
2 - Total sum of PCB congeners excludes those with dioxin-like effects which are evaluated along with dioxins/furans for sediment
LOAEL - lowest-observed-adverse-effect level
NOAEL - no-observed-adverse-effect level
TRV - toxicity reference value
1 - no TRV for muskrat located in Sample and Suter (1996); value for mink used
2 - no TRV for raccoon located in Sample and Suter (1996); value for mink used
a - TRVs taken from Sample, B.E., D.M. Opresko and G.W. Suter II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. ES/ER/TM-86/R3. Oak Ridge National Laboratoy, Oakridge, TN.
b - TRVs taken from EPA. 2005. Ecological Soil Screening Levels (Eco-SSLs) for Silver. Washington, DC. US Environmental Protection Agency
c - no NOAEL located; value derived by dividing the LOAEL by a factor of 10
d - value for Aroclor 1254
e - TRVs taken from EPA. 2007. Eco-SSLs for Poly Aromatic Hydrocarbons (PAHs). Washington, DC. US Environmental Protection Agency
f - value for low molecular weight PAHs
g - value for high molecular weight PAHs
h - no LOAEL located; value derived by multiplying the NOAEL by a factor of 10
i - value for chlordane
j - value for DDT and metabolites
k - value for 2,3,7,8-tetrachlorodibenzodioxin
l - TRV taken from Tillitt et. al. 1996. Dietary Exposure of Mink to Carp from Saginaw Bay. Characterization of Dietary Exposure to Planar Halogenated Hydrocarbons, Dioxin Equivalents, and Biomagnificatior
m - value for BHC-mixed isomers
n - Crum et al., 1993 as cited in source a (Sample et al., 1996)
o - value for Aroclor 1254
Not evaluated - chemical not detected or analyzed in media (soil or sediment) evaluated using the designated receptor
Not applicable - chemical not evaluated in food chain models using the designated receptor

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Table 5-1
Dioxin/Furan Toxicity Equivalent Calculations Used in Screening Exercises
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Dioxins/furans (ng/kg)	TEF[1]	Maximum Concentration Detected in Soil	TEQ	Maximum Concentration Detected in Sediment	TEQ
1,2,3,4,6,7,8-Hpcdd	0.01	1290	12.9	40.1	0.401
1,2,3,4,6,7,8-Hpcdf	0.01	309	3.09	91.1	0.911
1,2,3,4,7,8,9-Hpcdf	0.01	26.2	0.262	2.3 J	0.023
1,2,3,4,7,8-Hxcdd	0.1	4.4 J	0.44	0.576 J	0.0576
1,2,3,4,7,8-Hxcdf	0.1	9.43	0.943	2.88 J	0.288
1,2,3,6,7,8-Hxcdd	0.1	42.4	4.24	2.2 J	0.22
1,2,3,6,7,8-Hxcdf	0.1	6.98	0.698	3.79 J	0.379
1,2,3,7,8,9-Hxcdd	0.1	5.2	0.52	1.5 J EMPC	0.15
1,2,3,7,8,9-Hxcdf	0.1	2.05 J	0.205	0.936 J EMPC	0.0936
1,2,3,7,8-Pecdd	1	3.86 J	3.86	0.548 J	0.548
1,2,3,7,8-Pecdf	0.1	5.38	0.538	0.909 J	0.0909
2,3,4,6,7,8-Hxcdf	0.1	6.8	0.68	2.31 J	0.231
2,3,4,7,8-Pecdf	1	7.46	7.46	2.04 J EMPC	2.04
2,3,7,8-Tcdd	1	1.96 J EMPC	1.96	0.263 J	0.263
2,3,7,8-Tcdf	1	12.3	12.3	2.07	2.07
Ocdd	0.0003	11200 J	3.36	731	0.2193
Ocdf	0.0003	2260	0.678	63	0.0189
Total 2,3,7,8-TCDD TEQs (ng/kg)			54.1		8.0

Notes:
1 - highest value taken from WHO 2005 (see Section 8 for full citation)
EMPC - estimated maximum potential concentration
J - estimated
TCDD - tetrachlorodibenzodioxin
TEF - toxicity equivalence factor
TEQ - toxicity equivalent (calculated by multiplying the TEF by the maximum concentration in soil or sediment)
ng/kg - nanograms per kilogram

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Table 5-2
Biota-Sediment Accumulation Factors and Bioaccumulation Factors
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Fish Biota-Sediment Accumulation Factor		Mollusk Biota-Sediment Accumulation Factor		Plant Bioaccumulation Factor		Earthworm Bioaccumulation Factor		Small Mammal Bioaccumulation Factor	
Arsenic	0.12	h,i	0.029	o	0.036	b	0.11	b	0.05	c,g
Cadmium	0.8	h,j	1.4	h	0.364	b	0.96	b	0.82	c,g
Copper	1.0	m	0.38	h,k	0.4	b	0.04	b	17	c,g
Lead	0.18	h,i	0.0046	o	0.045	b	0.03	b	64	c,g
Nickel	1.0	m	0.9	b,l	0.032	b	0.02	b	5.4	c,g
Selenium	1.0	m	0.9	b,l	0.016	b	Not evaluated		Not evaluated	
Silver	1.0	m	0.9	b,l	0.4	b	0.22	b	0.004	c,g
Zinc	1.8	h,i	1.1	h,k	0.0000000000012	b	0.56	b	154	c,g
Acenaphthene	Not evaluated		Not evaluated		Not evaluated		1.47	c	0	c
Acenaphthylene	Not evaluated		Not evaluated		Not evaluated		22.90	c	0	c
Anthracene	Not evaluated		Not evaluated		Not evaluated		2.42	c	0	c
Benzo(a)anthracene	Not evaluated		Not evaluated		Not evaluated		1.59	c	0	c
Benzo(a)pyrene	Not evaluated		Not evaluated		Not evaluated		1.33	c	0	c
Benzo(b)fluoranthene	Not evaluated		Not evaluated		Not evaluated		2.6	c	0	c
Benzo(g,h,i)perylene	Not evaluated		Not evaluated		Not evaluated		2.94	c	0	c
Benzo(k)fluoranthene	Not evaluated		Not evaluated		Not evaluated		2.60	c	0	c
Chrysene	Not evaluated		Not evaluated		Not evaluated		2.29	c	0	c
Dibenzo(a,h)anthracene	Not evaluated		Not evaluated		Not evaluated		2.31	c	0	c
Fluoranthene	Not evaluated		Not evaluated		Not evaluated		3.04	c	0	c
Fluorene	Not evaluated		Not evaluated		Not evaluated		9.57	c	0	c
Indeno(1,2,3-cd)pyrene	Not evaluated		Not evaluated		Not evaluated		2.86	c	0	c
Phenanthrene	Not evaluated		Not evaluated		Not evaluated		1.72	c	0	c
Pyrene	Not evaluated		Not evaluated		Not evaluated		1.75	c	0	c
4,4-DDE	Not evaluated		Not evaluated		Not evaluated		1.26	b,f	4.9	c,f
4,4-DDT	Not evaluated		Not evaluated		Not evaluated		1.26	b	4.9	c
beta-BHC	Not evaluated		Not evaluated		Not evaluated		6.34	c	1.0	m
delta-BHC	Not evaluated		Not evaluated		Not evaluated		6.34	c	1.0	m
gamma-chlordane	Not evaluated		Not evaluated		Not evaluated		7,925.7	b,d	1.0	m
Dieldrin	Not evaluated		Not evaluated		Not evaluated		14.70	c	14.4	c
Endrin	Not evaluated		Not evaluated		Not evaluated		1,296.6	b,d	1.0	m
Heptachlor	Not evaluated		Not evaluated		Not evaluated		1.4	b	1.0	m
Heptachlor Epoxide	Not evaluated		Not evaluated		Not evaluated		1.0	m	1.0	m
Aroclor-1248	2.3	a,n	4.7	a,n	0.01	b,e	1.13	b	1.0	m

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Table 5-2
Biota-Sediment Accumulation Factors and Bioaccumulation Factors
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Fish Biota-Sediment Accumulation Factor		Mollusk Biota-Sediment Accumulation Factor		Plant Bioaccumulation Factor		Earthworm Bioaccumulation Factor		Small Mammal Bioaccumulation Factor	
Aroclor-1254	2.3	a,n	4.7	a,n	0.01	b	1.13	b	1.0	m
Aroclor-1260	Not evaluated		Not evaluated		Not evaluated		1.13	b,e	1.0	m
Aroclor-1268	2.3	a,n	4.7	a,n	0.01	b,e	Not evaluated		Not evaluated	
Total PCB Congeners[1]	4.2	a,p	Not evaluated		Not evaluated		Not evaluated		Not evaluated	
Total 2,3,7,8-TCDD TEQs[2]	0.2	q,r	Not evaluated		Not evaluated		1.59	b,r	1.0	m

Notes:

1 - Total sum of PCB congeners excludes those with dioxin-like effects which are evaluated along with dioxins/furans for sediment

2 - Includes the total sum of dioxin/furan and dioxin-like PCB congeners toxic equivalents for sediment; PCB congeners not analyzed in soil samples

a - EPA BSAF Database, Office of Research and Development, National Health and Environmental Effects Research Laboratory, Mid-Continent Ecology Division

b - EPA Region 6 Multimedia Planning and Permitting Division, Office of Solid Waste., August 1999, Screening Level Ecological risk Assessment Protocol: Appendix C: Media to Receptor BCF Values

c - EPA, Guidance for Developing Ecological Soil Screening Levels, Attachment 4-1 Exposure Factors and Bioaccumulation Models for Derivation of Wildlife Eco-SSLs, OSWER Directive 9285.7-55, April 2007.

d - BAF calculated using the regression equation: $LogBCF=(0.819*logK_{ow})-1.146$ as per Appendix C in source"b".

e - value for Aroclor 1254

f - value for DDT

g - no BAF values located; values shown are estimated tissue concentrations calculated using the regression equation as presented in source "c"

h - PTI Environmental Services. 1995. Bioaccumulation Factor Approach Analysis for Metals and Polar Organic Compounds, Final Report submitted to Washington State Department of Ecology. October.

i - average of all whole body values with the exception of arsenic where only one value was provided

j - value for the freshwater clam *Corbicula fluminea*

k - average of values for the freshwater mussel *Elliptio complanata*

l - value for benthic macroinvertebrates

m- default value of "1" used when no BSAF/BAF were located

n - value for total PCBs

o - average values for *Corbicula fluminea* taken from CDM and Stillwater Sciences. 2011. Screening Level Evaluation of Contaminants in Sediments from Three Reservoirs and the Estuary of the Klamath River, 2009-2011. Prepared for U.S. Department of the Interior Klamath Dam Removal Water Quality Sub Team Klamath River Secretarial Determination. September.

p - average value for total PCBs measured in whole body freshwater fish

q - EPA Framwork for the Application of the Toxicity Equivalence Methodology for Polychlorinated Dioxins, Furan, and Biphenyls in Ecological Risk Assessment

r - value for 2,3,7,8-TCDD

s - Environmental Restoration Division Manual ERD-AG-003, page 7-4, dated April 6 1999

Not evaluated - chemical not detected or analyzed in media (soil or sediment) used to calculate food/prey item concentrations

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Table 5-3
Food Chain Exposure Model Summary - Sediment Exposure
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Hazard Quotient											
	Bald Eagle		Great Blue Heron		Mink		Muskrat		Wood Duck		Raccoon	
	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL
Arsenic	0.01	0.02	0.04	0.09	**1.5**	**15**	**1.4**	**14**	0.02	0.04	0.14	**1.4**
Cadmium	0.01	0.07	0.02	0.33	0.08	0.85	0.07	0.67	0.01	0.17	0.01	0.14
Copper	0.04	0.05	0.18	0.24	0.95	**1.3**	0.66	0.87	0.04	0.05	0.00	0.08
Lead	**1.6**	**16**	**8**	**84**	**2**	**24**	**1.9**	**19**	**2**	**24**	0.16	**1.6**
Nickel	0.01	0.01	0.04	0.06	0.09	0.18	0.02	0.03	0.01	0.01	0.01	0.01
Selenium	0.11	0.23	0.56	**1.1**	**3**	**5**	0.44	0.73	0.13	0.27	0.22	0.36
Silver	0.001	0.00	0.01	0.02	0.07	0.68	0.05	0.48	0.002	0.00	0.01	0.07
Zinc	0.18	**1.6**	0.87	**8**	0.59	**1.2**	0.05	0.09	0.14	**1.2**	0.03	0.06
Aroclor 1248	0.01	0.06	0.03	0.28	0.42	**4**	0.03	0.28	0.01	0.13	0.06	0.6
Aroclor 1254	0.01	0.11	0.05	0.55	0.18	0.88	0.01	0.06	0.02	0.25	0.03	0.14
Aroclor 1268	0.00	0.04	0.02	0.19	0.06	0.30	0.004	0.02	0.01	0.08	0.01	0.05
Total 2,3,7,8-TCDD TEQs	0.00279	0.0279	Not applicable		0.22	**6**	Not applicable		Not applicable		Not applicable	
Total PCB congeners	0.09	0.9	Not applicable		**1.4**	**7**	Not applicable		Not applicable		Not applicable	

Notes:
LOAEL - lowest observed adverse effect level
NOAEL - no observed adverse effect level
Not applicable - chemical not evaluated in food chain models using the designated receptor
Shaded cells indicate hazard quotient greater than or equal to 1

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Table 5-4
Food Chain Exposure Model Summary - Soil Exposure
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Hazard Quotient							
	American Robin		Short-tailed Shrew		Red-tailed Hawk		Red Fox	
	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL	LOAEL	NOAEL
Arsenic	0.22	0.54	0.45	**5**	0.001	0.003	0.10	**1.0**
Cadmium	0.81	**11**	0.23	**2**	0.005	0.07	0.03	0.29
Copper	**1.1**	**1.4**	0.31	0.41	0.04	0.05	0.32	0.43
Lead	**206**	**2064**	**3**	**26**	**1.5**	**15**	**1.0**	**10**
Nickel	0.13	0.18	0.01	0.03	0.01	0.009	0.02	0.05
Silver	0.01	0.02	0.02	0.21	0.00002	0.0001	0.001	0.01
Zinc	**109**	**985**	**6**	**12**	0.22	**2**	0.39	0.77
Acenaphthene	0.00004	0.0004	0.0001	0.001	0.00000001	0.0000001	0.0000003	0.000003
Acenaphthylene	0.001	0.01	0.003	0.03	0.00000003	0.0000003	0.0000009	0.000009
Anthracene	0.0001	0.001	0.0003	0.003	0.00000003	0.0000003	0.0000008	0.000008
Benzo(a)anthracene	0.2	2	0.19	**1.9**	0.00006	0.0006	0.0007	0.007
Benzo(a)pyrene	0.05	0.5	0.03	0.3	0.00002	0.0002	0.0005	0.005
Benzo(b)fluoranthene	0.2	2	0.24	**2.4**	0.00005	0.0005	0.0006	0.006
Benzo(g,h,i)perylene	0.1	0.97	0.10	0.98	0.00002	0.0002	0.0002	0.002
Benzo(k)fluoranthene	0.2	**1.6**	0.16	**1.6**	0.00003	0.0003	0.0004	0.004
Chrysene	0.2	**2**	0.20	**2**	0.00005	0.0005	0.0006	0.006
Dibenzo(a,h)anthracene	0.01	0.1	0.01	0.1	0.000003	0.00003	0.00003	0.0003
Fluoranthene	0.05	0.5	0.05	0.5	0.00001	0.0001	0.0001	0.001
Fluorene	0.001	0.01	0.002	0.02	0.00000004	0.0000005	0.000001	0.00001
Indeno(1,2,3-cd)pyrene	0.09	0.9	0.09	0.88	0.00002	0.0002	0.0002	0.002
Phenanthrene	0.0007	0.01	0.001	0.01	0.0000002	0.000002	0.000005	0.00005
Pyrene	0.09	0.9	0.09	0.86	0.00003	0.0003	0.0003	0.003
4,4'-DDE	**3**	**31**	0.003	0.02	0.68	**6**	0.012	0.06
4,4'-DDT	**20**	**187**	0.019	0.1	**4**	**38**	0.07	0.3
beta-BHC	0.01	0.1	0.002	0.005	0.0001	0.0005	0.0003	0.002
delta-BHC	0.3	**1.4**	0.034	0.068	0.003	0.01	0.09	0.9
gamma-chlordane	**69**	**350**	**21**	**42**	0.0005	0.003	0.0026	0.01
Dieldrin	**1.0**	**10**	**0.6**	**6**	0.06	0.6	0.5	**5**
Endrin	**255**	**2552**	**7**	**74**	0.01	0.1	0.006	0.06
Heptachlor	0.00002	0.0002	0.001	0.01	0.000001	0.00001	0.001	0.01
Heptachlor Epoxide	0.0003	0.003	0.1	0.7	0.00002	0.0002	0.01	0.1
Aroclor 1248	**4**	**38**	**5**	**49**	0.2	**2**	**4**	**41**
Aroclor 1254	**1.1**	**11**	**0.9**	**9**	0.05	0.5	0.2	**1.2**
Aroclor 1260	**3**	**34**	**3**	**28**	0.2	**2**	0.8	**4**
Total 2,3,7,8-TCDD TEQs	0.7	**7**	**1.5**	**15**	0.02	0.2	0.9	**9**

Notes:
LOAEL - lowest observed adverse effect level
NOAEL - no observed adverse effect level
Shaded cells indicate hazard quotient greater than or equal to 1

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Figures

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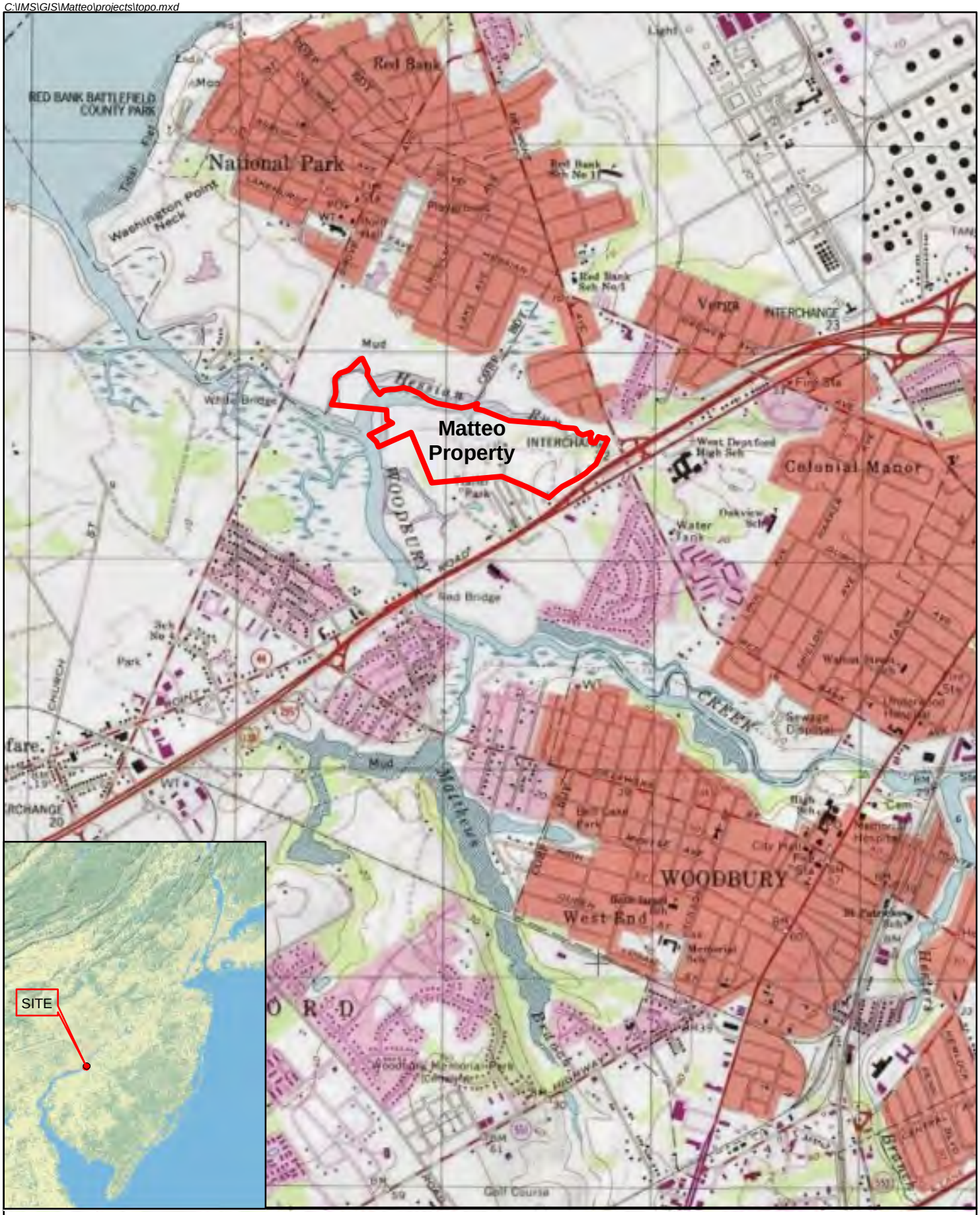

Source: USGS 7.5 Minute Quadrangle, Woodbury, NJ

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0 500 1,000 2,000 3,000 Feet

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Figure 1-1
Site Location Map
Matteo & Sons, Inc. Site
Thorofare, NJ

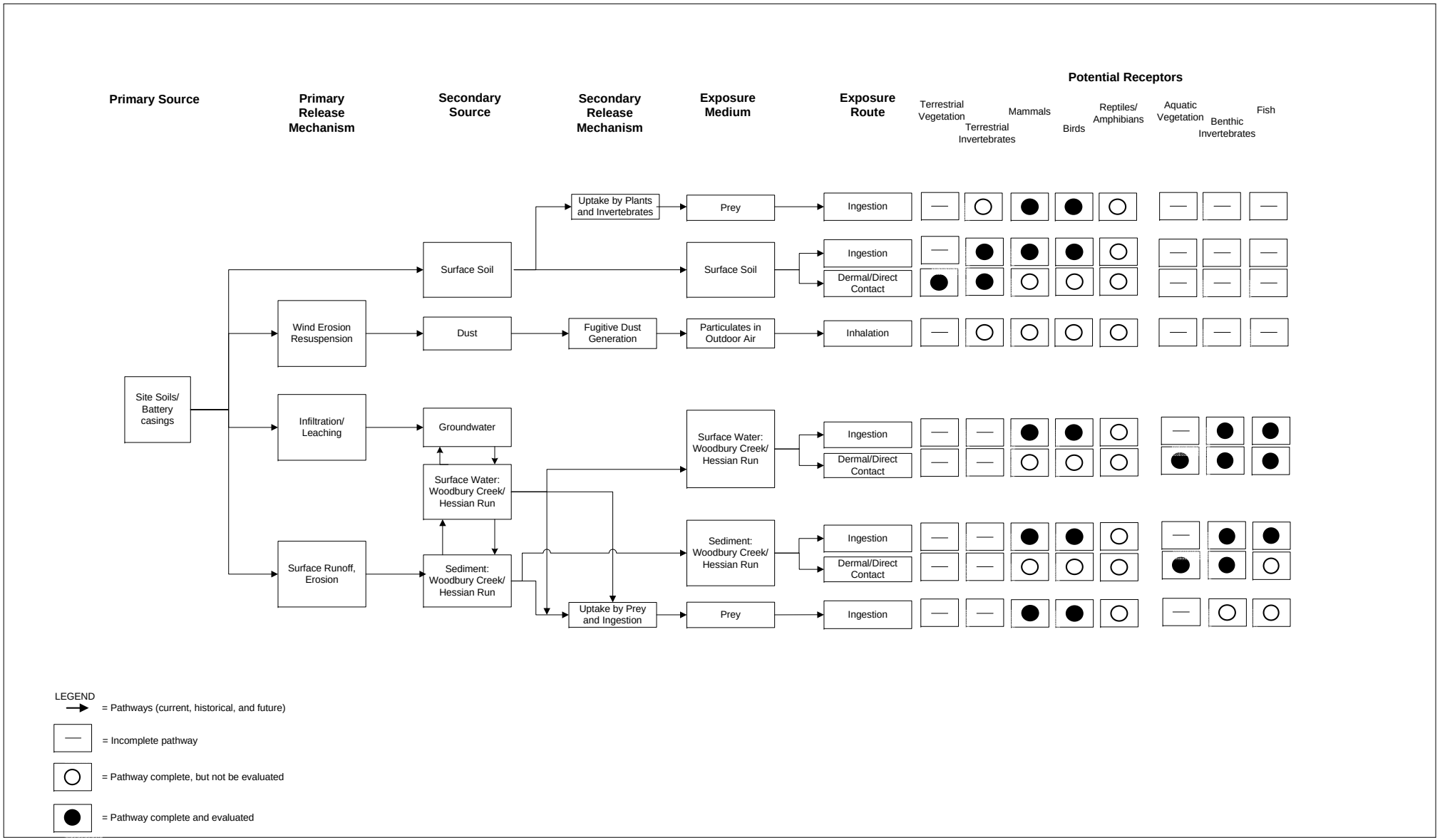

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Figure 2-1
Conceptual Site Model
Matteo & Sons, Inc. Site
Thorofare, NJ

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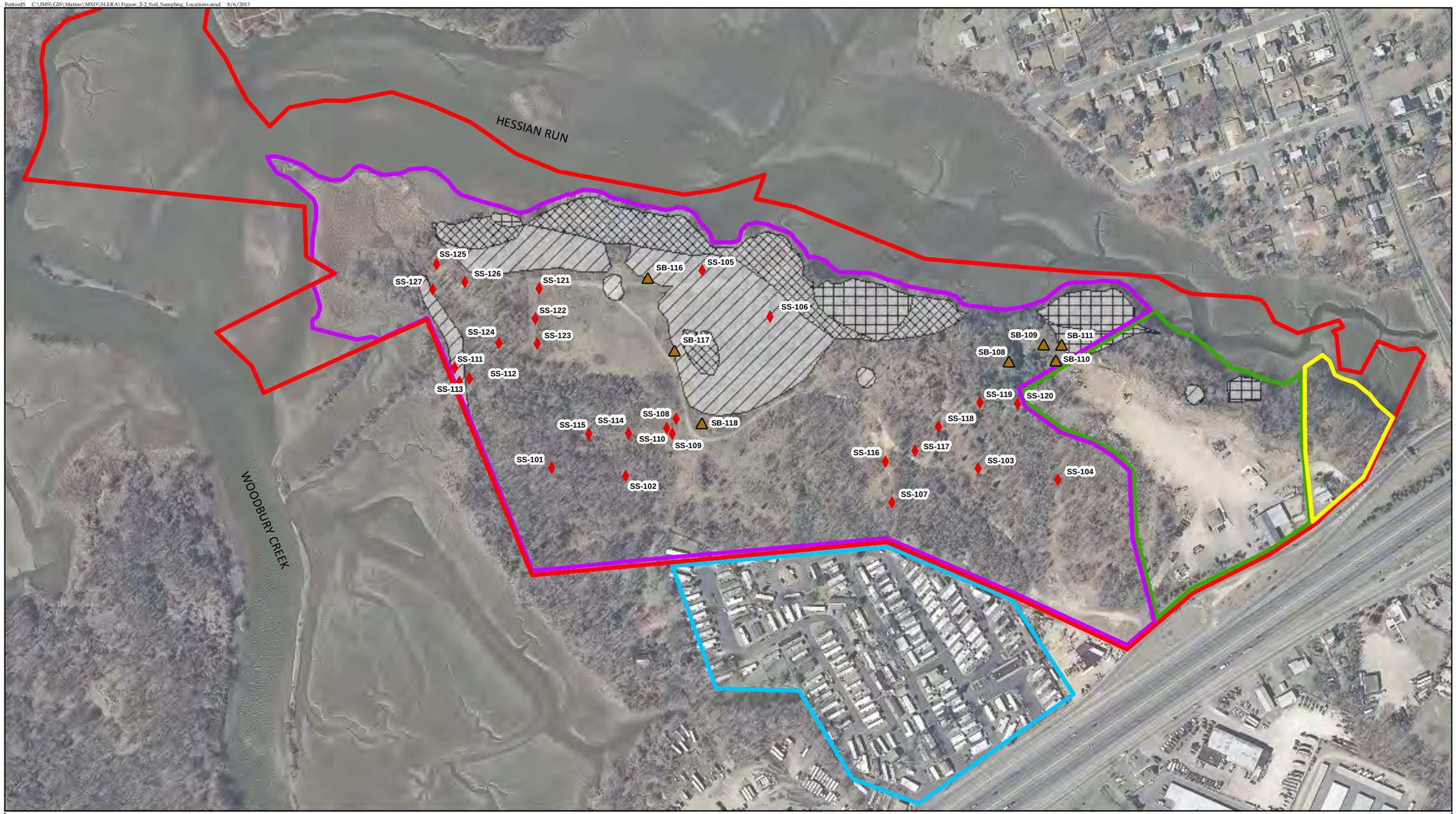

Site Areas

- Matteo Property
- Scrapyard Area
- Open Field/Waste Disposal Area
- Rental Home Area
- Willow Woods Property

- RI Soil Boring Sample Location
- RI Surface Soil Sample Location

Delineated Waste Disposal Areas

- Batteries and Waste
- Batteries
- Waste

N

0 150 300 600 Feet

1 inch = 300 feet

Figure 2-2
Soil Sample Locations
Matteo & Sons, Inc. Site
Thorofare, NJ

CDM Smith

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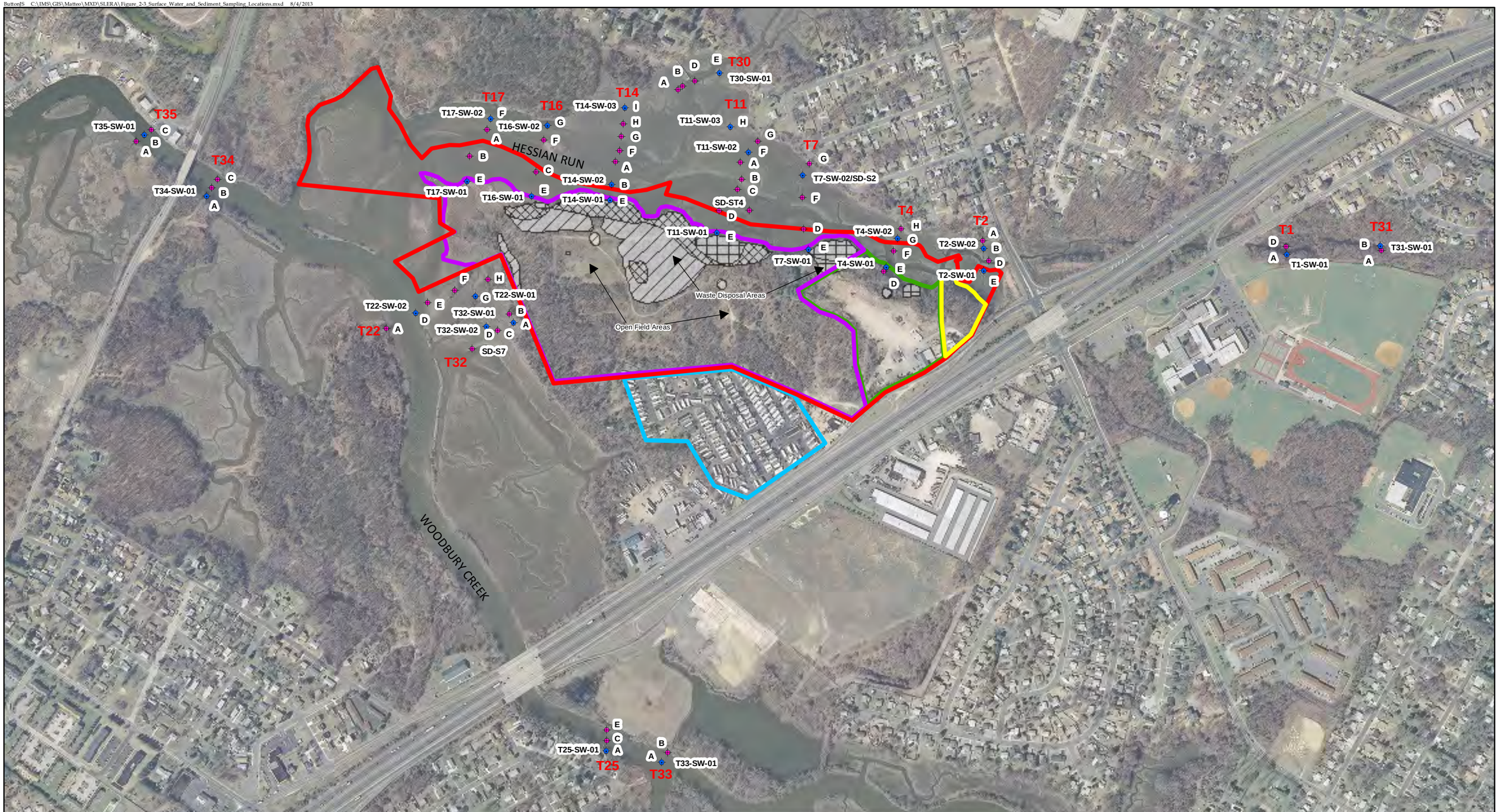


Site Areas

- Matteo Property
- Scrapyard Area
- Open Field/Waste Disposal Area
- Rental Home Area
- Willow Woods Property

- RI Surface Water Sample Location
- RI Sediment Core Sample Location

Delineated Waste Disposal Areas

- Batteries and Waste
- Batteries
- Waste

T25 Transect Label

N

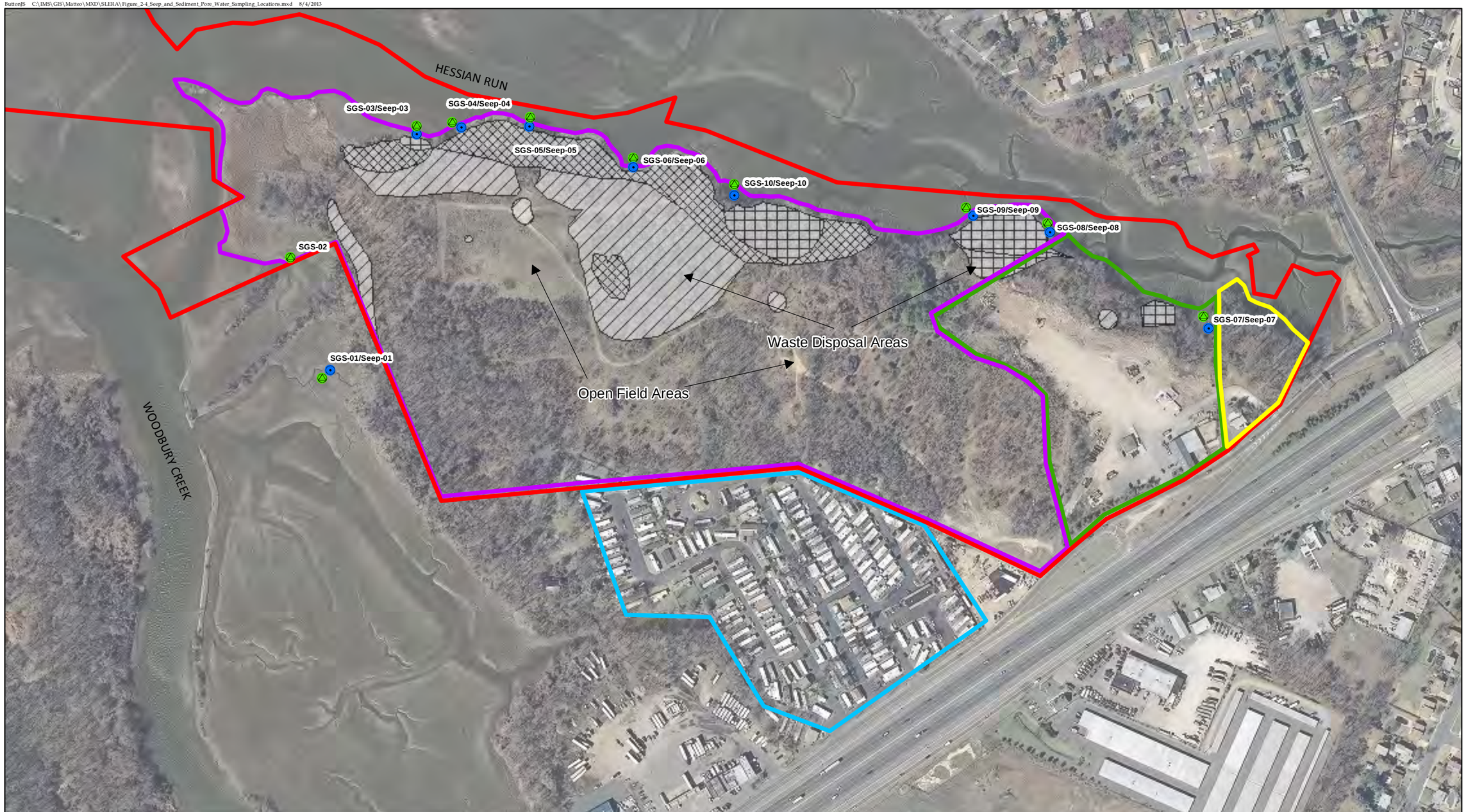
0 300 600 1,200 Feet

1 inch = 600 feet

Figure 2-3
Sediment and Surface Water Sample Locations
Matteo & Sons, Inc. Site
Thorofare, NJ

CDM Smith

ButtonJS C:\IMS\GIS\Matteo\MXD\SLERA\Figure_2-4_Seep_and_Sediment_Pore_Water_Sampling_Locations.mxd 8/4/2013



Site Areas

- Matteo Property
- Scrapyard Area
- Open Field/Waste Disposal Area
- Rental Home Area
- Willow Woods Property

- Sediment Porewater Sample Location
- Seep Sample Location

Delineated Waste Disposal Areas

- Batteries and Waste
- Batteries
- Waste

N

0 150 300 600 Feet

1 inch = 300 feet

Figure 2-4
Seep and Sediment Porewater Sample Locations
Matteo & Sons, Inc. Site
Thorofare, NJ

CDM Smith

Appendix A

Appendix A

Letters from the United States Environmental Protection Agency and New Jersey Department of Environmental Protection

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

JAN 2 6 2012

RECEIVED
JAN 3 0 2012
CDM SMITH
EDISON, NEW JERSEY

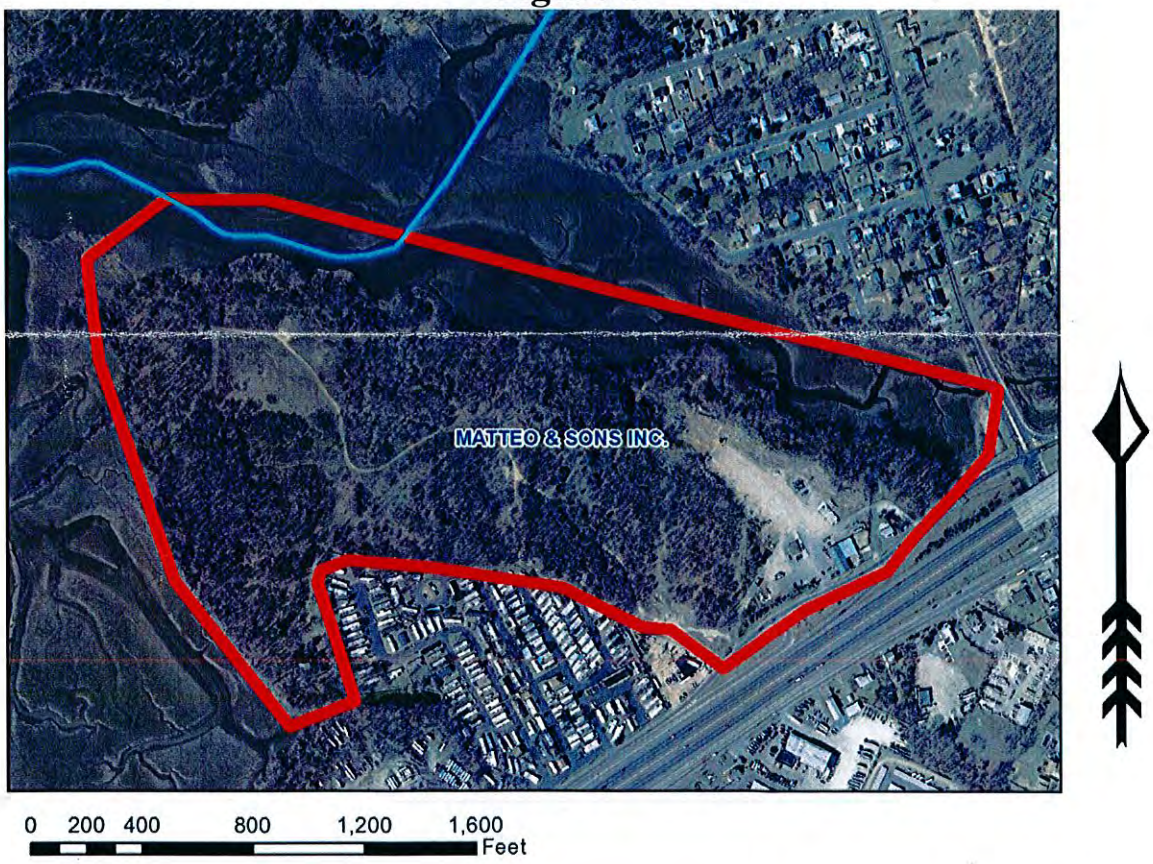
George G. Molnar
Environmental Scientist
CDM Federal
1110 Fieldcrest Avenue, 6th Floor
Edison, New Jersey 08837

Dear Mr. Molnar:

I have received your request for information concerning Federally-listed endangered or threatened species or critical habitats located on or in the vicinity of the Matteo & Sons Superfund Site, located in Thorofare, West Deptford Township, Gloucester County, New Jersey. It is my understanding that this information is needed to assist in the preparation of a screening level ecological risk assessment for this project.

The Matteo & Spns Superfund Site is an active scrap metal and recycling facility, consisting of a metal recycling operation, a junkyard, and an inactive, 224,000 square foot landfill comprised of crushed battery casings. Facility operations have led to widespread PCB and lead contamination onsite. Project boundaries are shown on Figure 1.

Figure 1



In accordance with procedures put in place by the New Jersey Field Office of the U.S. Fish and Wildlife Service (FWS), the Environmental Protection Agency (EPA) has reviewed the available information on the FWS website to determine what, if any, impacts to Federally-listed endangered or threatened species or critical habitats are possible as a result of the remedial investigation and future remediation of this site. We note that the table entitled "Federally Listed and Candidate Species Occurences in New Jersey by County and Municipality" indicates that there are historic records for swamp pink (*Helonias bullata*) from within West Deptford Township. This designation means that while current populations of swamp pink are not known to exist in the Township, there are historical records of its existence there.

The FWS New Jersey Field Office website notes that swamp pink is "...An obligate wetland species, swamp pink occurs in a variety of palustrine forested wetlands including swampy forested wetlands bordering meandering streamlets, headwater wetlands, sphagnous Atlantic white-cedar swamps, and spring seepage areas. Specific hydrologic requirements of swamp pink limit its occurrence within these wetlands to areas that are perennially saturated, but not inundated, by floodwater. The water table must be at or near the surface, fluctuating only slightly during spring and summer months. Groundwater seepage with lateral groundwater movement are common hydrologic characteristics of swamp pink habitat."

In order to determine if swamp pink habitat could exist within the project area, an examination of National Wetlands Inventory (NWI) mapping, as well as available aerial photography, was conducted. Our investigation notes that small portions of the site, generally along the western, northern, and eastern boundaries, have been delineated as NWI wetlands. These wetlands are almost entirely comprised of riverine, tidal, unconsolidated shore, mud, regularly flooded wetlands, along with a very small area of palustrine emergent wetlands (see Figure 3). NWI mapping does not indicate the presence of any forested wetlands within the project impact area. Further, the regular flooding of these wetlands would tend to preclude the presence of swamp pink based upon the above information developed by the FWS. Therefore, we do not anticipate any impacts to swamp pink as a result of site-related activities. Further, there are no other Federally-listed endangered or threatened species or critical habitats listed for West Deptford Township.

Consequently, in consideration of the above, we have determined that the investigation and cleanup of the Matteo & Sons Superfund Site will have no affect on any Federally-listed threatened or endangered species or critical habitats. A letter from FWS confirming EPA's ability to make this determination has been enclosed.

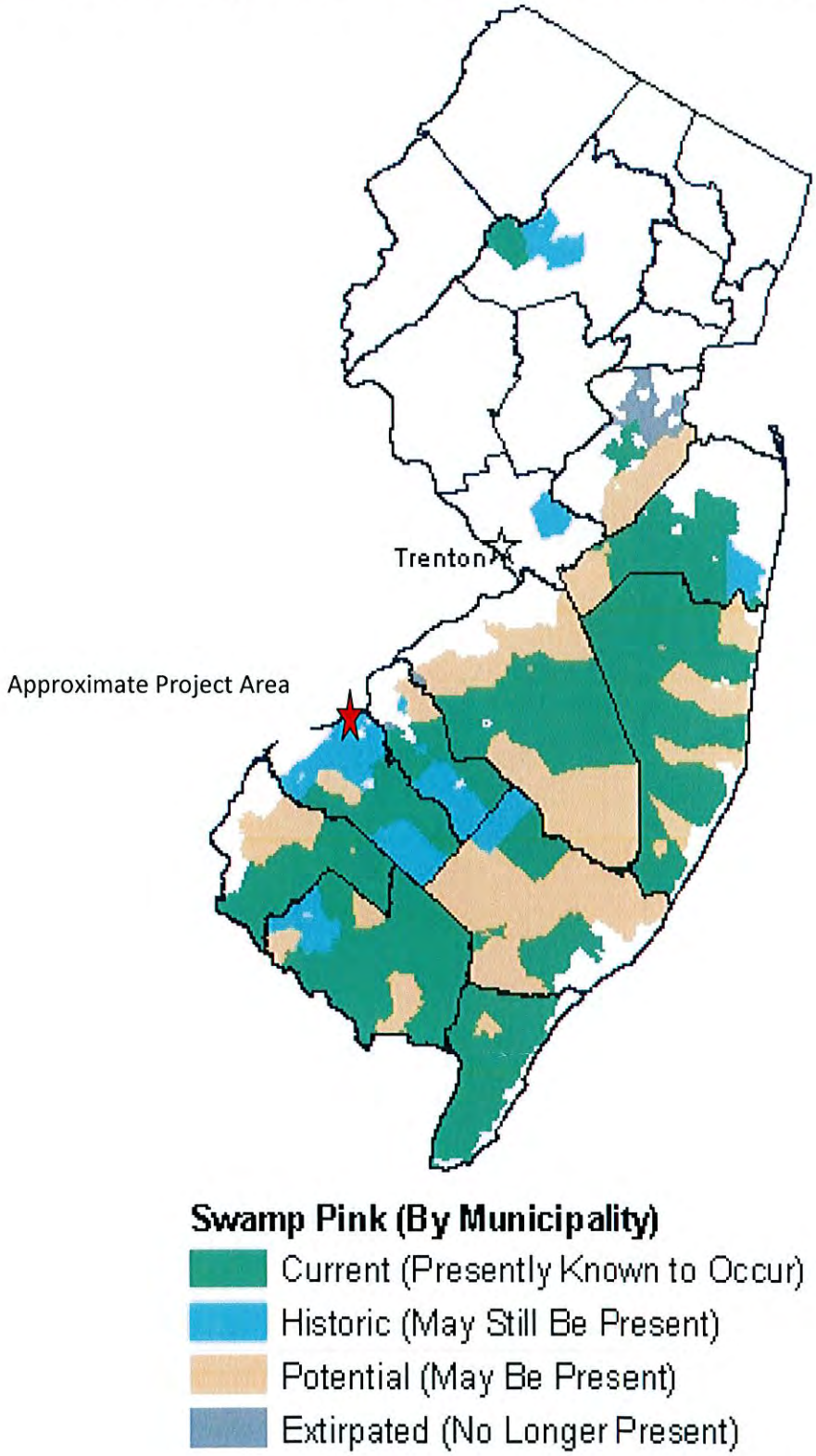
Please note that should the scope of future investigations or cleanups associated with this site go beyond the approximate boundaries of Figure 1, or should additional species be listed under the Endangered Species Act, a revised determination from this office will be needed.

Sincerely,

Steven J. Ferreira, Environmental Scientist
Environmental Review Section

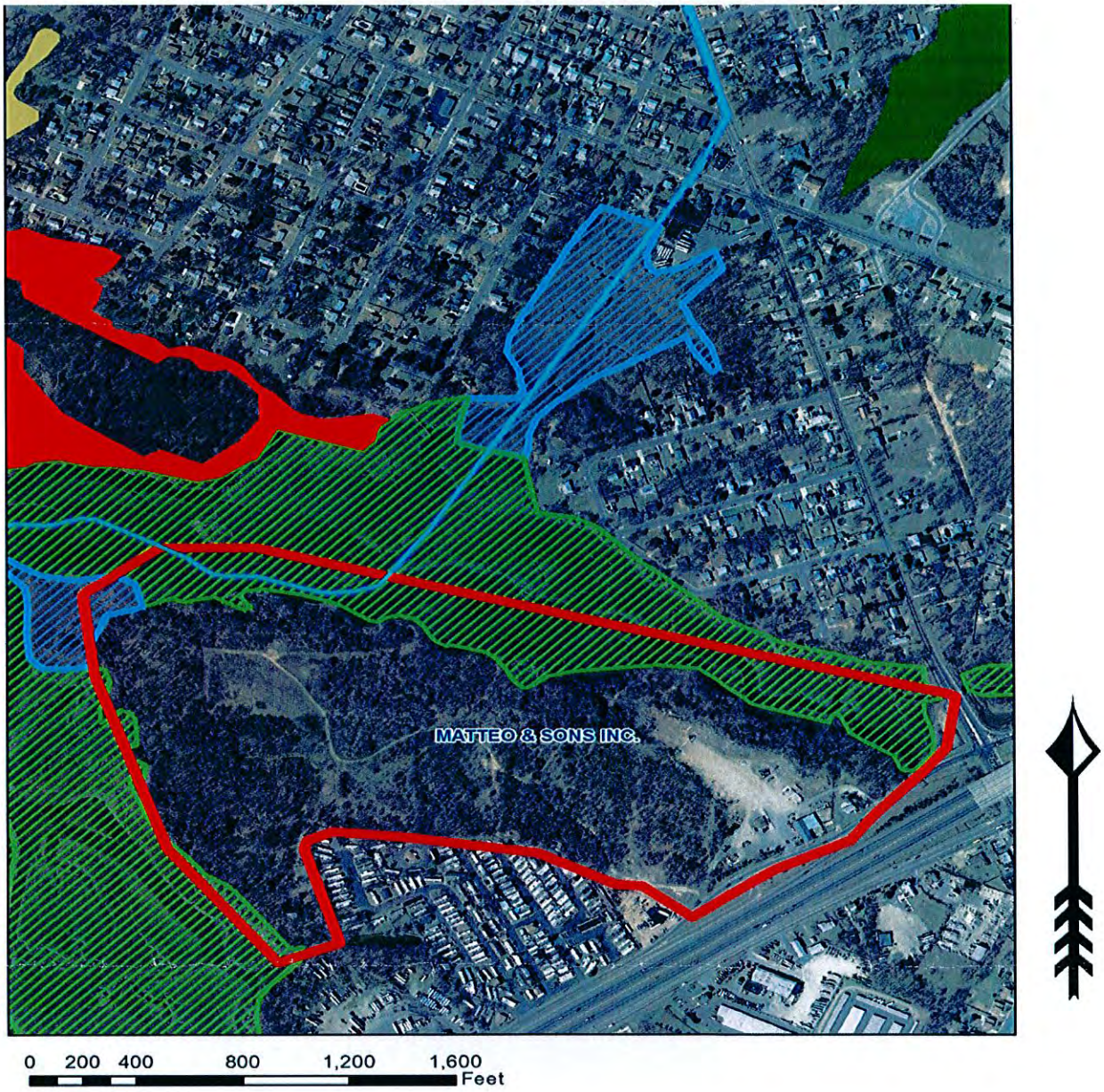
Enclosure

Figure 2: Swamp Pink Distribution in New Jersey (US FWS)



http://www.fws.gov/northeast/njfieldoffice/Endangered/swamppink.html#distribution

Figure 3: National Wetlands Inventory Wetlands Map For the Matteo & Sons Superfund Site



Legend	
	Site Boundary
National Wetlands Inventory	
	Riverine Wetlands
	Palustrine Emergent Wetlands
	Freshwater Emergent Wetlands

United States Department of the Interior

FISH AND WILDLIFE SERVICE

New Jersey Field Office
927 North Main Street, Building D
Pleasantville, New Jersey 08232
Tel: 609-646-9310 Fax: 609-646-0352
http://www.fws.gov/northeast/njfieldoffice

March 10, 2009

To Whom It May Concern:

Section 7(a)(2) of the Endangered Species Act (ESA) requires Federal agencies to consult with the U.S. Fish and Wildlife Service (Service) to ensure that actions they fund, authorize, permit or otherwise carry out will not jeopardize the continued existence of any listed species or adversely modify designated critical habitats. Federal agencies must initiate consultation with the Service if a proposed action *may affect* one or more listed species. In addition, the Service provides review of non-Federal actions that *may affect* federally listed species or their habitats as technical assistance to help non-Federal project proponents ensure compliance with the ESA and with New Jersey land use regulations. Staffing constraints currently limit the Service's New Jersey Field Office to reviewing only those projects that *may affect* federally listed species. The *may affect* determination is made by the Federal action agency or non-Federal project proponent using the information and instructions on our web site.

http://www.fws.gov/northeast/njfieldoffice/Endangered/consultation.html

Federal agencies are not required to contact the Service if a proposed action will have *no effect* on listed species, or if no listed species are present in the action area. No further ESA consultation or coordination is necessary for projects where the Federal action agency or non-Federal project proponent has followed the procedures on our web site and determined that proposed project activities will have *no effect* on federally listed species. Service concurrence with a *no effect* determination is not required under the ESA and will not be provided by the New Jersey Field Office. In addition to this letter, the Federal action agency or non-Federal project proponent should retain in their paper files documentation from our web site at the time of their review, including the relevant portion(s) of the *Federally Listed and Candidate Species Occurrences in New Jersey by County and Municipality*. Note that under the ESA, a species list is valid for only 90 days; the Service recommends consulting our web site regularly during project planning and implementation for updated species lists and information.

Thank you for your cooperation. Please contact Wendy Walsh at (609) 383-3938, extension 48, if you have any questions or require further assistance regarding federally listed threatened or endangered species.

Sincerely,

J Eric Davis Jr.
Supervisor

State of New Jersey

CHRIS CHRISTIE
Governor

KIM GUADAGNO
Lt. Governor

DEPARTMENT OF ENVIRONMENTAL PROTECTION
Division of Parks and Forestry
Mail Code 501-04
ONLM -Natural Heritage Program
P.O. Box 420
Trenton, NJ 08625-0420
Tel. #609-984-1339
Fax. #609-984-1427

BOB MARTIN
Commissioner

November 15, 2011

George C. Molnar
CDM
110 Fieldcrest Avenue, 6th Floor
Edison, NJ 08837

Re: Matteo & Sons Site

Dear Mr. Molnar:

Thank you for your data request regarding rare species information for the above referenced project site in West Deptford Township, Gloucester County.

Searches of the Natural Heritage Database and the Landscape Project (Version 3 for the highlands region, Version 2.1 elsewhere) are based on a representation of the boundaries of your project site in our Geographic Information System (GIS). We make every effort to accurately transfer your project bounds from the topographic map(s) submitted with the Request for Data into our Geographic Information System. We do not typically verify that your project bounds are accurate, or check them against other sources.

We have checked the Natural Heritage Database and the Landscape Project habitat mapping for occurrences of any rare wildlife species or wildlife habitat on the referenced site. Please see Table 1 for species list and conservation status.

Table 1 (on referenced site).

Common Name	Scientific Name	Federal Status	State Status	Grank	Srank
great blue heron	*Ardea herodias*		SC/S	G5	S3B,S4N

Neither the Natural Heritage Database nor the Landscape Project has records for any additional rare wildlife species or wildlife habitat within 1/4 mile of the referenced site.

We have also checked the Natural Heritage Database for occurrences of rare plant species or ecological communities. The Natural Heritage Database does not have any records for rare plants or ecological communities on or within 1/4 mile of the site.

A list of rare plant species and ecological communities that have been documented from Gloucester County can be downloaded from http://www.state.nj.us/dep/parksandforests/natural/heritage/countylist.html. If suitable habitat is present at the project site, the species in that list have potential to be present.

Status and rank codes used in the tables and lists are defined in EXPLANATION OF CODES USED IN NATURAL HERITAGE REPORTS, which can be downloaded from http://www.state.nj.us/dep/parksandforests/natural/heritage/nhpcodes_2008.pdf.

If you have questions concerning the wildlife records or wildlife species mentioned in this response, we recommend that you visit the interactive I-Map-NJ website at the following URL, http://www.state.nj.us/dep/gis/depsplash.htm or contact the Division of Fish and Wildlife, Endangered and Nongame Species Program at (609) 292 9400.

PLEASE SEE 'CAUTIONS AND RESTRICTIONS ON NHP DATA', which can be downloaded from http://www.state.nj.us/dep/parksandforests/natural/heritage/newcaution2008.pdf.

Thank you for consulting the Natural Heritage Program. The attached invoice details the payment due for processing this data request. Feel free to contact us again regarding any future data requests.

Sincerely,

Robert J. Cartica
Administrator

c: NHP File No. 11-3907572-0290

Appendix B

Appendix B

United States Environmental Protection Agency/Environmental Response Team Ecological Risk Assessment, Matteo Iron and Metal Site (Provided on CD)

Lockheed Martin Technology Services
Environmental Services REAC
2890 Woodbridge Avenue Building 209 Annex
Edison, NJ 08837-3679
Telephone 732-321-4200 Facsimile 732-494-4021

LOCKHEED MARTIN

DATE: 14 July 2005

TO: Mark D. Sprenger, Ph.D., EPA/ERT Work Assignment Manager

THROUGH: Dennis Miller, REAC Program Manager

FROM: Karen Kracko, REAC Task Leader

SUBJECT: DOCUMENT TRANSMITTAL UNDER WORK ASSIGNMENT 0-148

Attached please find the following document prepared under this work assignment:

FINAL REPORT
Ecological Risk Assessment
Matteo Iron and Metals Site
West Deptford, New Jersey

cc: Central File - WA 0-148 (w/attachment)
Dennis Miller, REAC Program Manager (w/o attachment)

REAC

OFFICE OF EMERGENCY AND REMEDIAL RESPONSE

FINAL REPORT
MATTEO IRON AND METAL SITE
ECOLOGICAL RISK ASSESSMENT
WEST DEPTFORD, NEW JERSEY
JULY 2005

U.S. EPA Work Assignment No.: 0-148
Lockheed Martin Work Order No.: EAC00148
U.S. EPA Contract No.: EP-C-04-032

Prepared by:

Lockheed Martin/REAC

FOR K.KRACKO

Karen Kracko
Task Leader

7/14/05
Date

Dennis Miller
Program Manager

7/14/05
Date

Prepared for:

EPA/ERT
Mark D. Sprenger, PhD
Work Assignment Manager

0148-DFR-071405

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LIST OF ACRONYMS AND ABBREVIATIONS

AUF	Area Use Factor
BM	Benchmark
BTAG	Biological Technical Assistance Group
BW	Body weight
°C	Degrees centigrade
C_F	Concentration of contaminant in food
C_S	Concentration of contaminant in sediment/soil
C_W	Concentration of contaminant in water
cm	Centimeter
COPC	Contaminant of Potential Concern
DO	Dissolved oxygen
d.w.	Dry weight
e.g.	For example
EC_{50}	Effective Concentration for 50% of exposed organisms
ED_{50}	Effective Dose for 50% of dosed organisms
EPA	United States Environmental Protection Agency
ERA	Ecological Risk Assessment
ERT	Environmental Response Team
etc.	Etcetera
ft	Feet
FIR	Food ingestion rate
g	Grams
GPS	Global Positioning System
≥	Greater than or equal to
HQ	Hazard Quotient
ID	Identification
i.e.	In other words
kg	Kilogram
Pb	Lead
L	Liter
LC_{50}	Lethal Concentration for 50% of exposed organisms
LEL	Lowest effect level
LD_{Lo}	Lowest Lethal Dose
LOAEL	Lowest Observed Adverse Effect Level
LD_{50}	Lethal Dose for 50% of exposed organisms
Hg	Mercury
MDL	Method detection limit
µ	Micron
µS/cm	Microsiemens per centimeter
mg/kg BW/day	Milligrams per kilogram body weight per day
mg/L	Milligrams per liter
mm	Millimeter
m	Meter
MATC	Maximum Acceptable Toxicant Concentration
µg/kg	Micrograms per kilogram
µg/L	Micrograms per liter
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
mL	Milliliter
NIST	National Institute for Standards and Technology
NJAC	New Jersey Administrative Code

NJDEP	New Jersey Department of Environmental Protection
NOAEL	No Observed Adverse Effect Level
NTU	Nephelometric Turbidity Units
Pb	Lead
PCB	Polychlorinated Biphenyls
PEM1	Persistent wetlands
%	Percent
PFO1	Palustrine forested broad-leaved deciduous wetlands
ppm	Parts per million
ppt	Parts per thousand
R1EM	Riverine tidal emergent wetland
R1OW	Riverine tidal open water
REAC	Response, Engineering and Analytical Contract
RI	Remedial Investigation
SEL	Severe effect level
sp.	Species
SRM	Standard reference materials
SRT	Standard reference toxicant
std units	Standard units
SLERA	Screening Level Ecological Risk Assessment
SIR	Sediment/Soil ingestion rate
SOP	Standard Operating Procedure
SWQS	Surface Water Quality Standards
TRV	Toxicity Reference Value
TAL	Target Analyte List
TLm	Threshold Limit - median
TOC	Total Organic Carbon
U.S.	United States
WIR	Water ingestion rate
WA	Work Assignment
ww	Wet weight

1.0 INTRODUCTION

1.1 Site Background

The Matteo Iron and Metal Site is an 80-acre property located in West Deptford, Gloucester County, New Jersey (NJ). It is bordered by Woodbury Creek and Hessian Run to the west, United States (U.S.) Highway 130 to the south, and Belmont Avenue to the east. The Site was historically used for farming and is currently used as a scrap metal recycling facility. The majority of the site is heavily vegetated, undeveloped land. Based on available records, the Matteo family operated an unregistered landfill and junkyard, and a metals recycling facility at the site since 1961. From 1971 to 1985, a "sweating fire box" was used to melt lead (Pb) battery terminals for Pb reclamation (Berger 2004a). Currently, the junk yard accepts primarily non-automotive scrap, but it formerly accepted large numbers of automotive batteries. The landfill accepted industrial and domestic waste; a large portion of the landfill capacity was devoted to automotive battery casings. These casings are primarily located along the banks of Hessian Run (NJDEP 1996).

As a result of the above activities, Pb has been identified as the primary contaminant of potential concern (COPC) in surface soils, surface water, sediment and groundwater at this site. Polychlorinated biphenyl (PCB) contamination has also been identified in some surface soils and sediments.

1.2 Site Description

The Matteo Iron and Metal Site is located at the confluence of Woodbury Creek and Hessian Run, which are tidally influenced at this location. Tidal fluctuations range from approximately 5.4 feet at neap tide to approximately 6 feet at spring tides. At low tide, Woodbury creek is approximately 10 feet deep while Hessian Run is a narrow stream less than a foot deep (Berger 2004b). Both Woodbury Creek and Hessian Run are classified as FW-2NT/SE2 waterways in which there may be a freshwater/saltwater interface as determined by salinity measurements at mean high tide. However, salinity measurements in both streams taken during the Remedial Investigation (RI) averaged 0.01 parts per thousand (ppt), indicating a freshwater habitat (Berger 2004b). The marshes associated with Woodbury Creek and Hessian Run are freshwater tidal marshes. These areas have been identified by the Atlantic Coast Inventory as part of the Delaware River Estuary (NJDEP 1996).

1.3 Purpose and Scope of Work

The purpose of this investigation was to conduct an ecological risk assessment (ERA) using existing site-specific data. Available data included PCB and Pb concentrations in surface soil (Pb only), sediment, water (Pb only), and tissue (fish, clam, earthworm and plant); sediment toxicity tests conducted with *Hyalella azteca* and *Chironomus tentans*; a benthic community survey; and a fish community survey (Berger 2004b). No additional data were collected.

2.0 SCREENING LEVEL RISK ASSESSMENT (Steps 1 and 2, U.S. EPA 1997)

The purpose of a screening-level ecological risk assessment (SLERA) is to determine whether site-related ecological effects are negligible, or whether there is a potential for adverse ecological effects and a more detailed ERA is needed.

2.1 Screening-Level Problem Formulation and Ecological Effects Evaluation

The initial step in the SLERA is to determine the nature and extent of site-related contamination and to characterize potential ecological receptors. Based on known site history and existing chemical data, Pb and PCBs are the COPCs at this site. Lead and PCBs are present in surface soils and sediments on-site; Pb is also present in surface water and groundwater (Berger 2004a).

2.2 Screening-Level Exposure Estimate and Risk Calculation

In the second step of the SLERA, risk was estimated by comparing Pb and PCB concentrations measured on-site with ecological screening benchmark (BM) values. Lead concentrations measured in surface water were compared to the New Jersey Department of Environmental Protection (NJDEP) Surface Water Quality Standards (SWQS), New Jersey Administrative Code (N.J.A.C.) 7:9B. Lead and PCB concentrations measured in sediment samples were compared to the Lowest Effect Level (LEL) and Severe Effect Level (SEL) Sediment Quality Criteria cited in NJDEP (1998).

For data collected in the RI, the concentration of Pb in most of the unfiltered surface water samples (20 of 24) exceeded the SWQS for ecological receptors (Table 5-32; Berger 2004a). In general, Pb concentrations measured in unfiltered samples collected at low tide exceeded concentrations in samples collected at the same location at high tide. Lead concentrations in two of the filtered samples exceeded the SWQS for ecological receptors (Table 5-32; Berger 2004a). In sediment, measured Pb concentrations exceeded the LEL at all three depths sampled (0-6 inches, 12-24 inches, and 24-36 inches) throughout the study area. The SEL was also exceeded at all three depth intervals; with the exception of one sample, all SEL exceedances were within Hessian Run. The highest Pb concentration (greater than 15,000 milligrams per kilogram [mg/kg]) was detected along the central portion of the north shoreline of the site (Sample T9-E, Table 5-26; Berger 2004a).

The LEL and SEL sediment criteria for PCBs are Aroclor-specific; Aroclor 1254 was the most prevalent Aroclor measured. Detected concentrations of Aroclor 1254 exceeded the LEL at all three depths sampled. The majority of Hessian Run was affected, with the exception of the central channel portions. In Hessian Run, the extent of the LEL exceedance is greater in the top two feet of sediment than in the 24- to 36-inch depth interval. In Woodbury Creek, the greatest extent of LEL exceedance is in the 24- to 36-inch interval. At two sample locations along the central portion of the north shoreline adjacent to the Site, PCB concentrations in sediment exceeded the SEL (Sample T9-E and T11E; Table 5-27; Berger 2004a).

For data collected in the Aquatic Biota Study (Berger 2004b), total Pb concentrations in surface water samples did not exceed acute aquatic life protection criteria but did exceed chronic aquatic life protection criteria at six of ten sample stations. The concentration of Pb in sediment exceeded the LEL at all ten sample locations, and the concentration of Pb in sediment exceeded the SEL at three sample stations (located adjacent to the site). The concentration of PCBs measured at eight of the ten sample locations exceeded the LEL, but none exceeded the SEL (Berger 2004b).

Based on the SLERA, further evaluation of risk from site-related Pb and PCBs is required.

3.0 PROBLEM FORMULATION (Steps 3 and 4, EPA 1997)

The purpose of problem formulation is to establish the goals, extent, and focus of the ERA for the site. Problem formulation constitutes Steps 3 and 4 of the United States Environmental Protection Agency (EPA) guidance. In the problem formulation phase, the questions and issues that need to be addressed are defined based on potentially complete exposure pathways and ecological effects. The problem formulation presented here was developed according to the guidelines established in the Ecological Risk Assessment Guidance for Superfund (U.S. EPA 1997).

3.1 Contaminants of Potential Concern

Based on known site history and existing chemical data from site investigations, Pb and PCBs were selected as the COPCs at this site.

3.2 Ecological Effects

A literature search was conducted to obtain information on the ecological effects of Pb and PCBs. If data were available, attempts were made to include toxicity information for species of concern that may be present at or

near the site. Toxicological profiles for Pb and PCBs are presented in Appendix A.

3.3 Ecosystems Potentially at Risk

The objective of the exposure assessment was to determine the pathways and media through which receptors may be exposed to site contaminants. Potential exposure pathways are dependent on habitats and receptors present on-site, the extent and magnitude of contamination, and environmental fate and transport of COPCs.

The Matteo Iron and Metal Site is located in West Deptford, NJ (Figure 1), and is comprised of forest and meadow habitats, extensive freshwater tidal wetlands, a metal recycling area, a junkyard, and an inactive landfill. The upland areas are comprised of approximately 55 acres of forested habitat, scrub/shrub habitat, and open fields. The forest habitat is dominated by red oak, post oak, white oak and black cherry in the canopy. Stand age is variable, with older stands along the border of the Site where disturbance has been minimal. The open meadow habitat is in the center of the Site, and is associated with the former agriculture activities. Dominant plants in this habitat include small white aster, grasses, and mugwort. Four types of wetlands were observed on-site: riverine tidal emergent wetlands (R1EM), palustrine emergent, persistent wetlands (PEM1), palustrine forested broad-leaved deciduous wetlands (PFO1), and riverine tidal open water (R1OW) (Berger 2004a).

The Matteo Iron and Metal Site may provide habitat for a variety of wildlife species due to the diversity of habitat types present and the location adjacent to an extensive freshwater tidal marsh. Bird and mammal species observed utilizing the Site during the RI and Aquatic Biota Study are listed below:

<u>BIRDS:</u>
Red-tailed hawk (*Buteo jamaicensis*)
Mallard duck (*Anas platyrhynchos*)
American crow (*Corvus brachyrhynchos*)
Belted kingfisher (*Ceryle alcyon*)
Blue jay (*Cyanocitta cristata*)
Canada goose (*Branta canadensis*)
Downy woodpecker (*Dicoides pubescens*)
Carolina chickadee (*Poecile carolinesis*)
Great horned owl (*Bubo virginianus*)
Herring gull (*Larus argentatus*)
House sparrow (*Passer domesticus*)
Killdeer (*Charadrius vocifeerus*)
Mockingbird (*Minus dolyglottos*)
Mourning dove (*Zenaida macroura*)
Northern cardinal (*Cardinalis cardinalis*)
Red-winged blackbird (*Agelaius phoeniceus*)
Song sparrow (*Melospiza melodia*)
White-breasted nuthatch (*Sitta carolinensis*)
Great egret (*Ardea alba*)
Osprey (*Pandion haliaetus*)
Common tern (*Sterna hirundo*)
Cormorant (*Phalacrocorax auritus*)

<u>MAMMALS:</u>
Eastern gray squirrel (*Sciurus carolinensis*)
White-tailed deer (*Odocoilus virginianus*)
Muskrat (*Ondotra zibethicus*)
Cottontail rabbit (*Sylvilagus floridanus*)

Bird species not observed on-site during the field investigations but that would likely utilize the creeks and associated tidal flats and marsh include shorebirds, waterfowl and wading birds. Some wetland-dependant species may utilize the wetlands during breeding season. Other species may utilize the tidal marshes during migration for resting and feeding.

3.4 Assessment Endpoints

Assessment endpoints are explicit expressions of the actual environmental values (i.e., ecological resources) that are to be protected. Valuable ecological resources include those without which ecosystem function would be significantly impaired or those providing critical resources (e.g., habitat). Appropriate selection and definition of assessment endpoints are critical to the utility of a risk assessment as they focus risk assessment design and analysis. It is not practical or possible to directly evaluate risks to all of the individual components of the ecosystem on-site, so assessment endpoints are used to focus the risk assessment on particular components of the ecosystem that could be adversely affected by the contaminants associated with the site. In general, the assessment endpoints selected for the site are aimed at the viability of aquatic and terrestrial populations and organism survivability.

Each assessment endpoint was chosen in an attempt to evaluate and protect the various communities that utilize the aquatic, wetland and upland habitats present on the Matteo Iron and Metal Site. By protecting each of these assessment endpoints, the aquatic and terrestrial ecosystems should be protected based on the concepts of trophic dynamics/energy transfer and population and community dynamics. The concept of trophic dynamics is based on the assumption that plants and animals can be placed into feeding groups or trophic levels, where the energy from one level can be passed onto the level above it, thereby keeping the system in a state of equilibrium (Smith 1980). An example of a simple trophic level transfer would be a plant (primary producer), which is eaten by an herbivore, which is eaten by a carnivore. Trophic/energy transfer is an important consideration when assessing ecosystem health, as deleterious effects to any one level may affect the overall energy budget of the system. In a system impacted by contaminants, trophic transfer takes on another level of importance as energy transfer may now include the potential transfer of contaminants up the food chain through bioaccumulation/biomagnification.

The concepts of population and community dynamics are also integral to the concept of trophic dynamics. A population may be defined as a group of individuals of the same species within an ecosystem. Populations occupy specific niches in the community and therefore within the energy budget of the ecosystem. As such, population level effects (factors affecting mortality, reproduction, immigration, etc.) are critical to energy transfer and community dynamics. A community may be defined as a group of populations living together in an environment that interact through competition, predation, mutualism, etc. Community interactions influence community attributes such as species abundance and diversity, which are critical parameters in the assessment of ecosystem structure and energy transfer. Protection of an ecosystem must take into consideration trophic, population, and community dynamics.

While an assessment endpoint focuses primarily on specific effects to a given population, it is with an understanding that the population does not exist within a "black box", but rather interacts with and affects other populations, the community, and the trophic dynamics of that community and ecosystem. For example, some of the assessment endpoints chosen for this ERA examine populations that function as both predators and prey. Predation, while critical to energy transfer in the system, also plays an important role in regulating and maintaining population size and species abundance and diversity. For example, piscivorous/aquatic feeding birds prey on fish and benthic organisms, thereby potentially affecting the density and diversity of these populations and communities. Conversely, the piscivorous/aquatic feeding birds may also serve as prey items to upper level carnivores and contribute to regulating the density and diversity of upper trophic levels. The concept of energy transfer is critical, and will be discussed individually for each endpoint. Each endpoint relates to some population or community level in a system where protection of the given endpoint will help preserve the overall function and integrity of the trophic, population, and community dynamics. More specifically, the overall assessment endpoint for this ERA is viability of the aquatic, wetland and terrestrial

ecosystems associated with the Matteo Iron and Metal site. As such, each of the specific assessment endpoints listed are sub-categories of this overall endpoint. It is through the protection of these various populations and communities that the overall health of the system is ensured. The assessment endpoints, testable hypotheses, and measurement endpoints are summarized below.

3.4.1 Assessment Endpoint No. 1: Viable Tidal Flat Community Structure and Function

The functioning of a tidal flat has a direct impact on the health of the entire ecosystem associated with the tidal flat. The tidal flat provides exclusive habitat and refuge for many species. Small fish move into the shallows as a refuge from predatory fish. Tidal flats function as nurseries for estuarine organisms, provide food and refuge from predators, and play an important role in energy flow, nutrient cycling, and organic matter processing. Biota utilizing the tidal flat often rely extensively on the resources (e.g., forage) available during high tide when fish move to the tidal flat to feed on the resident community. At low tide, birds and some mammals move onto the tidal flat to feed.

Alteration of the community structure can result in a loss of forage species which can result in a loss of the functionality of the system in supporting the growth and development of other members of the tidal flat community. For example, if large invertebrates are absent from the tidal flat, there may be effectively no food for foraging birds at low tide or larger fishes at high tide.

The benthic macroinvertebrate community also plays a role in the tidal flat community. The benthic macroinvertebrate community is typically diverse taxonomically, morphologically, and physiologically, and often consists of numerically abundant populations. Additionally, the benthic macroinvertebrate community plays a key role in ecosystem functions such as nutrient cycling and organic matter processing, and is a food resource for the pelagic community, including fish, as well as semiaquatic organisms such as birds and mammals.

The benthic macroinvertebrate community was determined to be of concern in the tidal flats due to its role in energy flow and materials cycling, its potential for exposure to contaminants, and its role as a food source for higher trophic level organisms.

3.4.2 Assessment Endpoint No. 2: Tidal Flat Nursery and Refuge Functioning

Tidal flats function as nursery and refuge areas for small and developing aquatic organisms. These organisms may include developing and growing fishes and young fishes migrating to coastal bays. In addition, many other young and developing organisms utilize tidal flats for refuge or protection from predators or avoidance of adverse environmental conditions (e.g., moving into quiet waters to rest). Examples of species in the Delaware River system which use tidal flats for their nursery function and as a migration pathway are American shad (*Alosa sapidissima*) and striped bass (*Morone saxatilis*).

Fish serve a vital role in nutrient and energy transfer within an aquatic system. Specifically, fish act as a link between aquatic and terrestrial ccosystems and between the benthic and pelagic environments. Fish that consume benthic organisms are consumed by other fish, who are in turn consumed by terrestrial organisms such as mammals and birds. These predator-prey interactions represent a transfer of energy from and within the aquatic ecosystem. Since the number of organisms supported at any position in a food chain depends upon the energy supply available, the role of energy transfer played by fish is integral to the productivity of an aquatic ecosystem. Furthermore, since energy and nutrient cycles are delicately balanced, even a small decline in the fish population can have detrimental impacts on the balance of energy within an ecosystem.

Fish are also important recreationally and commercially. It has been shown that declines in fish populations associated with chemical contamination have adversely affected commercial and recreational fishing industries in many areas of the country (Natural Resource Council 1992; Miller

et al. 1993). In some areas this has had a major impact on local economies due to losses from decreased tourism and decreased revenues from the commercial sale of fish.

The fish community was determined to be of concern due to its role in energy flow, their role as a food source for higher trophic level organisms, and their potential for exposure to contaminants.

3.4.3 Assessment Endpoint No. 3: Viability and Function of the Piscivorous Bird Community

Piscivorous birds are upper trophic level organisms that feed primarily on fish and invertebrates. This assessment endpoint focuses on those avian species which would utilize the tidal flat for feeding, and are important in the maintenance of a balanced ecosystem and in the nutrient and energy cycles between aquatic and terrestrial systems. Since nutrients and energy are limiting factors in the production of an ecosystem, the transfer of energy from an aquatic to a terrestrial system is essential.

Piscivorous birds are upper trophic level predators, and would be susceptible to exposure to contaminants which bioaccumulate in prey organisms. Fish have been shown to accumulate contaminants that are present in aquatic ecosystems. Therefore, birds that consume fish have the potential for exposure and accumulation of large concentrations of contaminants in their tissues.

Additionally, the Delaware Bay is an important area for nesting and wintering bald eagles. The bald eagle is listed as threatened on the Federal Endangered Species List and as endangered on the State Endangered Species List. The inclusion of the bald eagle as an endpoint in this ERA does not initiate a formal or informal consultation as defined by the Endangered Species Act. This receptor was included because available information indicated that it may use the area surrounding the site for forage. Although the birds are opportunistic, a large percentage of their diet is comprised of fish. The NJDEP (2004) indicates that there is a nesting pair of bald eagles located at the mouth of Mantua Creek at the Delaware River. This nest is approximately 3 miles south of the Matteo Iron and Metals site. There are also nests further south at the mouth of Raccoon Creek and to the north in Camden County, both located along the Delaware River. In addition, a review of the NJDEP (2005) Landscape Project critical habitat maps indicates that the bald eagle foraging area encompasses both Woodbury Creek and Hessian Run, adjacent to the Matteo Iron and Metals site.

Therefore, an evaluation will be conducted to determine the risk specifically to this species from the ingestion of fish collected adjacent to the site.

3.4.4 Assessment Endpoint No. 4: Viability and Function of the Piscivorous Mammal Community

This assessment endpoint is aimed at the viability and function of piscivorous mammal populations at this Site. Piscivorous mammals play an important role in energy flow between aquatic and terrestrial systems, and may serve as a food resource for higher trophic level organisms.

Piscivorous mammals are upper trophic level organisms that rely primarily on fish as forage. Foraging behavior of piscivorous mammals represents a pathway by which nutrients and energy are transferred from aquatic to terrestrial ecosystems. In addition to contributing to aquatic and terrestrial energy flow pathways, the predation of fish regulates fish population size and species abundance and diversity. Conversely, piscivorous mammals also serve as prey items for upper trophic level predators. Predation by and of piscivorous mammals therefore contributes to balanced populations of fish and other aquatic and terrestrial organisms, a balance that is essential for normal ecosystem functioning.

Since piscivorous mammals are upper trophic level predators, they are especially susceptible to exposure to certain contaminants which can bioaccumulate in the organisms upon which they feed. The higher the trophic level of the food chain, the more concentrated the contaminants in the tissues become due to bioaccumulation or biomagnification. In a freshwater system, mammals are common

predators of fish. Fish have been shown to accumulate contaminants that are present in aquatic ecosystems. Therefore, mammals that consume fish have the potential to accumulate large concentrations of contaminants in their tissues.

The piscivorous mammal community was determined to be of concern due to its role in energy flow, their potential for exposure to contaminants, and their role as a food source for higher trophic level organisms. Based on the above discussion, it was determined that viability and function of the piscivorous mammal community was a valid assessment endpoint for this risk assessment.

3.4.5 Assessment Endpoint No. 5: Viability and Function of the Omnivorous Bird Community

Omnivorous birds are organisms that rely on both animal tissue and plant matter for forage. The foraging behavior of omnivorous birds represents a pathway by which nutrients and energy are transferred from lower to higher links in the food chain For example, invertebrates are consumed by mid-level omnivores which are in turn consumed by an upper level consumer. Omnivores may also transfer energy from the detrital food chain to the grazing food chain by consuming detritivores (e.g., millipedes).

Since omnivorous birds are mid- to trophic level predators, they are susceptible to exposure to contaminants which bioaccumulate or biomagnify in the organisms upon which they feed. Omnivorous birds consume vegetation and invertebrates which have been shown to accumulate certain contaminants that are present in terrestrial ecosystems. Therefore, birds that consume these items have the potential to accumulate large concentrations of contaminants in their tissues.

Some birds are resident year-round and some are migratory. The variable mobility of potential avian receptors, relatively large home range, variable diet, and often seasonal residency, suggest that the potential for exposure and the identification of specific exposure routes and concentrations are associated with some uncertainty. Nonetheless, the avian omnivorous community is of concern due to their role in energy transfer and regulating populations, and the potential for exposure and adverse effects in a mid-to higher trophic level organism. Therefore, it was determined that viability and function of the omnivorous avian community was a valid assessment endpoint for this risk assessment.

3.4.6 Assessment Endpoint No. 6: Viability and Function of the Omnivorous Mammal Community

Omnivorous mammals are organisms that rely on a both plant and animal matter for forage. The role of an omnivore is essential to an ecosystem as they transfer the energy available to a varying number of trophic levels. In addition to contributing to energy pathways in a terrestrial system, omnivore foraging on small mammals and vegetation regulates small mammal and vegetation density, species abundance, and diversity. Conversely, omnivorous mammals may also serve as prey items for upper trophic level predators. Predation by and of omnivorous mammals therefore contributes to a balanced small mammal and vegetative community, as well as regulating other mid- to upper trophic level terrestrial organisms. This balance is essential for normal ecosystem functioning.

Since omnivorous mammals are mid- to upper trophic level consumers, they are susceptible to exposure to contaminants which can bioaccumulate in the organisms upon which they feed. The higher the trophic level of the food chain, the more concentrated the contaminants in the tissues become due to bioaccumulation or biomagnification. In a terrestrial system, omnivorous mammals are common predators of small mammals and plants; both have been shown to accumulate contaminants that are present in terrestrial ecosystems. Therefore, mammals that consume small mammals or plants have the potential to accumulate contaminants in their tissues.

Based on their role in energy transfer and regulating populations, as well as the potential for exposure and adverse effects in mid-to upper trophic level organisms, the viability of the omnivorous mammal

community was selected as a valid assessment endpoint for this risk assessment.

3.4.7 Assessment Endpoint No. 7: Viability and Function of the Insectivorous Bird Community

This assessment endpoint is aimed at the viability and function of the soil invertebrate feeding bird populations at the Matteo Iron and Metal Site. Soil-invertebrate feeding birds are mid-trophic level organisms that rely primarily on soil invertebrates as forage. The foraging behavior of soil-invertebrate feeding birds represents a pathway by which nutrients and energy are transferred from lower to higher links in the food chain For example, soil invertebrates are consumed by mid-level birds which are in turn consumed by an upper level consumer. Birds such as the American robin transfer energy from the detrital food chain to the predator food chain when they consume detritivores (e.g., earthworms).

Since some soil-invertebrate feeding birds are mid-trophic level predators, they are susceptible to exposure to contaminants which bioaccumulate in the organisms upon which they feed. The higher the trophic level of the food chain, the more concentrated the contaminants in the tissues become due to bioaccumulation or biomagnification. Soil invertebrates have been shown to accumulate contaminants that are present in terrestrial ecosystems. Therefore, birds that consume soil invertebrates have the potential to accumulate large concentrations of contaminants in their tissues. Additionally, soil invertebrates such as earthworms may contain large amounts of soil entrained in their gut, resulting in incidental exposure of soil-invertebrate feeding birds to contaminated soils.

Some birds are resident year-round and some are migratory. The variable mobility of potential avian receptors, relatively large home range, variable diet, and often seasonal residency, suggest that the potential for exposure and the identification of specific exposure routes and concentrations are associated with some uncertainty. Nonetheless, the soil-invertebrate feeding avian community is of concern due to their role in energy transfer and regulating populations, and the potential for exposure and adverse effects in a higher trophic level organism. Therefore, viability of the soil-invertebrate feeding avian community was determined to be a valid assessment endpoint for this risk assessment.

3.4.8 Assessment Endpoint No. 8: Viability and Function of the Insectivorous Mammal Community

This assessment endpoint is aimed at the viability and function of the insectivorous small mammal community at the Matteo Iron and Metal Site. Small mammals that consume soil invertebrates play a key role in ecosystem functions such as energy flow, and are an important food resource for higher trophic level species.

Soil invertebrate feeding mammals are mid-trophic level organisms that rely primarily on insects as forage. The foraging behavior of insectivorous mammals may represent a pathway by which nutrients and energy are transferred from lower to higher links in the food chain. For example, insects are consumed by mid-level insectivores (shrews) which are in turn consumed by an upper level consumer (marsh hawk). Insectivores also transfer energy from the detrital food chain to the grazing food chain when insectivores consume detritivores (e.g., earthworms).

Since soil invertebrate feeding mammals are mid-level predators, they are susceptible to exposure to contaminants which can bioaccumulate in the organisms upon which they feed. The higher the trophic level of the food chain, the more concentrated the contaminants in the tissues become due to bioaccumulation or biomagnification. In a terrestrial system, small mammals such as shrews are common predators of insects. Insects have been shown to accumulate contaminants that are present in terrestrial ecosystems. Therefore, mammals that consume insects have the potential to accumulate large concentrations of contaminants in their tissues.

The soil invertebrate feeding mammal community was determined to be of concern due to its role in

energy flow, their potential for exposure to contaminants, and their role as a food source for higher trophic level organisms. Based on the above discussion, it was determined that viability and function of the soil invertebrate feeding mammal community was a valid assessment endpoint for this risk assessment.

3.4.9 Assessment Endpoint No. 9: Viability and Function of the Herbivorous Mammal Community

This assessment endpoint is aimed at the viability and function of the herbivorous small mammal community at this Site. Herbivorous mammals play a key role in ecosystems functions such as energy flow, and are an important food resource for higher trophic level species.

Herbivorous small mammals are lower trophic level organisms that rely primarily on vegetation as forage. The role of herbivores is essential within an ecosystem as they transfer the energy available in plant tissue (primary producers) to animal tissue, and make it available to upper trophic level organisms.

Herbivorous mammals are susceptible to exposure to contaminants which can accumulate in and on plant tissues upon which they feed. Plants have been shown to accumulate contaminants that are present in terrestrial ecosystems. Therefore, mammals that consume plants have the potential to accumulate these contaminants within their tissues. In addition, because of their size, small mammals generally have small home ranges (Harestad and Bunnell 1979). The low mobility of small mammals which inhabit contaminated areas suggests a high potential for exposure, and enables specific exposure routes and concentrations to be identified with a high degree of certainty.

The herbivorous mammal community is of concern due to the potential for accumulation of contaminants and transfer to higher trophic level consumers, as well as for the potential for direct exposure and adverse effects. Additionally, small mammals are a large component of the terrestrial food chain base, representing an important food resource for carnivorous birds and mammals. Based on the above discussion, the viability and function of the herbivorous mammal community was determined to be a valid assessment endpoint for this risk assessment.

3.5 Testable Hypotheses

The testable hypotheses are specific risk questions that are based on the assessment endpoints. Based on the mechanism of contaminant toxicity, the number of exposure pathways that may exist for an assessment endpoint, or other factors, there may be more than one question for each assessment endpoint.

3.5.1 Assessment Endpoint No.1: Viable Tidal Flat Community Structure and Function

Are levels of site contaminants in sediment and surface water sufficient to cause adverse alterations to the structure and/or function of the tidal flat community?

3.5.2 Assessment Endpoint No. 2: Tidal Flat Nursery and Refuge Functioning

Are levels of site contaminants in sediment and surface water sufficient to cause adverse alterations to the nursery/refuge function of the tidal flat including migration pathways for fish?

3.5.3 Assessment Endpoint No. 3: Viability and Function of the Piscivorous Bird Community

Are levels of site contaminants in fish captured on-site sufficient to cause adverse toxic effects or reproductive impairment to piscivorous bird species utilizing the tidal flats, marshes or streams on-site?

3.5.4 Assessment Endpoint No. 4:Viability and Function of the Piscivorous Mammal Community

Are levels of site contaminants in fish captured on-site sufficient to cause adverse toxic effects or reproductive impairment to piscivorous mammals utilizing the tidal flats, marshes or streambanks on-site?

3.5.5 Assessment Endpoint No. 5: Viability and Function of the Omnivorous Bird Community

Are levels of site contaminants in vegetation and clams collected on-site sufficient to cause adverse toxic effects or reproductive impairment to omnivorous birds utilizing the tidal flats, marshes or streambanks on-site?

3.5.6 Assessment Endpoint No. 6: Viability and Function of the Omnivorous Mammal Community

Are levels of site contaminants in vegetation and clams collected on-site sufficient to cause adverse toxic effects or reproductive impairment to omnivorous mammals utilizing the tidal flats, marshes or streambanks on-site?

3.5.7 Assessment Endpoint No. 7: Viability and Function of the Insectivorous Bird Community

Are levels of site contaminants in soil invertebrates captured on-site sufficient to cause adverse toxic effects or reproductive impairment to soil invertebrate feeding bird species utilizing the upland areas on-site?

3.5.8 Assessment Endpoint No. 8: Viability and Function of the Insectivorous Mammal Community

Are levels of site contaminants in soil invertebrates captured on-site sufficient to cause adverse toxic effects or reproductive impairment to soil invertebrate feeding mammal species utilizing the upland areas on-site?

3.5.9 Assessment Endpoint No. 9: Viability and Function of the Herbivorous Mammal Community

Are levels of site contaminants in plants collected on-site sufficient to cause adverse toxic effects or reproductive impairment to herbivorous mammals utilizing the tidal flats, marshes or streambanks on-site?

3.6 Measures of Exposure and Effects

Measures of exposure and effects are quantifiable ecological characteristics that are related to the valued characteristics selected as assessment endpoints. They should be linked to the assessment endpoints by the mechanism of toxicity and the route of exposure. Measures of exposure are site-specific data on COPC concentrations; these are actual COPC concentrations that ecological receptors that utilize a site can be exposed to. Measures of effects are used to derive a quantitative estimate of potential effects, and to form a basis for extrapolation to the assessment endpoints.

Measures of exposure and effects were selected on the basis of the presence of receptors on the site, the presence of a complete exposure pathway, and the sensitivity of the receptor to the contaminants. The following attributes were selected to represent exposure pathways and assessment endpoints identified for the site.

3.6.1 Measurable Attributes for Assessment Endpoint No. 1: Viable Tidal Flat Community Structure and Function

Measures of Exposure

Concentrations of Pb and PCBs measured in surface water and sediments collected from Hessian Run and Woodbury Creek.

Measures of Effects

Results of site-specific studies that evaluated the community structure of the benthic macroinvertebrates inhabiting Hessian Run and Woodbury Creek.

Results from 28-day solid phase toxicity tests conducted using *Hyalella azteca*.

Results from 20-day solid phase toxicity tests conducted using *Chironomus tentans*.

3.6.2 Measurable Attributes for Assessment Endpoint No. 2: Tidal Flat Nursery and Refuge Functioning

Measures of Exposure

Determine the concentrations of Pb and PCBs in surface water and sediments collected from Hessian Run and Woodbury Creek.

Measures of Effects

Results of site-specific studies that evaluated the community structure of fish inhabiting Hessian Run and Woodbury Creek.

3.6.3 Measurable Attributes for Assessment Endpoint No. 3: Viability and Function of the Piscivorous Bird community

Measures of Exposure

Measured concentrations of Pb and PCBs in fish collected from locations on-site.

Measures of Effects

Through food chain models for the great blue heron (*Ardea herodius*) and bald eagle (*Haliaeetus leucocephalus*), evaluate the toxicity of dietary exposure to Pb and PCBs on-site through comparison to toxicity reference values (TRVs).

3.6.4 Measurable Attributes for Assessment Endpoint No.4: Viability and Function of the Piscivorous Mammal Community

Measures of Exposure

Measured concentrations of Pb and PCBs in fish collected from locations on-site.

Measures of Effects

Through food chain models for the mink (*Mustela vison*), evaluate the toxicity of dietary exposure to Pb and PCBs on-site through comparison to TRVs.

3.6.5 Measurable Attributes for Assessment Endpoint No. 5: Viability and Function of the Omnivorous Bird Community

Measures of Exposure

Measured concentrations of Pb and PCBs in vegetation and clams collected from locations on-site.

Measures of Effects

Through food chain models for the wood duck (*Aix sponsa*), evaluate the toxicity of dietary exposure to Pb and PCBs on-site through comparison to TRVs.

3.6.6 Measurable Attributes for Assessment Endpoint No. 6: Viability and Function of the Omnivorous Mammal Community

Measures of Exposure

Measured concentrations of Pb and PCBs in vegetation and clams collected from locations on-site.

Measures of Effects

Through food chain models for the raccoon (*Procyon lotor*), evaluate the toxicity of dietary exposure to Pb and PCBs on-site through comparison to TRVs.

3.6.7 Measurable Attributes for Assessment Endpoint No. 7: Viability and Function of the Insectivorous Bird Community

Measures of Exposure

Measured concentrations of Pb and PCBs in earthworms collected from upland areas on-site.

Measures of Effects

Through food chain models for the American robin (*Turdus migratorius*), evaluate the toxicity of dietary exposure to Pb and PCBs on-site through comparison to TRVs.

3.6.8 Measurable Attributes for Assessment Endpoint No. 8: Viability and Function of the Insectivorous Mammal Community

Measures of Exposure

Measured concentrations of Pb and PCBs in earthworms collected from upland areas on-site.

Measures of Effects

Through food chain models for the short-tailed shrew (*Blarina brevicauda*), evaluate the toxicity of dietary exposure to Pb and PCBs on-site through comparison to TRVs.

3.6.9 Measurable Attributes for Assessment Endpoint No. 9: Viability and Function of the Herbivorous Mammal Community

Measures of Exposure

Measured concentrations of Pb and PCBs in plants collected from locations on-site.

Measures of Effects

Through food chain models for the muskrat (*Ondotra zibethicus*), evaluate the toxicity of dietary exposure to Pb and PCBs on-site through comparison to TRVs.

3.7 Conceptual Model

The conceptual model uses contaminant and habitat characteristics to identify exposure pathways that will be evaluated by the selected measurement endpoints. For this risk assessment, the toxicity of contaminants in sediment and surface water will be evaluated using results from the toxicity tests, a benthic invertebrate community survey, and a fish community survey. Terrestrial and aquatic receptor species may be exposed by feeding on organisms that have accumulated contaminants in their tissues, or being directly exposed to sediment. Higher trophic level receptors may also be exposed via incidental ingestion of sediment and water. Risk to these receptors will be evaluated using food chain models. The following pathways will be evaluated in this risk assessment:

I. Tidal flat
- Direct contact with sediment
- Direct contact with interstitial water
- Direct contact with water
- Ingestion of tidal flat biota
- Incidental ingestion of sediment
- Incidental ingestion of water

II. Tidal flat used as a nursery/refuge
- Direct contact with sediment
- Direct contact with water
- Ingestion of tidal flat biota
- Incidental ingestion of sediment
- Incidental ingestion of water

III. Piscivorous Birds
- Ingestion of surface water
- Incidental ingestion of sediment
- Ingestion of fish

IV. Piscivorous Mammals
- Ingestion of surface water
- Incidental ingestion of sediment
- Ingestion of fish

V. Omnivorous Birds
- Ingestion of surface water
- Incidental ingestion of sediment
- Ingestion of vegetation
- Ingestion of clams

VI. Omnivorous Mammals
- Ingestion of surface water
- Incidental ingestion of sediment
- Ingestion of vegetation
- Ingestion of clams

VII. Insectivorous Birds
Ingestion of surface water
Incidental ingestion of soil
Ingestion of soil invertebrates

VIII. Insectivorous Mammals
Ingestion of surface water
Incidental ingestion of soil
Ingestion of soil invertebrates

IX. Herbivorous Mammals
Ingestion of surface water
Incidental ingestion of sediment
Ingestion of plants

4.0 EXPOSURE CHARACTERIZATION

The objective of the exposure assessment is to determine the pathways and media through which receptors may be exposed to site contaminants. Potential exposure pathways are dependent on habitats and receptors present on site, extent and magnitude of contamination, and environmental fate and transport of COPCs. The following discussion is limited to those organisms chosen as receptor species in the food chain exposure models.

Life history and exposure profiles for the receptor species selected for the assessment endpoints are presented in Appendix B. For each receptor, a conservative and representative exposure profile has been identified. For this risk assessment, conservative exposure parameters were used in food chain models to evaluate risk from site-related COPCs. Conservative exposure parameters include the lowest reported adult body weight and highest ingestion rates. Home range, feeding territory and breeding territory size have been reported in the literature for several species. For this ERA, an area use factor (AUF) of 1.0 was utilized, as the conservative assumption was made that the receptor species spends all of its time, and acquires all of its food from the site.

The primary food items of the receptor species (or items closely related to their primary food) were analyzed for COPCs, to estimate site-specific receptor contaminant exposure. For example, dietary composition studies indicate that the great blue heron consumes fish, reptiles, and amphibians. Forage fish were collected for analysis at the Matteo Iron and Metal site. A diet of 100% forage fish was used in the exposure profile for great blue herons. It was assumed that contaminant levels in forage fish were representative of contaminant levels in all food items consumed by great blue herons present at this site.

To be conservative, the maximum Pb and PCB concentrations measured in soil, sediment, surface water and food items collected on-site were used in the exposure models.

5.0 ECOLOGICAL EFFECTS CHARACTERIZATION

A comprehensive literature search was conducted to locate studies in which the toxicity of COPCs to wildlife receptors was evaluated. These studies were reviewed to evaluate the appropriateness of using a particular study to derive a TRV. A discussion of these studies, and the criteria used to evaluate studies are described along with the toxicity profiles in Appendix A. Two important criteria used to evaluate studies were study design and species tested. Relatively few toxicological studies have been conducted using wildlife species. Many TRVs were selected from studies in which the test organism was closely related taxonomically to a selected receptor species. It may be more appropriate to select effect levels derived from test organisms which are closely related on trophic level, and with respect to prey preferences (e.g., using an effect level for a black-crowned night heron to derive a TRV for another piscivorous species, such as the great blue heron). In all cases, an attempt was made to use consistently conservative assumptions where possible in this ERA. Conservative assumptions were used to minimize the possibility of concluding that risk is not present when risk actually does exist (i.e., the elimination of false negatives). If an acceptable study reported an effect level for a dietary exposure

route to a taxonomically related species, the lowest reported lowest observable adverse effect level (LOAEL) and the associated no observable adverse effect level (NOAEL) were selected as the TRVs.

5.1 Risk Characterization

The hazard quotient (HQ) method (Barnthouse *et al.* 1986; U.S. EPA 1997) was employed in this ERA. Briefly, the HQ method compares exposure concentrations to TRVs based on ecological endpoints such as mortality, reproductive failure, or reduced growth. This is done using chronic toxicity values derived from the literature that are intended to represent a lower dose over a longer duration of exposure, resulting in subtle effects that would be expected to manifest themselves at the population level over the long term. Both NOAEL and LOAEL values were used to determine HQs.

The comparison is expressed as a ratio of potential intake values to population effect levels, as follows:

$$\text{Hazard Quotient} = \frac{\text{Exposure Concentration (Maximum)}}{\text{Chronic Effect Level (e.g., NOAEL or LOAEL)}}$$

5.2 Methods Used to Estimate Risk

5.2.1 Use of Sediment Toxicity Tests to Evaluate Risk to Tidal Flat Function

The results of the sediment toxicity test using *Hyalella azteca* and *Chironomus tentans* were used to predict the effects of the sediment contamination adjacent to and downstream of the Matteo site with regard to the following assessment endpoint:

- Tidal Flat Community Structure and Function

The toxicity test was used to determine the potential risk to the benthic invertebrate communities from the contamination within Hessian Run and to determine if Pb and PCBs pose a risk. In addition, NOAEL and LOAEL values for each of the COPC were identified by comparing the measured levels of each contaminant in each sample to the toxicity of that sample. The resulting NOAELs and LOAELs provide a range below which the concentration of each contaminant is expected to be protective of the benthic invertebrate communities.

5.2.2 Use of Community Structure Indices to Determine Risk

In order to determine the risk to several assessment endpoints, the community structure of fish and benthic invertebrates were evaluated. Several metrics were calculated which compared the species abundance, richness, and diversity at sample locations upstream (stations 1 and 2 in Hessian Run, and 8 and 9 in Woodbury Creek), adjacent to (stations 3, 4, 5 and 6), and downstream (stations 7 and 10) of the site. These values were then compared to the reference stations (1, 2, 8 and 9) in order to determine if there was a link between contaminant levels and changes to the metrics.

This information contributed to the risk characterization for the following assessment endpoints:

- Tidal Flat Community Structure and Function
- Tidal Flat Nursery and Fish Refuge

5.2.3 Food Chain Models

This information contributed to the risk characterization for the following assessment endpoints:

- Viability of the Piscivorous Bird Community
- Viability of the Piscivorous Mammal Community
- Viability of the Omnivorous Bird Community

- Viability of the Omnivorous Mammal Community
- Viability of the Insectivorous Bird Community
- Viability of the Insectivorous Mammal Community
- Viability of the Herbivorous Mammal Community

The seven receptor species were assumed to be exposed to contaminant residues via ingestion of food, water and incidental ingestion of soil or sediment. Site-specific Pb and PCB concentrations in sediment, surface water, and tissue, in conjunction with the dietary composition of the receptor species, were used to determine the total dose to which the receptor species were exposed, per the following formula:

$$\text{Total dose} = \{\Sigma[(FIR \times C_F) + (SIR \times C_S) + (WIR \times C_W)] \times AUF\}/BW$$

where:

FIR = Food Ingestion Rate
C_F = Contaminant Concentration in the Prey Item
SIR = Sediment/Soil Ingestion Rate
C_S = Contaminant Concentration in the Sediment/Soil
WIR = Water Ingestion Rate
C_W = Contaminant Concentration in Water
AUF = Area Use Factor
BW = Body Weight

Concentrations of PCBs in surface soils and surface water were not measured, and therefore, not included in the food chain models. The concentration of Pb was measured in surface soils and water and the concentration was used in the food chain models where appropriate.

The effect level values for each COPC were based on studies published in the literature. The exposure concentrations were estimated by employing a food chain model for each receptor species (e.g., the great blue heron) associated with an assessment endpoint (e.g., viability of the piscivorous avian community). In these food chain models, ingestion rates of each COPC for each receptor species were determined based on measured concentrations of each contaminant in water, sediment, and food items collected at the site as well as known or estimated water, sediment/soil, and food ingestion rates and body weights of each receptor species. The exposure concentrations and toxicity values were entered into the HQ equation, and a HQ was calculated. If the HQ was greater than or equal to ($\geq$) 1.0, based on a chronic NOAEL, it could not be concluded that there was no chronic risk from that contaminant to the ecological receptor in question. If the HQ was $\geq$ 1.0, based on a chronic LOAEL for a particular contaminant, there was the potential to produce an actual adverse effect on survival, reproduction, or growth of the ecological receptor in question. If the HQ was $\geq$ 1.0, based on an acute TRV, there was the potential to produce an actual adverse effect on survival of the ecological receptor in question.

Receptor species from different trophic levels were used for food chain accumulation modeling where appropriate. Organisms which are likely to be exposed to contaminants because of specific behaviors, patterns of habitat use, or feeding habits were selected for evaluation in this ERA. The availability of appropriate toxicity information on which risk calculations was based was also an important consideration. The surrogate receptor species selected for this ERA were the great blue heron, mink, wood duck, raccoon, American robin, short-tailed shrew, and muskrat.

One exposure scenario was evaluated for each receptor species using conservative life history parameters, and maximum concentrations of contaminants in food, water, and sediment. Life history parameters from published literature were used in the food chain models. Conservative life history parameters included the lowest published adult body weight and the highest published ingestion rates

for food, water, and incidental sediment.

The results of these models were used to determine the contamination values that bound the threshold for adverse effects to each assessment endpoint (U.S. EPA 1997) and can be used as one line of evidence for evaluating site management alternatives.

Sediment concentrations were entered into the models as dry weights, and food item concentrations were entered into the models as wet weights to be compared to the TRVs derived from the literature. The supporting data were not available to convert sediment to wet weight or food items to dry weight (see Section 8.0). In addition, the water concentrations entered into the models were for unfiltered water because this represented a more realistic exposure via ingestion of water than the use of filtered water.

This ERA utilized simplifying assumptions in the food chain models, since it is difficult to mimic a complete diet. According to food chain dynamics, maximum stability results when a large number of species eat a restricted diet, or when a smaller number of species eats a wide variety of other species. The seasonal availability of prey also results in a prey specialization by the consumer. Given these factors and the conservative approach used in the food chain models, piscivorous and herbivorous receptor species were assumed to only consume a single food item at the Matteo Iron and Metal site. It was assumed that COPC concentrations in the food items collected were representative of the COPC concentrations in all food items potentially consumed by that receptor.

The first part of the discussion examines the generated exposure and effects data and integrates these observations into concise statements that identify risks to the assessment endpoints. This discussion is followed by a summary that documents the environmental contamination levels that exceed the threshold for adverse effects to the assessment endpoints (U.S. EPA 1997). The boundary for the adverse effects threshold was the NOAEL-based HQ value. The following assumptions were made:

- If the NOAEL-based HQ was ≥ 1.0 but the LOAEL-based HQ was not, it was concluded that it could not be determined that there was no model calculated risk.
- A contaminant concentration was considered to exceed the threshold and demonstrate model calculated risk to the given receptor if both the NOAEL-based HQ and LOAEL-based HQ were ≥ 1.0.
- If neither the NOAEL- or LOAEL-based HQs were ≥ 1.0, it was concluded that there is no model calculated risk to the given receptor.

5.2.4 Treatment of Data

There were several instances when specific PCB Aroclors were not detected in sediment or food items. In order to calculate a total Aroclor concentration for use in the food chain accumulation models, only those Aroclors that were detected were included in the calculation. This includes those values that were flagged with a "J" data qualifier (as an estimated concentration). Those Aroclors that were flagged with a "U" data qualifier (not detected) were not used in the calculation of a total Aroclor concentration.

6.0 BIOTA STUDY RESULTS

All site-specific data utilized in this ERA were collected during the Aquatic Biota Study conducted during the RI in 2003 (Berger 2004b). A summary of the biota samples that were collected during this study is in Table 1. No additional data were collected.

6.1 Surface Water Analytical Results

Surface water was collected from all 10 sample locations at high tide within the approximate quarter channel nearest the site. Surface water samples were analyzed for Pb, total hardness, and pH. Results are listed in Table 2. For this risk assessment, only the results from the total Pb analysis were used in the food chain models. However, data is available for Pb in filtered water samples (Table 2; Berger 2004a). During this survey salinity was recorded at below 0.11 ppt. Lead concentrations in surface water ranged from below the detection limit (1.3 micrograms per liter [ug/L]) to 19.5 ug/L.

6.2 Sediment Analytical Results

Surface sediment (0-6" depth) was collected from seven locations in Hessian Run (Stations 1 - 7) and three locations in Woodbury Creek (Stations 8 - 10). Samples were collected from the mid-tide level at each station at low tide. The concentrations of Pb and PCBs are recorded in this risk assessment (Table 3) however, additional data (pH and total organic carbon) are available in Berger (2004a). Sediment Pb concentrations ranged from 70 to 19,600 mg/kg, and total PCB concentrations in sediment ranged from below the detection limit (0.03 mg/kg) to 35 mg/kg.

6.3 Sediment Toxicity Test Results

Two gallons of surface sediment were collected at all 10 aquatic sample locations in the study area and submitted for toxicity testing. Samples were collected at the same time and stations as the samples collected for sediment chemistry analysis.

6.3.1 Acute Toxicity Tests Conducted with *Hyallela azteca*

Twenty-eight day solid phase toxicity tests were conducted on samples from all ten stations from the study area and one control sediment of known quality (from Spruce Run Reservoir in Hunterdon County, NJ). Endpoints measured were mortality (mean survival) and growth (mean dry weight).

The percent (%) survival of amphipods from Stations 1, 2, 3, 5, and 8 were not significantly different than the control location. There was 100 % mortality in the sample collected from Station 4. Amphipods exposed to samples from Stations 6,7, 9, and 10 had significantly lower survival compared to those exposed to the control sediment (Table 4).

Growth was not evaluated for stations where survival was impacted (Stations 4, 6, 7, 9 and 10). Average dry weight was significantly less in amphipods exposed to sediment collected at Station 8 than for amphipods exposed to the control sediment. No effects on growth were observed in amphipods exposed to sediment collected from Stations 1, 2, 3 and 5 (Table 4).

6.3.2 Acute Toxicity Tests Conducted with *Chironomus tentans*

Twenty-day solid phase toxicity tests were conducted on samples from all ten stations from the study area and one control sediment of known quality (from Spruce Run Reservoir in Hunterdon County, NJ). Endpoints measured were mortality (mean survival) and growth (mean dry weight).

The % survival of chironomids from Stations 8 and 9 was not significantly different than the control location. There was 100 % mortality observed in sample collected from Station 4. Chironomids exposed to samples from Stations 1, 2, 3, 5, 6, 7, and 10 had significantly lower survival compared to those exposed to the control treatment (Table 4).

Growth was not evaluated for stations where survival was impacted (Stations 1,2,3,4,5,6,7,and 10). No effects on growth were observed in chironomids exposed to sediment collected from Stations 8 and

9 (Table 4).

It should be noted that the recommended minimum control survival for chironomids in a 20-day exposure is 70%, and observed control survival was 66.7%. The reduced control survival may have been due to handling procedures during placement of test organisms in test chambers. Technically, this invalidates the results of the toxicity tests, and therefore, for the purposes of this risk assessment, more reliance will be placed on the results of the *H. azteca* toxicity tests. However, survival rates for site samples were markedly lower than the controls.

It should also be noted that a 65-day chironomid growth and emergence test was also conducted on site sediment. The results and conclusions of this test is described in detail in the Aquatic Biota Study Report (Berger 2004b) and are not described within this risk assessment.

6.4 Fish Community Survey Results

Fish samples were collected at seven stations in Hessian Run and three stations in Woodbury Creek using a seine (0.25-inch mesh). Three replicate hauls were made within two hours of low tide in the opposite direction of the prevailing tidal current. Fish were identified in the field, and 25 individuals of each species were measured per replicate sample, if available.

Although fish community data summaries were presented in the Aquatic Biota Study Report (Berger 2004b), the summary calculations presented for stations adjacent to the site and reference locations could not be reproduced using the data presented in Table 13, Berger (2004b) and the statistical summary sheet in the Appendix. In addition, the report included results from Stations 7 and 10 in the "reference stations" summary. These stations are downstream of the site, and should not be considered reference locations. For this ERA, the data presented for the individual stations was utilized to calculate the mean number of species and mean diversity values presented in Table 5; these values differ from the values in Berger (2004b).

Table 5 presents abundance, richness, and species diversity of the fish community at each of the ten sample stations. Species richness and diversity were low at sample Stations 3, 4, 5 and 6 (adjacent to the Site). Only four fish species were caught at sample stations adjacent to the site, while eleven species were captured at the reference stations. The mean diversity at the four stations adjacent to the site (Stations 3,4,5, and 6) as measured by the Shannon-Weaver Diversity Index was 0.282 as compared to a diversity index of 0.326 at the reference stations. Two species, banded killifish (*Fundulus diaphanus*) and mummichog (*F. heteroclitus*) comprised most of the fish captured at stations adjacent to the site.

The fish communities in Hessian Run consisted almost entirely of omnivorous species (99% to 100%). Omnivores were also dominant in Woodbury Creek (76% to 93% of individuals captured), but other trophic levels were also present.

6.5 Benthic Macroinvertebrate Community Survey

Samples for benthic macroinvertebrate community analysis were collected at seven stations in Hessian Run and three stations in Woodbury Creek. The substrate in the study area is predominantly silt with underlying clay. Benthic cores were collected by inserting a 100 millimeter (mm) by 100 mm hand-held square core 100 mm into the substrate at water's edge at low tide. Three replicate samples were collected at each sample station. Samples were sorted in the field and identified to the lowest practicable taxon in the laboratory. Table 6 presents species abundance, richness, and diversity at each of the ten sample stations.

Although benthic community data summaries were presented in the Aquatic Biota Study Report (Berger 2004b), the summary calculations presented for stations adjacent to the site and reference locations could not be reproduced using the data presented in Table 13, Berger (2004b) and the statistical summary sheet in the Appendix. In addition, the report included results from Stations 7 and 10 in the "reference stations" summary.

These stations are downstream of the site, and should not be considered reference locations. For this ERA, the data presented for the individual stations was utilized to calculate the mean number of species and mean diversity values presented in Table 6; these values differ from the values in Berger (2004b).

Macroinvertebrate diversity in Hessian Run and Woodbury Creek was low, with oligochaetes, chironomids and the Asian clam comprising over 97% of the individuals collected. Diversity in samples collected at stations adjacent to the site (Stations 3,4,5 and 6) was lower (0.353) than diversity at reference stations (0.404).

The macroinvertebrate communities at stations adjacent to the site were comprised almost exclusively of deposit feeders (95%), with few filter feeders (4%) or carnivores (less than 1%). Deposit feeders also dominated macroinvertebrate communities at the reference stations (83%), but greater numbers of filter feeders (16%) were present.

The macroinvertebrate community present at Stations 3, 4, 5 and 6 was comprised entirely of pollution tolerant organisms. Communities at the reference stations were comprised primarily of tolerant taxa (96.5%), but some moderately tolerant taxa were present (3.3%) and a single sensitive individual was collected.

6.6 Fish Tissue Results

Banded killifish were collected for tissue analysis (whole body) from three stations in Hessian Run adjacent to the site (Stations 3, 4 and 5) and three stations in Woodbury Creek (Stations 8, 9 and 10). Three replicate samples were collected at each station. Pumpkinseed (*Lepomis gibbosus*) were collected for assessment of human health risk. However, due to the small size of individuals collected, whole-body analysis was also done for this species. Banded killifish are omnivorous, while pumpkinseed are water column feeders. Concentrations of Pb and PCBs were measured in fish tissue (Tables 7 and 8).

Only Aroclors 1248, 1254, and 1260 were detected in the killifish samples. The concentration of total Aroclors ranged from 0.236 to 0.674 mg/kg wet weight. Generally, the concentration of total Aroclors increased in a downstream direction in both the fish collected from Hessian Run (Stations 3,4, and 5) as well as for the fish collected from Woodbury Creek (Stations 8,9, and 10).

The concentration of Pb in killifish ranged from 0.37 to 1.6 mg/kg wet weight. The highest concentration of Pb was detected in killifish collected from Station 3 and the lowest concentration of Pb was detected in killifish collected from Station 10.

Pumpkinseed were only collected from 2 stations. The concentration of total Aroclors for the fish collected from Station 4 (Hessian Run) ranged from 0.277 to 0.66 mg/kg, wet weight. The concentration of total Aroclors in fish collected from Station 9 (Woodbury Creek) ranged from 0.227 to 0.482 mg/kg, wet weight.
The concentration of Pb in pumpkinseed collected from Hessian Run ranged from 0.47 to 0.6 mg/kg, wet weight. The concentration of Pb in pumpkinseed collected from Woodbury Creek ranged from 0.17J (estimated concentration) to 0.61 mg/kg, wet weight.

6.7 Benthic Macroinvertebrate Tissue Results

Asian clams (*Corbicula fluminea*) were collected for tissue analysis from three stations in Hessian Run adjacent to the site (Stations 3, 4 and 5) and three stations in Woodbury Creek (Stations 8, 9 and 10). Three replicate samples were collected at each station; 250 clams were collected per sample.

The concentration of total Aroclors in Asian clams ranged from 0.146 to 0.396 mg/kg, wet weight. The concentration of Pb in Asian clams ranged from 0.38 to 1.3 mg/kg, wet weight.

While Asian clams are residents, they feed on plankton transported by the tides. Therefore, the tissue concentrations of Pb and PCBs may not reflect the sediment concentration of contaminants in the immediate

station as strongly as a tissue concentrations in a deposit feeding invertebrate species would (Berger 2004b).

6.8 Wetland Plant Tissue Results

Spatterdock (*Nuphar luteum*) and wild rice (*Zizania aquatica*) were collected for tissue analysis. Plants were collected from three stations in Hessian Run adjacent to the site (Stations 3, 4 and 5) and one station in Woodbury Creek (Station 8). For both species, only above-ground parts of the plant were collected. Only vegetation parts free of sediment were collected. Spatterdock samples consisted of stems and leaves, while wild rice samples were comprised of stems, leaves and seed heads. Concentrations of Pb and PCBs measured in plant tissue are presented in Tables 10 and 11.

For spatterdock, only Aroclors 1254 and 1260 were detected in the samples (except for Aroclor 1248 in one replicate sample collected from Station 8). The concentration of total Aroclors ranged from below the detection limit (0.005 mg/kg) to 0.027 mg/kg, wet weight. The concentration of Pb in spatterdock ranged from 1.4 to 9.8 mg/kg, wet weight.

For wild rice, only Aroclors 1254 and 1260 were detected in the samples. The concentration of total Aroclors ranged from below the detection limit (0.005 mg/kg) to 0.0214 mg/kg, wet weight. The concentration of Pb in wild rice ranged from 0.23J mg/kg (estimated concentration) to 8.2 mg/kg, wet weight.

6.9 Soil Invertebrate Tissue Results

Earthworm (*Lumbricus spp.*) samples were collected from three upland areas on-site and one off-site reference station. Three replicate samples were collected at each station using shovels. After collection, earthworms were rinsed with distilled water to remove associated soil particles. Worms were not dissected or depurated prior to analysis. In the laboratory, whole earthworms were homogenized and analyzed for Pb and PCBs. Collocated soil samples were not collected. Lead and PCB concentrations measured in earthworms are presented in Table 12.

The concentration of total Aroclors detected in earthworm ranged from 0.012 (reference area) to 9.1 mg/kg, wet weight. The concentration of Pb detected in earthworm ranged from 4.5 (reference area) to 1,150 mg/kg, wet weight.

7.0 RESULTS OF THE HAZARD EVALUATION

Below is a discussion of the risk posed to each of the assessment endpoints. The discussion includes a comparison of sediment and water concentrations to benchmark values, the results of benthic macroinvertebrate and finfish surveys, and food chain models utilizing site-specific tissue concentrations. A summary of all food chain exposure model results is presented in Table 13.

7.1 Assessment Endpoint No. 1: Tidal Flat Community Structure and Function

The concentration of Pb in surface water exceeded the NJDEP chronic criteria at 6 stations (Stations 2, 3, 5, 6, 8 and 10). The concentration of Pb at Station 9 was below the detection limit of 2.8 ug/L and the chronic criterion for this location is 2.7 ug/L. Therefore, it could not be determined if the concentration of Pb at this station exceeded the criterion. The concentration of Pb in the surface water did not exceed the NJDEP acute criterion at any of the stations.

The concentration of Pb in sediment exceeded the SEL at 3 sample stations adjacent to the site (3, 4, and 6) and exceeded the LEL at all sample stations.

The concentration of PCBs in sediment do not exceed the SEL (SELs are only available for Aroclors 1016, 1248, 1254, and 1260) at any sample station. The concentration of Aroclor 1248 exceeded the LEL at sample

Stations 7 and 9. The detection limit for Aroclor 1248 was higher than the LEL at Stations 1, 2, 3, 4, 5, 6, and 8, therefore, it could not be determined conclusively if the concentration of Aroclor 1248 exceeded the LEL or not. The detection limit for Aroclor 1248 at Station 10 was equal to the LEL, and therefore, this sample did not exceed the LEL.

The concentration of Aroclor 1260 exceeded the LEL at all stations except Stations 8 and 10. However, the detection limit for Aroclor 1260 at Stations 8 and 10 was higher than the LEL, therefore, it could not be determined conclusively if the concentration of Aroclor 1260 at these stations exceeded the LEL or not.

One hundred % mortality was observed in *H. azteca* exposed to sediment collected from Station 4. Station 4 had the highest concentration of total Aroclors (35 mg/kg, dry weight) of any sediment sample collected during the biota study (Berger 2004b) however, it did not have the highest Pb concentration. For the *H. azteca* test, there was also significant mortality observed in samples collected from Stations 6, 7, 9, and 10. These results do not appear to correlate with Pb or PCB concentrations. There may be several explanations for this response. Often when a large volume of sediment is collected for toxicity testing, incomplete homogenization of the sample will result in chemical concentrations that do not correlate with the observed toxicity. In addition, Pb and PCBs were the only chemical parameters measured in these samples. However, the toxic response may also be the result of the sediment type, other contaminants in the sediment, or other water quality issues.

Given the poor survival in the control sample of the *C. tentans* test, it is difficult to assess the toxic response. However, there was acute toxicity in samples collected from Stations 1,2,3,4,5,6,7, and 10.

The mortality observed in the sediment bioassays did not correlate with measured concentrations of either Pb or PCBs. Lead and PCB concentrations in surface water and sediment were lower at Station 10 than at other locations, however significant mortality was observed in samples from this location in both bioassays. Based on the bioassay results, it was not possible to identify a sediment concentration protective of the benthic community.

The benthic community diversity was lower at stations adjacent to the site (Stations 3, 4, 5, and 6), and the species found at these stations were all pollution tolerant.

7.2 Assessment Endpoint No. 2: Tidal Flat Nursery and Refuge Functioning

Fish diversity at Stations 3, 4, 5, and 6 (adjacent to the site) was slightly lower than the diversity in the samples collected at the reference stations.

7.3 Assessment Endpoint No. 3: Viability and Function of the Piscivorous Bird Community

Dietary exposure concentrations for the piscivorous bird community were modeled using the great blue heron and bald eagle as surrogate receptor species.

Based on the food chain model with the great blue heron as the receptor species, it could not be concluded there was no model-calculated risk to the piscivorous bird community from Pb at this site, as the calculated NOAEL-based HQ exceeded 1.0 (Table 14). It also could not be concluded there was no model-calculated risk to the piscivorous bird community from PCBs at this site, as the calculated NOAEL-based HQ exceeded 1.0.

Based on the food chain model with the bald eagle as the receptor species, it could not be concluded there was no model-calculated risk to the piscivorous bird community from Pb at this site, as the calculated NOAEL-based HQ exceeded 1.0 (Table 14). It also could not be concluded there was no model-calculated risk to the piscivorous bird community from PCBs at this site, as the calculated NOAEL-based HQ exceeded 1.0.

7.4 Assessment Endpoint No. 4: Viability and Function of the Piscivorous Mammal Community

Dietary exposure concentrations for the piscivorous mammal community were modeled using the mink as a surrogate receptor species. It could not be concluded there was no model-calculated risk to the piscivorous mammal community from Pb at this site, as the calculated NOAEL-based HQ exceeded 1.0 (Table 14).

There was model-calculated risk to the piscivorous mammal community from PCBs at this site, with calculated NOAEL- and LOAEL-based HQs greater than 1.0.

7.5 Assessment Endpoint No. 5: Viability and Function of the Omnivorous Bird Community

Dietary exposure concentrations for the omnivorous bird community were modeled using the wood duck as a surrogate receptor species. There was model-calculated risk to the omnivorous bird community from Pb at this site, with calculated NOAEL- and LOAEL-based HQs significantly greater than 1.0 (Table 15).

It could not be concluded there was no model-calculated risk to the omnivorous bird community from PCBs at this site, as the calculated NOAEL-based HQ exceeded 1.0.

7.6 Assessment Endpoint No. 6: Viability and Function of the Omnivorous Mammal Community

Dietary exposure concentrations for the omnivorous mammal community were modeled using the raccoon as a surrogate receptor species. There was model-calculated risk to the omnivorous mammal community from Pb at this site, with calculated NOAEL- and LOAEL-based HQs greater than 1.0 (Table 15).

There was also model-calculated risk to the omnivorous mammal community from PCBs at this site, with calculated NOAEL- and LOAEL-based HQs greater than 1.0.

7.7 Assessment Endpoint No. 7: Viability and Function of the Insectivorous Bird Community

Dietary exposure concentrations for the insectivorous bird community were modeled using the American robin as a surrogate receptor species. There was model-calculated risk to the insectivorous bird community from Pb at this site, with calculated NOAEL- and LOAEL-based HQs significantly greater than 1.0 (Table 16).

It could not be concluded there was no model-calculated risk to the insectivorous bird community from PCBs at this site, as the calculated NOAEL-based HQ exceeded 1.0

Food chain models were also evaluated using an acute TRV for this assessment endpoint (Table 17). There was an acute model-calculated risk to the insectivorous bird community from Pb at this site, with a calculated acute TRV-based HQ of 3.0. Using an acute TRV, there was no model-calculated risk to the insectivorous bird community from PCBs at this site.

7.8 Assessment Endpoint No. 8:Viability and Function of the Insectivorous Mammal Community

Dietary exposure concentrations for the insectivorous mammal community were modeled using the short-tailed shrew as a surrogate receptor species. There was model-calculated risk to the insectivorous mammal community from Pb at this site, with calculated NOAEL- and LOAEL-based HQs significantly greater than 1.0 (Table 16).

There was model-calculated risk to the insectivorous mammal community from PCBs at this site, with calculated NOAEL- and LOAEL-based HQs significantly greater than 1.0.

Food chain models were also evaluated using an acute TRV for this assessment endpoint (Table 17). There was an acute model-calculated risk to the insectivorous mammal community from Pb at this site, with a calculated

acute TRV-based HQ of 7.7. Using an acute TRV, there was no model-calculated risk to the insectivorous mammal community from PCBs at this site.

7.9 Assessment Endpoint No. 9:Viability and Function of the Herbivorous Mammal Community

Dietary exposure concentrations for the herbivorous mammal community were modeled using the muskrat as a surrogate receptor species. There was model-calculated risk to the herbivorous mammal community from Pb at this site, with calculated NOAEL- and LOAEL-based HQs greater than 1.0 (Table 14).

There was also model calculated risk to the herbivorous mammal community from PCBs at this site, with calculated NOAEL- and LOAEL-based HQs greater than 1.0.

8.0 SOURCES OF UNCERTAINTY

This ERA evaluates exposure to contaminants through direct contact with water, soil and sediment; ingestion of food and water; and incidental soil or sediment ingestion. There are factors inherent in the risk assessment process which contribute to uncertainty and need to be considered when interpreting results. Major sources of uncertainty include natural variability, error, and insufficient knowledge. Natural variability is an inherent characteristic of ecological receptors, their stressors, and their combined behavior in the environment. Biotic and abiotic parameters in these systems may vary to such a degree that the exposure of similar ecological receptors within the same system may differ temporally and spatially. Factors that contribute to temporal and spatial variability may be differences in individual organism behavior (within a species), changes in the weather or ambient temperature, unanticipated interference from other stressors, differences between microenvironments, and numerous other factors.

In general, data were shown to two decimal places. However, values obtained from the literature were used as reported in the citation. Where means were calculated, the calculated value was retained. In the food chain models, the full value of calculations were retained. This was done to minimize rounding errors which may have added uncertainty, and does not imply additional precision. Hazard quotient calculations were shown to two decimal places, except where additional figures were needed to determine if the result was ≥ 1.0.

The data set used for food chain exposure modeling added some uncertainty to the calculation of risk. All sediment/soil analytical data was provided as mg/kg dry weight, while all tissue (plant or invertebrate) analytical data was provided as mg/kg wet weight. Since no supporting data (% solids and/or % moisture) was supplied to convert from dry weight to wet weight (or *vice versa*), the data were used as published. However, the uncertainty was minimized because the difference in COPC concentrations between the sediment/soil and tissue were several orders of magnitude. The sediment/soil was the risk driver, the tissue data did not contribute significantly to the overall calculated risk.

A major source of uncertainty arises from the use of toxicity values reported in the literature which are derived from single-species, single-contaminant laboratory studies. Prediction of ecosystem effects from laboratory studies is difficult. Laboratory studies cannot take into account the effects of environmental factors which may add to the effects of contaminant stress. NOAELs were generally selected from studies using single contaminant exposure scenarios. Species utilizing the Matteo Iron and Metal Site are exposed to a variety of contaminants.

In cases where a toxicity value has been converted by a factor of 10, the uncertainty associated with the absence of a directly relevant literature value was compounded by the uncertainty associated with a subjective mathematical adjustment.

Point estimates of exposure such as NOAELs, LOAELs, Lethal Dose to half of the exposed organisms (LD_{50}s), and mathematical means that are presented in the literature also have inherent variability, which is incorporated into the risk assessment. Additionally, because these values are statistically determined, they do not represent absolute thresholds; they are reflective of the experimental design. A reported LOAEL may not represent the lowest toxicity threshold for a species simply because lower concentrations were not tested in a study.

In addition, uncertainty associated with variability is introduced from the use of literature values for sediment, water, and food ingestion rates, dietary compositions, and body weights. These values reported in the literature are from studies that may have been conducted at a time of year or in a location that does not necessarily give an accurate representation of the life histories of the receptor species in the Matteo Iron area.

There is very little information available in the literature regarding the rates of incidental sediment ingestion for wildlife species. In this risk assessment some of these values were calculated from an allometric equation. Additional uncertainty regarding incidental soil/sediment ingestion is introduced by simplifying the diet in the food chain models. In reality, each receptor organism's diet is varied, and therefore, the associated soil/sediment intake fluctuates as different prey items are selected over time.

This ERA did not examine the contribution of dermal absorption or inhalation exposure as part of the exposure pathway. In contrast to the use of conservative assumptions, the error introduced into this risk assessment by the omission of these routes of exposure may be on the side of a less protective outcome. The relative degree to which this error alters the outcome of the risk assessment is unknown.

Error can be introduced by use of invalid assumptions in the conceptual model. Conservative assumptions were made in light of the uncertainty associated with the risk assessment process. This was done to minimize the possibility of concluding that no risk is present when a threat actually does exist (i.e., elimination of false negatives). Whenever possible, risk calculations were based on conservative values. For example, LOAELs used to calculate HQs were the lowest values found in the literature, regardless of toxic mechanism.

9.0 CONCLUSIONS OF THE RISK ASSESSMENT

Sediment and water samples were collected from 10 stations upstream, adjacent to, and downstream of the site. Samples were collected from both Hessian Run and Woodbury Creek. The results of these analyses were compared to toxicity BM to determine the risk to biota. Toxicity tests were also used to determine the impact of exposure to site sediment on biota. Community structure surveys were conducted on the indigenous benthic macroinvertebrate and fish communities to evaluate risk. Lastly, food chain models were used to determine the risk from the trophic transfer of contaminants in the food chain to upper trophic level species. The conclusions of the risk assessment are listed below:

- Lead concentrations measured in water samples were compared to both acute and chronic NJDEP SWQS. The concentration of Pb in surface water exceed these the chronic criteria at 6 stations (Stations 2, 3, 5, 6, 8 and 10). The concentration of Pb at Station 9 was not detected at a detection limit of 2.8 ug/L. The chronic criterion for this location is 2.7 ug/L, therefore, it could not be determined if the concentration of Pb at this station exceeded the criterion. The concentration of Pb in the surface water did not exceed the acute criteria at any of the stations.

- Lead concentrations in sediment samples exceed the SEL at stations adjacent to the site (Stations 3, 4, and 6), and exceed the LEL at all stations sampled.

- The concentration of PCBs in sediment does not exceed the SEL at any station. The concentration of Aroclor 1248 exceeded the LEL at sample Stations 7 and 9. However, the detection limit was higher than the LEL at Stations 1, 2, 3, 4, 5, 6, and 8, therefore, it could not be determined if the concentration of Aroclor 1248 exceeded the LEL or not. The detection limit for Aroclor 1248 at Station 10 was equal to the LEL, and therefore, this sample did not exceed the LEL. The concentration of Aroclor 1260 exceeded the LEL at all stations except Stations 8 and 10. However, the detection limit for Aroclor1260 at Stations 8 and 10 was higher than the LEL. Therefore, it could not be determined conclusively if the actual concentration of Aroclor 1260 at Stations 8 and 10 exceeded the LEL or not.

- Sediment toxicity tests indicate that the sample collected at Station 4, adjacent to the site, was 100% toxic to *H. azteca* and *C. tentans*. The indigenous benthic macroinvertebrate community was less diverse at stations adjacent to the site (Stations 3, 4 and 6) than the reference stations. In addition, the benthic assemblage at

stations 3, 4, 5 and 6 was entirely comprised of pollution tolerant species, while moderately tolerant or sensitive species were present at some reference locations.

- The fish community survey indicates that species richness and diversity was lower at stations adjacent to the site (Stations 3, 4, 5 and 6) than at all reference stations except Stations 1 and 2.

- Food chain model calculations indicate that insectivorous birds, insectivorous mammals, omnivorous birds, omnivorous mammals, and herbivorous mammals are at risk from the ingestion of Pb (LOAEL-based HQs greater than 1.0).

- Food chain model calculations indicate that insectivorous mammals, herbivorous mammals, omnivorous mammals and piscivorous mammals are at risk from the ingestion of PCBs (LOAEL-based HQs greater than 1.0).

- The food chain models also indicate that insectivorous birds and insectivorous mammal are at risk of acute toxicity from the ingestion of Pb.

- Based on food chain model calculations, it cannot be concluded that piscivorous mammals and piscivorous birds are not at risk from ingestion of Pb (NOAEL-based HQ greater than 1.0, LOAEL-based HQ less than 1.0).

- Based on food chain model calculations, it cannot be concluded that piscivorous birds, omnivorous birds, and insectivorous birds are not at risk from ingestion of PCBs (NOAEL-based HQ greater than 1.0, LOAEL-based HQ less than 1.0).

- For the food chain models, soil (and sediment) drive the risk to the mammals (except for PCBs to piscivorous mammals and Pb and PCBs to insectivorous mammals).

The risk assessment conclusions demonstrate the link between site contaminants and environmental impacts in the aquatic and terrestrial ecosystem. In addition, this ecological risk assessment indicates that the wildlife which utilize the area of highest site-related contamination as a foraging area are at risk.

10.0 LITERATURE CITED

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Table 1. Biota Study Sample Locations
Matteo Iron and Metal Site
West Deptford, NJ
July 2005

Station	Water Chemistry	Sediment Chemistry	Sediment Toxicity Tests			Fish Community Structure	Benthic Community Structure	Invertebrate	Fish Tissue		Plant Tissue		Invertebrate
			Hyalella azteca 28-d amphipod	*Chironomus tentans* 20-d midge	*Chironomus tentans* 65-d midge (emergence)			*Corbicula fluminea* Asiatic clam	*Lepomis gibbosus* Pumpkinseed	*Fundulus diaphanus* Banded killifish	*Nuphar luteum* Spatterdock	*Zizania aquatica* Wild Rice	*Lumbricus spp.* Earthworms
1*	X	X	X	X	X	X	X						
2*	X	X	X	X	X	X	X						
3	X	X	X	X	X	X	X	X		X			
4	X	X	X	X	X	X	X	X	X	X	X	X	
5	X	X	X	X	X	X	X	X		X	X	X	
6	X	X	X	X	X	X	X				X	X	
7*	X	X	X	X	X	X	X						
8*	X	X	X	X	X	X	X	X		X	X	X	
9*	X	X	X	X	X	X	X	X	X	X	X	X	
10*	X	X	X	X	X	X	X	X		X	X	X	
4E													X
4.5E													X
5E													X
8E*													X

* Indicates a reference location

Table 2. Concentration of Lead in Surface Water Samples
Matteo Iron and Metal Site
West Deptford, NJ
July 2005

Station	pH	Hardness mg/L	Lead ug/L	Acute Criteria[1] ug/L	Chronic Criteria[1] ug/L
1	7.2	228	1.3U	156.4	6.1
2	7.2	176	5.6	118.8	4.6
3	7.3	160	8.9	107.3	4.2
4	7.2	228	4.0	156.4	6.1
5	7.3	100	5.9	64.6	2.5
6	7.3	132	19.5	87.3	3.4
7	7.2	136	3.4	90.1	3.5
8	7.2	116	3.2	75.9	3
9	7.3	108	2.8U	70.2	2.7
10	7.2	76	5.0	47.8	1.9

U = Not detected above the sample quantitation limit
Results are for non-filtered water samples and do not include duplicate analyses
1 - Acute and chronic criteria are corrected for hardness
pH measured in standard units
mg/L = milligrams per liter
ug/L = micrograms per liter

Table 3. Concentrations of Lead and PCBs in Sediment
Matteo Iron and Metal Site
West Deptford, NJ
July 2005

Station	Lead mg/kg	Aroclor 1016 mg/kg	Aroclor 1221 mg/kg	Aroclor 1232 mg/kg	Aroclor 1242 mg/kg	Aroclor 1248 mg/kg	Aroclor 1254 mg/kg	Aroclor 1260 mg/kg	Total Aroclors[1]
1	217	0.05U	0.05U	0.05U	0.05U	0.05U	0.15J	0.15	0.3
2	175	0.04U	0.04U	0.04U	0.04U	0.04U	0.2	0.14	0.34
3	19600	0.11U	0.11U	0.11U	0.11U	0.11U	0.39	0.23	0.62
4	2200	1.4U	1.4U	1.4U	7J	1.4U	10	18	35
5	248	0.10U	0.10U	0.10U	0.10U	0.10U	1.2	0.44	1.64
6	349	0.083U	0.083U	0.083U	0.083U	0.083U	0.3	0.11	0.41
7	168	0.071U	0.071U	0.071U	0.071U	0.19J	0.66J	0.38	1.23
8	70	0.032U	0.032U	0.032U	0.032U	0.032U	0.032U	0.032U	0.032U
9	96.1	0.052U	0.052U	0.052U	0.052U	0.077	0.16J	0.089J	0.326
10	88	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U	0.03U
Lowest Effect Level	31	0.007	NA	NA	NA	0.03	0.06	0.005	
Severe Effect Level	250	53	NA	NA	NA	150	34	24	

U - Not detected at the sample quantitation limit
J - estimated concentration
1 - Total Aroclors is the sum of all Aroclors detected above the sample quantitation limit
mg/kg = milligrams per kilogram
Results reported as dry weight

Table 4. Percent Survival and Dry Weight
in 28-Day *H. azteca* and 20-Day *C. tentans* Toxicity Test
Matteo Iron and Metal Site
West Deptford, NJ
July 2005

Station	*Hyalella azteca*		*Chironomus tentans*	
	Mean Survival %	Mean Dry Weight mg	Mean Survival %	Mean Dry Weight mg
Control	98	0.076	66.7	0.645
1	96	0.093	26.7*	NA
2	94	0.081	25*	NA
3	84	0.073	5*	NA
4	0*	NA	0*	NA
5	92	0.075	25*	NA
6	70*	NA	33.3*	NA
7	56*	NA	16.7*	NA
8	92	0.057*	70	0.593
9	76*	NA	41.7	0.945
10	68*	NA	23.3*	NA

NA - not analyzed due to excessive mortality
* indicates statistically different than the control
% = percent
mg = milligrams

Table 5. Fish Species Abundance, Richness, and Diversity
Matteo Iron and Metal Site
West Deptford, NJ
July 2005

Species Name	Common Name	Station 1	2	3	4	5	6	7	8	9	10	On-site Stations (3,4,5,6)	Reference (1,2,8,9)	All other locations (1,2,7,8,9,10)
Fundulus diaphanus	Banded killifish	14	3	15	306	67	50	22	370	384	61			
Fundulus heteroclitus	Mummichog	8	6	12	708	224	26	16	2	15	4			
Etheostoma olmstedi	Tessellated darter	1						3	10	1	5			
Hybognathis regius	Eastern silvery minnow	1	1						2	38	42			
Alosa pseudoharengus	Alewife				2			3	39	4	13			
Lepomis gibbosus	Pumpkinseed		1		7	1		1	2	5	1			
Anguilla rostrata	American eel								3	2				
Anchoa sp.	Anchovy								2	1				
Menidia menidia	Silverside										1			
Morone americana	White perch		1					1	44	19	14			
Morone saxatilis	Striped bass								4		2			
Trinectes maculatus	Hogchoker							1	3					
	Total	24	12	27	1023	292	76	47	481	469	143	1418	986	1176
	Species Richness	4	5	2	4	3	2	7	11	9	9	2.5	5	5
	Shannon-Weaver Diversity Index	0.334	0.275	0.298	0.288	0.26	0.279	0.51	0.39	0.306	0.586	0.282	0.326	0.4

Table 6. Benthic Macroinvertebrate Species Abundance, Richness, and Diversity
Matteo Iron and Metal Site
West Deptford, NJ
July 2005

Species Abundance		Stations										On-site Stations	Reference	All other Stations
Order/Class	Species/Taxa	1	2	3	4	5	6	7	8	9	10	(3,4,5,6)	(1,2,8,9)	(1,2,7,8,9,10)
Oligochaeta	Oligochaete A	8	159	172	15	126	68	38	19	48	18			
	Oligochaete B					19	3	4	4					
Insecta	Odonata-Gomphidae	1												
	Diptera-Chironomidae	41	70	38	13	46	85	15	19	2	19			
Crustacea	Isopoda-Anthuridae		1								4			
	Amphipod-Gammaridae	7							1					
Bivalvia	Asiatic clam	50	21	12	1	11	2	1	5	4	6			
	Unionidae	4	2											
Hirudinea	Leech	2	3	3		1								
	Total	113	256	225	29	203	158	58	48	54	47	615	471	576
	Species Richness	7	6	4	3	5	4	4	5	3	4	3.4	4.3	3.9
	Shannon-Weaver Diversity Index	0.526	0.414	0.372	0.284	0.42	0.325	0.332	0.526	0.162	0.462	0.353	0.404	0.402
	Trophic Composition													
	Deposit Feeder	49.6	89.8	93.3	96.6	94.1	98.7	98.3	89.6	92.6	87.2			
	Filter Feeder	47.8	9	5.3	3.4	5.4	1.3	1.7	10.4	7.4	12.8			
	Carnivore	2.6	1.2	1.4	0	0.5	0	0	0	0	0			
	Pollution Tolerance													
	Tolerant	89.4	98.8	100	100	100	100	100	97.9	100	91.5			
	Moderately Tolerant	9.7	1.2	0	0	0	0	0	2.1	0	8.5			
	Sensitive	0.9	0	0	0	0	0	0	0	0	0			

Table 7. Concentrations of Lead and PCBs in *Fundulus diaphanus*
Matteo Iron and Metal Site
West Deptford, NJ
July 2005

Station	Sample ID	Lead (mg/kg)	Aroclor 1016 (mg/kg)	Aroclor 1221 (mg/kg)	Aroclor 1232 (mg/kg)	Aroclor 1242 (mg/kg)	Aroclor 1248 (mg/kg)	Aroclor 1254 (mg/kg)	Aroclor 1260 (mg/kg)	Total Aroclors (mg/kg)
3	3F1	1.5	0.015U	0.015U	0.015U	0.015U	0.036	0.19	0.067	0.293
	3F2	1.6	0.015U	0.015U	0.015U	0.015U	0.032	0.17	0.061	0.263
	3F3	1.6	0.025U	0.025U	0.025U	0.025U	0.043J	0.25	0.087	0.337
4	4F1F	0.78	0.05U	0.05U	0.05U	0.05U	0.1J	0.38J	0.13	0.61
	4F2F	0.78	0.025U	0.025U	0.025U	0.025U	0.068J	0.3J	0.16	0.528
	4F3F	0.7	0.025U	0.025U	0.025U	0.025U	0.056	0.24J	0.11J	0.406
5	5F1F	0.99	0.05U	0.05U	0.05U	0.05U	0.074	0.44J	0.16	0.674
	5F2F	1.2	0.05U	0.05U	0.05U	0.05U	0.069	0.39	0.16	0.619
	5F3F	0.82	0.025U	0.025U	0.025U	0.025U	0.09	0.26	0.075	0.425
8	8F1	0.7	0.025U	0.025U	0.025U	0.025U	0.053	0.18J	0.091	0.324
	8F2	0.71	0.015U	0.015U	0.015U	0.015U	0.038	0.12J	.078J	0.236
	8F3	0.69	0.025U	0.025U	0.025U	0.025U	0.053	0.19J	0.11J	0.353
9	9F1	0.85	0.025U	0.025U	0.025U	0.025U	0.062	0.26	0.097	0.419
	9F2	0.86	0.025U	0.025U	0.025U	0.025U	0.057J	0.17J	0.1J	0.327
	9F3	1.4	0.015U	0.015U	0.015U	0.015U	0.048	0.14J	0.078	0.266
10	10F1	0.37	0.05U	0.05U	0.05U	0.05U	0.075	0.3	0.18	0.555
	10F2	0.46	0.025U	0.025U	0.025U	0.025U	0.071	0.24J	0.14	0.451
	10F3	0.39	0.025U	0.025U	0.025U	0.025U	0.061	0.24J	0.14	0.441

U - not detected at the sample quantitation limit
J - estimated concentration
Total Aroclors - Sum of the detected Aroclors
ID = identification
mg/kg = milligrams per kilogram
Results reported as wet weight

Table 8. Concentrations of Lead and PCBs in *Lepomis gibbosus*
Matteo Iron and Metal Site
West Deptford, NJ
July 2005

Station	Sample ID	Lead (mg/kg)	Aroclor 1016 (mg/kg)	Aroclor 1221 (mg/kg)	Aroclor 1232 (mg/kg)	Aroclor 1242 (mg/kg)	Aroclor 1248 (mg/kg)	Aroclor 1254 (mg/kg)	Aroclor 1260 (mg/kg)	Total Aroclors (mg/kg)
Hessian	4F1L	0.6	0.025U	0.025U	0.025U	0.025U	0.081	0.24J	0.12	0.441
Run	4F2L	0.52	0.015U	0.015U	0.015U	0.015U	0.068	0.14J	0.069	0.277
(Station 4)	4F3L	0.47	0.05U	0.05U	0.05U	0.05U	0.1	0.27J	0.29J	0.66
Woodbury	9F1L	0.17J	0.01U	0.01U	0.01U	0.01U	0.035	0.12	0.072	0.227
Creek	9F2L	0.28	0.025U	0.025U	0.025U	0.025U	0.11	0.28	0.092	0.482
(Station 9)	9F3L	0.61	0.025U	0.025U	0.025U	0.025U	0.082	0.2	0.076	0.358

U - not detected at the sample quantitation limit
J - estimated concentration
Total Aroclors - Sum of the detected Aroclors
ID = identification
mg/kg = milligrams per kilogram
Results reported as wet weight

Table 9. Concentrations of Lead and PCBs in *Corbicula fluminea*
Matteo Iron and Metal Site
West Deptford, NJ
July 2005

Station	Sample ID	Lead (mg/kg)	Aroclor 1016 (mg/kg)	Aroclor 1221 (mg/kg)	Aroclor 1232 (mg/kg)	Aroclor 1242 (mg/kg)	Aroclor 1248 (mg/kg)	Aroclor 1254 (mg/kg)	Aroclor 1260 (mg/kg)	Total Aroclors (mg/kg)
3	3B1	0.79	0.025U	0.025U	0.025U	0.025U	0.066J	0.19	0.032J	0.288
	3B2	0.54	0.025U	0.025U	0.025U	0.025U	0.07	0.19	0.025U	0.26
	3B3	0.44	0.025U	0.025U	0.025U	0.025U	0.078	0.22	0.026	0.324
4	4B1	0.78	0.025U	0.025U	0.025U	0.025U	0.084	0.23	0.029	0.343
	4B2	0.73	0.025U	0.025U	0.025U	0.025U	0.1	0.26	0.033	0.393
	4B3	0.91	0.025U	0.025U	0.025U	0.025U	0.1	0.26	0.036	0.396
5	5B1	0.52	0.025U	0.025U	0.025U	0.025U	0.072	0.2	0.026	0.298
	5B2	0.53	0.025U	0.025U	0.025U	0.025U	0.062	0.18	0.025U	0.242
	5B3	0.59	0.025U	0.025U	0.025U	0.025U	0.066	0.18	0.025U	0.246
8	8B1	1.3	0.025U	0.025U	0.025U	0.025U	0.041J	0.12	0.025U	0.161
	8B2	0.57	0.015U	0.015U	0.015U	0.015U	0.034J	0.093	0.021	0.148
	8B3	0.92	0.015U	0.015U	0.015U	0.015U	0.035J	0.1	0.021	0.156
9	9B1	0.38	0.01U	0.01U	0.01U	0.01U	0.029	0.082	0.013	0.385
	9B2	0.46	0.015U	0.015U	0.015U	0.015U	0.047	0.14	0.022	0.209
	9B3	0.5	0.015U	0.015U	0.015U	0.015U	0.048	0.14J	0.024	0.212
10	10B1	0.86	0.025U	0.025U	0.025U	0.025U	0.046J	0.13	0.032	0.208
	10B2	0.56	0.025U	0.025U	0.025U	0.025U	0.047J	0.13	0.027J	0.204
	10B3	1.0	0.015U	0.015U	0.015U	0.015U	0.03J	0.091	0.025J	0.146

U - Not detected at the samples quantitation limit
J - estimated concentration
Total Aroclors - Sum of the detected Aroclors
ID = identification
mg/kg = milligrams per kilogram
Results reported as wet weight

Table 10. Concentrations of Lead and PCBs in *Nuphar luteum*

Matteo Iron and Metal Site

West Deptford, NJ

July 2005

Station	Sample ID	Lead (mg/kg)	Aroclor 1016 (mg/kg)	Aroclor 1221 (mg/kg)	Aroclor 1232 (mg/kg)	Aroclor 1242 (mg/kg)	Aroclor 1248 (mg/kg)	Aroclor 1254 (mg/kg)	Aroclor 1260 (mg/kg)	Total Aroclors (mg/kg)
4	4PN1	9.8	0.005U	0.005U	0.005U	0.005U	0.005U	0.015J	0.0083	0.0233
	4PN2	4.8	0.005U	0.005U	0.005U	0.005U	0.005U	0.0095J	0.005U	0.0095
	4PN3	5.2	0.005U	0.005U	0.005U	0.005U	0.005U	0.012J	0.0053	0.0173
5	5PN1	8.4	0.005U	0.005U	0.005U	0.005U	0.005U	0.015J	0.008	0.023
	5PN2	6.7	0.005U	0.005U	0.005U	0.005U	0.005U	0.014J	0.0076	0.0216
	5PN3	7.6	0.005U	0.005U	0.005U	0.005U	0.005U	0.013J	0.0058	0.0188
6	6PN1	4.9	0.005U	0.005U	0.005U	0.005U	0.005U	0.0088J	0.005U	0.0088
	6PN2	5.5	0.005U	0.005U	0.005U	0.005U	0.005U	0.01J	0.0051	0.0151
	6PN3	3.9	0.005U	0.005U	0.005U	0.005U	0.005U	0.0094J	0.005U	0.0094
8	8PN1	1.5	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
	8PN2	1.4	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
	8PN3	1.6	0.005U	0.005U	0.005U	0.005U	0.027	0.005U	0.005U	0.027

U - Not detected at the samples quantitation limit

J - estimated concentration

Total Aroclors - Sum of the detected Aroclors

ID = identification

mg/kg = milligrams per kilogram

Results in wet weight

Table 11. Concentrations of Lead and PCBs in *Zizania aquatica*

Matteo Iron and Metal Site

West Deptford, NJ

July 2005

Station	Sample ID	Lead (mg/kg)	Aroclor 1016 (mg/kg)	Aroclor 1221 (mg/kg)	Aroclor 1232 (mg/kg)	Aroclor 1242 (mg/kg)	Aroclor 1248 (mg/kg)	Aroclor 1254 (mg/kg)	Aroclor 1260 (mg/kg)	Total Aroclors (mg/kg)
4	4PZ1	2.2	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
	4PZ2	6.1	0.005U	0.005U	0.005U	0.005U	0.005U	0.007J	0.005U	0.007J
	4PZ3	5.6	0.005U	0.005U	0.005U	0.005U	0.005U	0.0052J	0.005U	0.0052J
5	5PZ1	1.3	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
	5PZ2	3.5	0.005U	0.005U	0.005U	0.005U	0.005U	0.0062	0.005U	0.0062
	5PZ3	1.8	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
6	6PZ1	8.2	0.005U	0.005U	0.005U	0.005U	0.005U	0.012J	0.0073J	0.0193
	6PZ2	6.0	0.005U	0.005U	0.005U	0.005U	0.005U	0.0084J	0.005U	0.0084
	6PZ3	7.1	0.005U	0.005U	0.005U	0.005U	0.005U	0.014J	0.0074J	0.0214
8	8PZ1	0.33	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
	8PZ2	0.36	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U
	8PZ3	0.23J	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U	0.005U

U - Not detected at the samples quantitation limit

J - estimated concentration

Total Aroclors - Sum of the detected Aroclors

ID = identification

mg/kg = milligrams per kilogram

Results in wet weight

Table 12. Concentrations of Lead and PCBs in Earthworms
Matteo Iron and Metal Site
West Deptford, NJ
July 2005

Station	Sample ID	Lead (mg/kg)	Aroclor 1016 (mg/kg)	Aroclor 1221 (mg/kg)	Aroclor 1232 (mg/kg)	Aroclor 1242 (mg/kg)	Aroclor 1248 (mg/kg)	Aroclor 1254 (mg/kg)	Aroclor 1260 (mg/kg)	Total Aroclors (mg/kg)
4E	4E1	441	0.50U	0.50U	0.50U	0.50U	0.50U	2.9	3.1	6.0
	4E2	400	0.50U	0.50U	0.50U	0.50U	0.50U	2.4	2.4J	4.8
	4E3	511	0.50U	0.50U	0.50U	0.50U	0.50U	2.1	3.2J	5.3
4.5E	4.5E1	339	0.50U	0.50U	0.50U	0.50U	0.50U	3.5	5.6	9.1
	4.5E2	269	0.50U	0.50U	0.50U	0.50U	0.50U	2.5	4	6.5
	4.5E3	414	0.50U	0.50U	0.50U	0.50U	0.50U	2.5	3.2	5.7
5E	5E1	1090	0.075U	0.075U	0.075U	0.075U	0.075U	0.62	0.37	0.99
	5E2	1150	0.10U	0.10U	0.10U	0.10U	0.10U	0.69	0.37	1.06
	5E3	1100	0.10U	0.10U	0.10U	0.10U	0.10U	0.73	0.36	1.09
8E	8E1	4.5	0.005U	0.005U	0.005U	0.005U	0.005U	0.012J	0.005U	0.012
	8E2	25.1	0.025U	0.025U	0.025U	0.025U	0.025U	0.12J	0.025U	0.12
	8E3	5.9	0.005U	0.005U	0.005U	0.005U	0.005U	0.014J	0.005U	0.014

U - Not detected at the samples quantitation limit
J - estimated concentration
Total Aroclors - Sum of the detected Aroclors
ID = identification
mg/kg = milligrams per kilogram
Results in wet weight

Table 13. Summary of Food Chain Model Results
Matteo Iron and Metal Site
West Deptford, NJ
July 2005

Assessment Endpoint	COPC	Acute Risk [a]	Risk[b]	Indeterminant Risk[c]	No risk[d]
Piscivorous Bird	Lead			X	
Great Blue Heron	PCB			X	
Piscivorous Bird	Lead			X	
Bald Eagle	PCB			X	
	Lead			X	
Piscivorous Mammal	PCB		X		
	Lead		X		
Omnivorous Bird	PCB			X	
	Lead		X		
Omnivorous Mammal	PCB		X		
	Lead	X	X		
Insectivorous Bird	PCB			X	
	Lead	X	X		
Insectivorous Mammal	PCB		X		
	Lead		X		
Herbivorous Mammal	PCB		X		

a - Only calculated for insectivorous birds and mammals
b - Hazard Quotient > 1 compared to both the LOAEL and NOAEL
c - Hazard Quotient < 1 compared to the LOAEL but > 1 compared to the NOAEL
d - Hazard Quotient < 1 compared to both the LOAEL and NOAEL
COPC = contaminant of potential concern
PCB = polychlorinated biphenyl
LOAEL = Lowest observed adverse effect level
NOAEL = No observable adverse effect level

Table 14. Food Chain Models for Mink, Great Blue Heron, Bald Eagle and Muskrat
Matteo Iron and Metal Site
West Deptford, NJ
July 2005

Species	COC	Conc. in Sediment (mg/kg d.w.)	Sediment Ingestion Rate (kg/day w.w.)	Total Ingested Sediment (mg/day)	Conc. in Water (mg/L)	Water Ingestion Rate (L/day)	Total Ingested Water (mg/day)	Conc. in Food (mg/kg w.w.)	Food Ingestion Rate (kg/day w.w.)	Total Food Conc. (mg/day)	Body Weight (kg)	Dose (mg/kg BW/day)	LOAEL (mg/kg BW/day)	HQ LOAEL	NOAEL (mg/kg BW/day)	HQ NOAEL
Mink	Lead	19,600	0.000687	13.465	0.0195	0.0604	0.001	1.6	0.408	0.653	0.454	31.10	80	0.4	8	3.9
	PCBs	35	0.000687	0.024	0	0.0604	0.000	0.674	0.408	0.275	0.454	0.66	0.1	**6.6**	0.05	**13.2**
Great Blue Heron	Lead	19,600	0.00058	11.368	0.0195	0.097	0.002	1.6	0.342	0.547	2.09	5.70	15	0.4	1.5	3.8
	PCBs	35	0.00058	0.020	0	0.097	0.000	0.674	0.342	0.231	2.09	0.12	0.94	0.1	0.094	1.3
Bald Eagle	Lead	19,600	0.00118	23.128	0.0195	0.14	0.003	1.6	0.700	1.120	3.63	6.68	15	0.4	1.5	4.5
	PCBs	35	0.00118	0.041	0	0.14	0.000	0.674	0.700	0.472	3.63	0.14	0.94	0.2	0.094	1.5
Muskrat	Lead	19,600	0.00289	56.644	0.0195	0.057	0.001	9.8	0.286	2.803	0.541	109.89	80	1.4	8	13.7
	PCBs	35	0.00289	0.101	0	0.057	0.000	0.027	0.286	0.008	0.541	0.20	0.1	**2.0**	0.05	**4.0**

mg/kg = milligrams per kilogram
kg/day = kilograms per day
mg/day = milligrams per day
mg/L = milligrams per liter
L/day = liters per day
d.w. = dry weight
w.w. = wet weight
mg/kg BW/day = milligrams per kilogram body weight per day
LOAEL = lowest observed adverse effect level
NOAEL = no observable adverse effect level
HQ = hazard quotient
PCBs = polychlorinated biphenyls
Conc. = concentration
COC = contaminant of concern

Table 15. Food Chain Models for Raccoon and the Wood Duck
Manco Iron and Metal Site
West Deptford, NJ
July 2005

Raccoon	Conc. in Sediment (mg/kg d.w.)	Sediment Ingestion Rate (kg/day)	Total Intake through Sediment (mg/day)	Conc. in Water (mg/L)	Water Ingestion Rate (L/day)	Total Intake through Water (mg/day)	Conc. in Plants (mg/kg w.w.)	Percent of Diet Plants	Conc. in Inverts. (mg/kg w.w)	Percent of Diet Inverts.	Food Ingestion Rate (kg/day)	Total Food Conc. (mg/day)	Body Weight (kg)	Dose (mg/kg BW/day)	LOAEL (mg/kg BW/day)	HQ LOAEL	NOAEL (mg/kg BW/day)	HQ NOAEL
Lead	19,600	0.0376	736.96	0.0195	0.201	0.0039195	9.8	0.61	1.3	0.39	0.3624	2.350	2.2	336.05	80	**4.20**	8	**42.01**
PCBs	35	0.0376	1.316	0	0.201	0	0.027	0.61	0.396	0.39	0.3624	0.062	2.2	0.63	0.1	**6.26**	0.05	**12.53**
Wood duck																		
Lead	19,600	0.0065	127.4	0.0195	0.037	0.0007215	9.8	0.5	1.3	0.5	0.103	0.572	0.5	255.94	15	**17.06**	1.5	**170.63**
PCBs	35	0.0065	0.2275	0	0.037	0	0.027	0.5	0.396	0.5	0.103	0.022	0.5	0.50	0.94	0.53	0.094	**5.30**

mg/kg = milligrams per kilogram
kg/day = kilograms per day
mg/day = milligrams per day
mg/L = milligrams per liter
L/day = liters per day
d.w. = dry weight
w.w. = wet weight
mg/kg BW/day = milligrams per kilogram body weight per day
LOAEL = lowest observed adverse effect level
NOAEL = no observable adverse effect level
HQ = hazard quotient
PCBs = polychlorinated biphenyls
Conc. = concentration

Table 16. Food Chain Models for Short-tailed Shrew and American Robin
Matteo Iron and Metal Site
West Deptford, NJ
July 2005

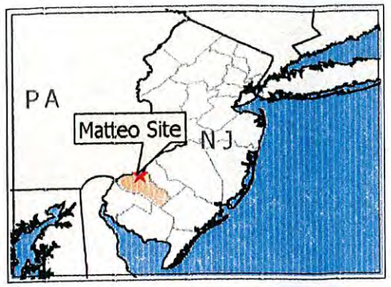
Short-tailed shrew	Conc. in Soil (mg/kg d.w.)	Soil Ingestion Rate (kg/day w.w.)	Total Ingested Soil (mg/day)	Conc. in Water (mg/L)	Water Ingestion Rate (L/day)	Total Ingested Water (mg/day)	Conc. in Food (mg/kg w.w.)	Food Ingestion Rate (kg/day w.w.)	Total Food Conc. (mg/day)	Body Weight (kg)	Dose (mg/kg BW/day)	LOAEL (mg/kg BW/day)	HQ LOAEL	NOAEL (mg/kg BW/day)	HQ NOAEL
Lead	31,300	0.0007	21.91	0.0195	0.0028	0.0000546	1150	0.0078	8.970	0.0125	2470.40	80	**30.9**	8	**308.8**
PCBs	0	0.0007	0	0	0.0028	0	9.1	0.0078	0.071	0.0125	5.68	0.1	**56.8**	0.05	**113.6**
American robin															
Lead	31,300	0.0025	78.25	0.0195	0.0085	0.00016575	1150	0.0215	24.725	0.055	1872.28	15	**124.8**	1.5	**1248.2**
PCBs	0	0.0025	0	0	0.0085	0	9.1	0.0215	0.196	0.055	3.56	0.94	0.2	0.094	**37.8**

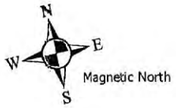
mg/kg = milligrams per kilogram
kg/day = kilograms per day
mg/day = milligrams per day
mg/L = milligrams per liter
L/day = liters per day
d.w. = dry weight
w.w. = wet weight
mg/kg BW/day = milligrams per kilogram body weight per day
LOAEL = lowest observed adverse effect level
NOAEL = no observable adverse effect level
HQ = hazard quotient
PCBs = polychlorinated biphenyls
Conc. = concentration

Table 17. Food Chain Models using Acute TRVs for Short-tailed Shrew and American Robin
Matteo Iron and Metal Site
West Deptford, NJ
July 2005

Short-tailed shrew	Conc. in Soil (mg/kg d.w.)	Soil Ingestion Rate (kg/day w.w.)	Total Ingested Soil (mg/day)	Conc. in Water (mg/L)	Water Ingestion Rate (L/day)	Total Ingested Water (mg/day)	Conc. in Food (mg/kg w.w.)	Food Ingestion Rate (kg/day w.w.)	Total Food Conc. (mg/day)	Body Weight (kg)	Dose (mg/kg BW/day)	Acute TRV (mg/kg BW/day)	Acute HQ
Lead	31,300	0.0007	21.91	0.0195	0.0028	0.0000546	1150	0.0078	8.970	0.0125	2470.40	320	**7.7**
PCBs	0	0.0007	0	0	0.0028	0	9.1	0.0078	0.071	0.0125	5.68	27	0.2
American robin													
Lead	31,300	0.0025	78.25	0.0195	0.0085	0.00016575	1150	0.0215	24.725	0.055	1872.28	625	**3.0**
PCBs	0	0.0025	0	0	0.0085	0	9.1	0.0215	0.196	0.055	3.56	394	0.01

mg/kg = milligrams per kilogram
kg/day = kilograms per day
mg/day = milligrams per day
mg/L = milligrams per liter
L/day = liters per day
d.w. = dry weight
w.w. = wet weight
mg/kg BW/day = milligrams per kilogram body weight per day
LOAEL = lowest observed adverse effect level
NOAEL = no observable adverse effect level
HQ = hazard quotient
PCBs = polychlorinated biphenyls
Conc. = concentration
TRV = toxicity reference value





Legend

Aquatic Biota Sampling Stations

Note: Sample locations are estimated based on Figure 1 of the Final Aquatic Study report prepared by the Louis Berger Group, Inc. December 30, 2004.

Map created using NJ DEP orthophotography
Sampling stations locations are estimated.

Map Creation Date: 16May2005

Coordinate system: New Jersey State Plane
FIPS: 2900
Units: Feet
Datum: NAD83

100 0 100 200 300
Meters

U.S. EPA Environmental Response Team
Response Engineering and Analytical Contract
EP-C-04-032
W.A.# 0-148

Figure 1
Site Location Map
Matteo Iron and Metal Site
West Deptford Township, N.

Data: g:\arcviewprojects\reac4\00-148
MXD file: g:\arcinfoprojects\reac4\EAC00148_MatteoMetal\148_sitemap_f1
Revision Number: 004

APPENDICES

Appendix A: Toxicological Profiles
Matteo Iron and Metal Site
July 2005

TOXICITY PROFILES FOR MATTEO IRON AND METAL SITE

Prepared By:

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July 2005

0148-DFR-071405

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1.0 DERIVATION OF TOXICITY REFERENCE VALUES

A toxicity reference value (TRV) is a contaminant dose level that is compared with a predicted exposure dose level, calculated based on site-specific data, to assess the presence and degree of risk to a receptor or group of receptors from that contaminant. A TRV is generally based on data from laboratory toxicological evaluations. Usually, two TRVs are used to predict ecological risk, a no observable adverse effect level (NOAEL) and a lowest observable adverse effect level (LOAEL). The NOAEL is the highest dose at which adverse effects are not expected to occur, and the LOAEL is the lowest dose at which adverse effects are expected to occur.

In order to derive TRVs, a comprehensive literature search was performed to identify studies on the toxicity of contaminants of concern (COCs) to ecological receptors. A variety of databases were searched, including Biological Abstracts, Applied Ecology Abstracts, Chemical Abstract Services, Medline, Toxline, BIOSIS, ENVIROLINE, Current Contents, Hazardous Substances Data Bank (HSDB), Registry of Toxic Effects of Chemical Substances (RTECS), Integrated Risk Information System (IRIS), and the Aquatic Toxicity Information Retrieval Database (AQUIRE).

In addition, a number of secondary literature sources provided summaries or reviews of toxicological literature related to a variety of contaminants. These documents were not used directly to derive TRVs because they do not capture the details of the toxicological methods needed for the selection of technically defensible TRVs. However, these summary documents provided an excellent source for locating original studies that may have been overlooked in the database searches. Examples of such summary documents include Agency for Toxic Substances and Disease Registry (ATSDR) documents, United States (U.S.) Fish and Wildlife Service Contaminant Hazard Reviews, U.S. Environmental Protection Agency (EPA) Great Lakes Water Quality Initiative documents, and U.S. EPA Ambient Water Quality Criteria documents.

Studies that were obviously not useful or appropriate for deriving a TRV were eliminated. A number of criteria were considered when evaluating the appropriateness of using a particular study for deriving a TRV. The most important consideration was the suitability of the test result for evaluating the assessment endpoint. A number of additional criteria were also considered. For example, studies were selected in which the test organism was in as similar a taxonomic grouping as possible to the measurement endpoint species. Exposure doses had to be quantified and effects measured and reported. The exposure duration was preferably either chronic, sub-chronic, or involved a sensitive life stage; multi generational studies were also appropriate. For laboratory studies, the likelihood that a similar result would be obtained if the test was repeated was an additional consideration. Sample sizes had to be adequate and the treatment groups must have been compared to appropriate control groups. At the very least, a negative control had to be included in the study design. In addition, the measured endpoints of the study had to be ecologically relevant. For the purposes of deriving a TRV for an ecological risk assessment, an ecologically relevant endpoint is one which is closely tied to the survival and viability of a population in the field. Usually, the endpoints measured for this purpose were survival, growth, and reproduction. In addition, appropriate statistical analyses must have been performed and the statistical significance reported. Finally, the study design preferably included at least three treatments in addition to any controls which may have been selected.

The selected TRVs were based preferably on high-quality studies which satisfy many or all of the above requirements. From these studies, the lowest concentration that was associated with adverse ecological effects on the test organism was selected as the LOAEL. Studies which reported both a LOAEL and NOAEL were selected over studies which reported only one effect level, due to the uncertainty associated with an unbounded effect level. If only a LOAEL could be identified from the studies, an uncertainty factor of 10 was used to calculate a NOAEL (Dourson and Stara 1983; U.S. EPA 1989; Sample *et al.* 1996; Amdur *et al.* 1996). If a LOAEL could not be located for a COC, a median lethal dose (LD_{50}) was selected; a factor of 10 was then used to calculate a LOAEL and a factor of 100 was used to calculate a NOAEL. Finally, if no adverse effect level could be located for a COC, the highest reported NOAEL was selected, and a factor of 10 was used to calculate a LOAEL. Professional judgement was used in some cases to select the most appropriate TRV.

The studies that were reviewed to derive toxicity reference values for this risk assessment are described below. Concentrations selected to be used as TRVs are summarized in Table 18.

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1.1 Lead

1.1.1 Lead Toxicity to Birds

1.1.1.1 Acute Toxicity

One-day old American kestrel (*Falco sparverius*) nestlings were orally dosed with metallic lead in corn oil at concentrations of 5 micrograms per liter (µg/L) corn oil (controls), 25 milligrams lead per kilogram body weight (mg Pb/kgBW), 125 mg Pb/kgBW or 625 mg Pb/kgBW daily for 10 days (Hoffman *et al.* 1985). Forty percent of the nestlings exposed to Pb at a concentration of 625 mg/kgBW were dead by day six. No mortality was observed in any other exposure group. Due to the acute nature of this study (short duration and high mortality), an exposure concentration of 625 mg/kgbW/day was selected to assess the short-term acute effects of Pb to birds in this risk assessment.

Hoffman, D.J., Franson, J.C., Pattee, O.H., Bunck, C.M. and A. Anderson. 1985. Survival, growth and accumulation of ingested lead in nestling American Kestrels (*Falco sparvereius*). Arch. Environ. Contam. Toxicol. 14:89-94.

1.1.1.2 Chronic Toxicity

The gastric motility of adult male and female red-tailed hawks (*Buteo jamaicensis*) fed 0.82 and 1.64 mg/kg BW/day (mg/kgBW/day concentration reported by authors) for three weeks was evaluated through the use of surgically implanted transducers. Neither concentration had any effect on gastric contractions or egestion of undigested material pellets (Lawler et al. 1991).

Adult male and female red-tailed hawks were administered lead acetate by gavage at a concentration of 0.82 mg/kg BW/day for three weeks (Redig et al. 1991). Compared to control birds, there was an 83 percent (%) decrease in delta-aminolevulinic acid dehydratase (ALAD) activity and a 74 % increase in the levels of free porphyrins circulating in the blood of experimental birds. Immune function (as measured by antibody titers to foreign red blood cells or mitogenic stimulation of T-lymphocytes) was not significantly affected at this exposure level.

Beyer et al. (1988) fed red-winged blackbirds, brown-headed cowbirds, common grackles, northern bobwhites and eastern screech owls diets containing lead acetate. The dietary concentration was increased by 60 % weekly until half of the birds in each treatment group died. Because the exposure concentrations changed throughout the experiment, this study was not used to derive TRVs for this risk assessment.

One-day old American kestrel chicks were dosed orally with metallic Pb at concentrations of 0, 25, 125 or 625 mg/kgBW/day for 10 days (Hoffman et al. 1985a and 1985b). Forty percent of the birds

in the highest dose group died after six days of exposure. Growth rates of birds which received Pb at concentrations of 125 or 625 mg/kgBW/day were significantly lower than the growth rates of control birds.

The effect of Pb on survival of American kestrels was evaluated by feeding the birds either a control diet, or a diet containing mallard ducks which had died of Pb poisoning (mean Pb concentration was 29.3 mg/kg) for 60 days (Stendell 1980). No kestrels died or exhibited visible signs of Pb poisoning during the 60-day exposure period. An ingestion rate of 0.0307 kg/day (Barrett and Mackey 1975) and a body weight of 0.111 kg (Dunning 1993) were used to convert the exposure concentration to units of mg/kgBW/day. A NOAEL of 8.1 mg/kgBW/day was calculated based on the results of this experiment.

Ringed turtle doves received 0 or 100 micrograms per milliliter (μg/ml) Pb in their drinking water from two weeks prior to breeding throughout a breeding cycle (Kendall and Scanlon 1981). Exposure to Pb did not increase the time required to produce eggs, and no adverse effects on egg production or fertility were observed. Bone Pb concentrations in adult birds and bone and liver Pb concentrations in juveniles were higher than in control birds or progeny of control birds. A water ingestion rate of 0.017 L/day (calculated using an allometric equation from Calder and Braun 1983) and a body weight of 0.16 kg (Schwarzbach et al. 1991) was used to convert the exposure concentration to units of mg/kgBW/day. A NOAEL of 10.6 mg/kgBW/day was calculated based on the results of this experiment.

Bobwhite quail were fed diets supplemented with Pb (as lead acetate) at concentrations of 0, 500, 1,000, 1,500, 2,000 and 3,000 mg/kg for 6 weeks (Damron and Wilson 1975). Weight gain and food consumption were significantly decreased in birds receiving the two highest exposure concentrations. Mortality of birds receiving 3,000 mg/kg Pb was 46.7 %, much greater than any other exposure group; however, it was not statistically significant due to large variability among replicate pens. In another experiment, male bobwhite were fed diets containing 0, 500, 1,000 or 1,500 mg/kg Pb (as lead acetate) for eight weeks. Mortality, food consumption, sperm concentration and sperm viability were measured; no effects were observed at any exposure concentration. A food ingestion rate of 0.0143 kg/day and adult body weight of 0.169 kg were used to convert the exposure concentrations to units of mg/kgBW/day; 2,000 mg/kg was selected as the NOAEL level. A NOAEL of 127 (exposure concentration of 1,500 mg/kg, endpoint measured sperm concentration and viability) and an estimated LOAEL of 1,270 mg/kgBW/day were calculated based on the results of this experiment.

Day-old mallard ducklings were fed diets supplemented with Pb-contaminated sediment at concentrations of 1.9 (control diet), 414 and 828 micrograms per gram (μg/g) for six weeks (Hoffman et al. 2000b). A clean sediment-supplemented control (24% sediment) and a positive control diet containing lead acetate at a concentration equivalent to the 828 μg/g Pb-contaminated sediment diet were included in the experimental design. Mortality was observed only in the lead acetate group (7 %), but was not significantly different from the control group. Hematocrit and hemoglobin were significantly lower in ducklings which received lead acetate. Blood ALAD activity levels were significantly lower and protoporphyrin levels were higher in both groups which received Pb-contaminated sediment and the ducklings which received lead acetate. Acid-fast renal tubular inclusion bodies and nephrosis are abnormalities associated with Pb poisoning; inclusion bodies were observed in 50 % and tubular nephrosis was observed in 75 % of ducklings fed lead acetate. Renal inclusion bodies were observed in two of nine ducklings from the 414 μg/g group, and in 4 of 9 ducklings from the 828 μg/g group. Growth was affected only in ducklings fed lead acetate. Based on the reduced growth observed in ducklings exposed to lead acetate at a concentration of 828 μg/g, this concentration was selected as the LOAEL for this experiment. A food ingestion rate of 0.0645 kg/day and body weight of 0.379 kg (cited by Sugden et al. 1981 for three-week old mallard ducklings) were used to convert the exposure concentrations to units of mg/kgBW/day. A LOAEL of 140.9 mg/kgBW/day and an estimated NOAEL of 14.1 mg/kgBW/day were calculated based on

results of this experiment.

Day-old Canada geese were fed diets supplemented with Pb-contaminated sediment concentrations of 1.9 (control diet), 414, 828 and 1,656 μg/g for six weeks (Hoffman et al. 2000a). Mortality was observed only in the highest exposure group (22 %), but it was not significantly different from the control group. Hematocrit, hemoglobin, and ALAD activity were significant lower and protoporphyrin levels were higher in the two highest exposure groups. Renal tubular degeneration was observed in one gosling from the 1,656 μg/g group, but histopathologic lesions most commonly associated with Pb poisoning in waterfowl were not observed in other geese. Growth was decreased in goslings from the highest exposure group. Based on the reduced growth observed in goslings exposed to lead at a concentration of 1,656 μg/g, this concentration was selected as the LOAEL for this experiment. A food ingestion rate of 0.093 kg/day and body weight of 1.44 kg (cited in National Research Council 1994 for three-week old geese) were used to convert the exposure concentrations to units of mg/kgBW/day. A LOAEL of 107 mg/kgBW/day and an estimated NOAEL of 53.5 mg/kgBW/day were calculated based on results of this experiment.

Heinz et al (1999) studied the bioavailability and toxicity of Pb-contaminated sediment to adult mallards. In the first experiment, ducks were fed a pelleted commercial duck diet containing 0, 3, 6, 12 or 24 % Pb-contaminated sediment (103, 207, 414 and 828 μg/g lead, respectively) for five weeks. Ducks fed the 24 % Pb-contaminated sediment exhibited atrophy of the breast muscles, green staining of the feathers around the vent, viscous bile, green staining of the gizzard lining, and renal tubular intranuclear inclusion bodies; one of 10 birds died. In the second experiment, the dietary concentration of the Pb-contaminated sediment was increased to 48 %, but only about 20 % was actually ingested due to food washing by the birds. Duration of this experiment was also five weeks. Protophyrin levels were elevated, and all of the Pb-exposed birds had renal tubular intranuclear inclusion bodies. A third experiment was conducted to determine if the effects of Pb were greater when birds were fed a nutritionally deficient diet. Ducks were fed a control diet, a commercial duck mash with 24 % Pb-contaminated sediment, or a ground corn diet with 24 % Pb-contaminated sediment for 15 weeks. Food washing was again observed; actual ingestion rates were 17 and 14 % for the Pb-contaminated duck mash and ground corn diets, respectively. Mortality occurred in four of five birds fed the Pb-contaminated ground corn diet. At necropsy, all birds fed the Pb-contaminated ground corn diet were emaciated, had renal tubular intranuclear inclusion bodies, and blackish-green bile. Based on the clinical signs of Pb poisoning observed in the first experiment, an exposure concentration of 828 μg/g Pb was selected as the LOAEL from this experiment. An ingestion rate of 0.139 kg/day and body weight of 1.25 kg (Piccirillo and Quesenberry 1980) were used to convert the exposure concentrations to units of mg/kgBW/day. A LOAEL of 92 mg/kgBW/day and a NOAEL of 46 mg/kgBW/day were calculated based on the results of this experiment.

Day-old Japanese quail were fed diets containing Pb (as lead acetate) at concentrations of 0, 1, 10, 100, 500 or 1,000 mg/kg for five weeks (Morgan et al. 1975). Body weight, packed cell volume, and hemoglobin were significantly reduced in birds that received 1,000 mg/kg lead. At five weeks of age, testes size was also significantly reduced in the highest exposure group; this exposure concentration was identified as the LOAEL. Mean body weights of the 500 and 1,000 mg/kg exposure groups at three weeks were 65 and 55 g. Ingestion rates were calculated as a percent of the adult ingestion rate of 18 g/day (body weight of 0.12 kg; Varghese 2000), resulting in ingestion rates of 9.8 and 8.3 g/day, respectively. A LOAEL of 151 mg/kgBW/day and a NOAEL of 75.4 mg/kgBW/day were calculated based on the results of this experiment.

Nine raptors (five red-tailed hawks, three rough-legged hawks and one golden eagle) were administered 3 mg/kgBW Pb daily in the form of a lead acetate trihydrate solution by mouth for 30 weeks (Reiser and Temple 1980). Control birds (six red-tailed hawks, one Swainsons hawk) were dosed with a sodium acetate solution by mouth. Clinical signs of lead toxicosis (anorexia, green bile-stained feces and anemia) were observed in eight of the nine experimental birds. Three birds died

three to four weeks following the onset of clinical symptoms. This study was not used to derive the TRVs for this risk assessment because dosing was via solution rather than dietary, and because different species were included within the experimental group.

Edens et al. (1976) exposed Japanese quail to four dietary concentrations of lead acetate (1, 10, 100 and 1,000 mg/kg) for a period of 12 weeks. Percent hatch of setable eggs was significantly decreased in hens exposed to 100 mg/kg Pb. Dietary Pb at a concentration of 1,000 mg/kg almost completely suppressed egg production. The results from this experiment will be used to develop the NOAEL and LOAEL values because of the ecological significance of the endpoints and the method and duration of exposure. An ingestion rate of 18 g/day and adult body weight of 0.12 kg (Varghese 2000) were used to convert the exposure concentration to units of mg/kgBW/day. A LOAEL of 15 mg/kg BW/day (100 mg/kg) and a NOAEL of 1.5 mg/kg BW/day were calculated. Based on the ecological significance of the endpoint (reproduction) and because the LOAEL is the lowest cited adverse effect level for birds, the TRV values from this study will be used to evaluate the risk posed by Pb to avian receptors.

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1.1.2 Lead Toxicity to Mammals

1.1.2.1 Acute Toxicity

Schafer and Bowles (1985) conducted acute oral toxicity tests using deer mice to determine the Approximate Lethal Dose (ALD) for numerous chemicals. To determine the ALD, range finding tests were conducted. A single dose of lead (as triphenyl lead chloride) was administered by gavage and animals were observed for 3-days to determine mortality. One mouse was tested per dose concentration; each succeeding treatment was 50% higher than the preceeding level and continued until mortality occurred. An ALD of 320 mg/kg was reported for Pb. Due to the acute nature of this study (short duration and mortality), this concentration was selected to assess the short-term acute effects of Pb to mammals in this risk assessment.

1.1.2.2 Chronic Toxicity

Mason and MacDonald (1986) evaluated the effect of Pb and cadmium (Cd) on otter (*Lutra lutra*).

Daily Pb intake was estimated on the basis of measured fecal Pb levels, the known ingestion rate for otter, and gastrointestinal Pb absorption rates for mammals. Estimated Pb intake correlated well with levels measured in major fish prey species. No apparent impact on population levels was found when the Pb intake was less than 0.15 mg/kg BW/day whereas otter populations were reduced in sites where the estimated Pb intake exceeded 2 mg/kg BW/day. This study was not used to derive a TRV for Pb, as other factors that may have influenced otter population levels were not evaluated.

Adult pregnant mice (C57Bl strain) were fed a diet containing Pb at concentrations of 0, 0.125, 0.25, 0.5, or 1 % for 48 hours following observation of the presence of a vaginal plug (Jacquet et al. 1976). Dietary Pb concentrations of 0.125 %, 0.25 %, and 0.5 % resulted in an increase in the number of embryos in the four-cell stage versus the eight-cell stage. At a dietary exposure level of 1 %, an increase in the number of undivided embryos was observed. In normal mouse embryo development, the embryo is in the eight-cell stage after 48 hours and is placed near the end of the oviduct ready to be discharged to the uterus. Effects of delayed cleavage on embryo loss prior to implantation is not known. An ingestion rate of 0.0058 kg/day and adult body weight of 0.033 kg (U.S. EPA 1988) were used to convert the exposure concentration to units of mg/kgBW/day. A LOAEL of 220 mg/kg BW/day (1,250 mg/kg), and an estimated NOAEL of 22 mg/kg BW/day were calculated based on the results of this experiment.

Pregnant female mice were given lead acetate in their drinking water at concentrations of 0, 500, 750 and 1,000 milligrams per liter (mg/L) starting on gestation day 12 and continuing to four weeks postpartum (Waalkes et al. 1995). Offspring were weaned and received Pb in their drinking water after weaning for 112 weeks. Renal lesions (atypical tubular hyperplasia or tumors) occurred rarely in control male mice (4 %) and increased in dose related fashion for Pb exposed male offspring: 500 ppm, 16 %; 750 ppm, 24 %; and 1,000 ppm, 48 %. The number of lesions in the 1,000 mg/L group was significantly higher than for the control group. Lead-treated females also developed renal lesions, but at much lower rates. An ingestion rate of 0.0058 kg/day and adult body weight of 0.033 kg (U.S. EPA 1988) were used to convert the exposure concentration to units of mg/kgBW/day. A LOAEL of 176 mg/kg BW/day (1000 mg/kg), and a NOAEL of 132 mg/kg BW/day were calculated based on results of this study.

Azar et al. (1973) administered Pb to rats at six dietary levels (1, 10, 50, 100, 1,000 and 2,000) for three generations and measured changes in reproduction and growth. No effects on number of pregnancies, number of pups born alive, fertility index, viability index or lactation index were observed at any exposure levels. An exposure concentration of 1,000 mg/kg resulted in reduced offspring weight and kidney damage in the young. An ingestion rate of 0.027 kg/day and adult body weight of 0.35 kg (U.S. EPA 1988) were used to convert the exposure concentration to units of mg/kgBW/day. A LOAEL of 80 mg/kg BW/day, and a NOAEL of 8 mg/kg BW/day were calculated. Based on the ecological significance of the endpoint (growth) and because the LOAEL is the lowest cited adverse effect level for mammals, the TRV values from this study will be used to evaluate the risk posed by Pb to mammalian receptors.

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1.2 Polychlorinated Biphenyls

1.2.1 Polychlorinated Biphenyl Toxicity to Birds

1.2.1.1 Acute Toxicity

A dietary concentration of 1500 mg/kg (dry weight) was administered to red-winged blackbirids for six days, by which time 50% of the birds had died (Stickel *et al.* 1984). Due to the acute nature of this study (short duration and high mortality), this dietary concentration was selected to assess the short term acute effects of polychlorinated biphenyls (PCBs) to birds in this risk assessment.

A body weight of 0.0415 kg (Dunning 1993) and a food ingestion rate of 0.0109 kg/day (Nagy 1987) were used to convert the exposure concentration to units of mg/kgBW/day, resulting in an acute exposure concentration of 394 mg/kgBW/day.

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1.2.1.2 Chronic Toxicity

A dietary concentration of 1500 mg/kg (dry weight) was administered to red-winged blackbirds for six days, by which time 50% of the birds had died (Stickel et al. 1984). Due to the acute nature of this study (short duration and high mortality), it was not used to assess the chronic effects of PCBs to birds in this risk assessment.

Mallard ducklings over 9 weeks of age, were fed a PCB-treated diet for 5 days, followed by 3 days of an untreated diet. The 8-day lethal concentration to half of the exposed organisms (LC50s) ranged from 1,975 mg/kg for Aroclor 1260 to 3,182 mg/kg for Aroclor 1242 (Heath et al. 1972). The lowest LC50 value was converted to a LOAEL of 197.5 mg/kg using an accepted conversion factor of 10. In order to express this value in units of mg/kg BW/day, a food ingestion rate of 0.0578 kg/day and a body weight of 0.936 kg reported for 8-week old mallard ducks were used (Sugden et al. 1981). This resulted in a LOAEL concentration of 12.2 mg/kg BW/day.

When Aroclor 1254 was fed to 9 month-old mallard hens at a concentration of 25 mg/kg, dry weight, in the diet for at least one month prior to egg laying, no detrimental effects on reproduction or nest attentiveness were observed (Custer and Heinz 1980). Assuming that the diet was one-third solids, this equates to a wet weight concentration of approximately 8.3 mg/kg. To convert this dosage to units of mg/kg BW/day, the dose was first multiplied by the food ingestion rate for the mallard duck of 0.139 kg/day, then divided by an adult body weight of 1.24 kg (Piccirillo and Quesenberry 1980) to yield a NOAEL of 0.92 mg/kg BW/day.

When screech owls were fed Aroclor 1248 in their diet at a concentration of 3 mg/kg for two breeding seasons, the number of eggs per clutch, hatchability, chick malformations, survival, and eggshell thickness were not affected (McLane and Hughes 1980). To convert to units of mg/kg BW/day, this value was divided by the reported mean body weight of 0.185 kg for screech owls (Dunning 1993) and multiplied by a food ingestion rate of 0.025 kg/day (Pattee et al. 1988). This resulted in a dietary exposure concentration (NOAEL) of 0.41 mg/kg BW/day.

Nestling white pelicans captured from the wild received 100 mg of Aroclor 1254 as daily oral doses for 10 weeks in addition to a controlled diet. Following the 10 week exposure period, the birds were stressed for an additional 2 weeks by reducing their food consumption in half. The initial mean body weight of the birds prior to the treatment was 6.2 kg. The mean body weight at the end of the 12 week experimental period was 4.8 kg. Micrograph examination of the livers from the birds in the treatment group indicated a 22% increase in hepatocyte size, a significant 25% increase in the number of mitochondria, a significant 20% fewer cristae per mitochondria, and a 22% increase in the number of lysosomes, microbodies, and other membrane-bounded vacuoles (Stotz and Greichus 1978). To convert to units of mg/kg BW/day, the dose (100 mg/day) was multiplied by the inverse of the lower mean body weight (from the end of the experimental period) to yield an exposure concentration of 20.8 mg/kg BW/day.

When Lillie et al. (1975) exposed chickens to diets containing either Aroclor 1016, 1232, 1242, 1248, or 1254 for 8 weeks, hatching success was significantly reduced at a concentration as low as 10 mg/kg (for Aroclor 1232 and Aroclor 1242), while no effects were noted at a concentration of 5 mg/kg. These values were converted to 0.71 and 0.36 mg/kg BW/day, respectively, using the reported body weight and ingestion rate for chickens indicated above. Similar results were described in Britton and Huston (1973), in which eggs from chickens fed diets containing 10 mg/kg Aroclor 1242 also exhibited reduced hatching success. Again, no effects were observed at a dietary concentration of 5 mg/kg. Similar results were also obtained by Scott (1977), in which hatching success was also decreased in chickens fed a diet containing 10 mg/kg Aroclor 1248. In this study, no effects were observed at 1 mg/kg. The value of 1 mg/kg was converted to a NOAEL of 0.071 mg/kg BW/day using a body weight of 1.45 kg and an ingestion rate of 0.103 kg/day for adult chickens (U.S. EPA 1988).

When Platanow and Reinhart (1973) exposed chickens to Aroclor 1254 in the diet, a concentration of 5 mg/kg resulted in a decrease in both egg production and female fertility. This concentration was converted to a dietary dosage of 0.36 mg/kg BW/day using the reported body weight and ingestion rate indicated above. Finally, when Lillie et al. (1974) exposed chickens to diets containing either Aroclor 1221, 1232, 1242, 1248, 1254, or 1268, chick growth was significantly reduced at a concentration as low as 2 mg/kg (for Aroclors 1248 and 1254). To convert this concentration to units of mg/kg BW/day, the body weight and ingestion rate indicated above were used, yielding a dietary dosage of 0.14 mg/kg BW/day.

Yearling male American kestrels were fed prey items (day-old cockerels) containing approximately 33 mg/kg, wet weight, of Aroclor 1254 for 62 to 69 days. This dose was converted by the investigators to a daily exposure concentration of 9 to 10 mg/kg BW/day. Kestrels receiving the treated diet exhibited a significant 22 to 27% reduction in sperm concentrations. This response was associated with a muscle PCB concentration of 107 mg/kg, lipid normalized, and a testes concentration of 128 mg/kg, lipid normalized (Bird et al. 1983).

Male and female pairs of American kestrels were fed diets containing 3 mg/kg, wet weight, of Aroclor 1248 incorporated into a commercial diet for approximately 20 weeks. Eggs were collected from the pairs 2 to 4 days after egg-laying was complete. The eggs collected from the treated pairs of birds exhibited a 5% reduction in eggshell thickness. This response was associated with a parent muscle tissue PCB concentration of 18.5±5.1 mg/kg, wet weight (Lowe and Stendell 1991). An ingestion rate of 0.0307 kg/day (Barrett and Mackey 1975) and a body weight of 0.111 kg (Dunning 1993) were

used to convert the exposure concentration to units of mg/kgBW/day, resulting in a LOAEL of 0.83 mg/kgBW/day. A recent summary paper by Peakall and Lincer (1996) indicates that PCBs do not cause eggshell thinning except at very high doses that are likely to cause other reproductive toxicological effects as well. Therefore, the LOAEL based on this study was not used to derive a TRV for evaluating the dietary toxicity of PCBs in birds.

Summer et al. (1996a) exposed white Leghorn hens for eight weeks with commercial diets mixed with contaminated carp from Saginaw Bay, Lake Huron. The concentrations of PCBs in the resulting diets, measured as the sum of Aroclors 1242, 1248, 1254, and 1260, were 0.3 mg/kg (control), 0.8 mg/kg, and 6.6 mg/kg, wet weight. Hens were artificially inseminated weekly, and food consumption, body weights, and egg production were monitored daily. Food consumption initially declined in all the treatment groups but was greatest in the high dose group by the end of the study. Body weights were greater in the control and the low dose groups by the end of the study. Finally, egg production initially decreased during the acclimation period prior to the study, but egg production in the high dose group returned to pre-trial levels by the end of the study while egg production in the control and the low dose group remained significantly lower. The decreased egg production, as well as the increased body weights, in the control and the low dose group were explained by the authors as effects of fatty liver hemorrhagic syndrome (FLHS), with which the necropsy results were consistent. It was hypothesized that the PCBs in the high dose group provided a protective mechanism against FLHS, thus resulting in the higher egg production, since this protective mechanism had been observed in other studies. In a second phase of this experiment (Summer et al. 1996b), eggs were allowed to develop through day 25 of incubation, and hatching and deformity rates were observed and noted. Rates of deformities correlated with concentrations of PCBs in food, and both treatments (0.8 and 6.6 mg/kg, wet weight, in the diet) produced significantly higher rates of deformities (24% and 40%, respectively) compared to the control (17%). To convert the lower PCB treatment concentration (0.8 mg/kg, wet weight) to units of mg/kg BW/day, the average daily PCB consumption of hens in this treatment group reported by the authors (Summer et al. 1996a) for the 8-week duration of the study (67.1 ug/day) was divided by the corresponding average body weight (1620 g) to obtain a dietary dosage of 0.0414 mg/kg BW/day. To convert the control PCB concentration (0.3 mg/kg, wet weight) to units of mg/kg BW/day, the average daily PCB consumption of hens in this treatment group reported by the authors (Summer et al. 1996a) for the 8-week duration of the study (26.75 ug/day) was divided by the corresponding average body weight (1690 g) to obtain a dietary dosage of 0.0158 mg/kg BW/day. Although this study provided the lowest LOAEL and NOAEL of the studies presented here, these values were not selected for use in this risk assessment because the food source for the study came from an area that is known to contain a variety of pollutants in addition to PCBs, and the contribution of these other contaminants to the effects observed in this study are unknown.

Another study investigated the behavioral component of reproduction in mourning doves given dietary supplements of 0, 10, or 40 mg/kg Aroclor 1254 (Tori and Peterle 1983). The exposure concentrations were converted to units of mg/kgBW/day using an ingestion rate of 0.0112 kg/day and a body weight of 0.1 kg (Kenaga 1973), resulting in doses of 0, 1.12 mg/kg BW/day, and 4.48 mg/kg BW/day. Control doves displayed normal courtship behaviors and patterns. Doves that were fed at the 10 parts per million (ppm) (1.12 mg/kg BW/day) level spent twice as much time in the courtship phase as the control birds, with only 50% completing courtship and nesting. Of the 50% that did nest and incubate eggs, nest initiation was significantly delayed, resulting in a delay in egg laying as well. None of the doves on the 40 ppm dietary supplement completed the nesting process (Tori and Peterle 1983). The authors hypothesized that the decline of reproductive activity was induced by the degradation of estrogen and androgen in the birds, which is presumably a result of increased hepatic microsomal enzyme activity as a response to the presence of PCBs.

Peakall and Peakall (1973) maintained ring doves on a diet that contained 10 mg/kg Aroclor 1254. They found that reproductive success was dependent on exposure of the female to the PCB compound. Females fed PCB-spiked food were less attentive to their nest and had erratic nesting behaviors which

interfered with egg development. Artificial incubation greatly increased the breeding success for these birds. The food concentration of 10 mg/kg was converted to units of mg/kg BW/day using an ingestion rate of 0.015 kg/day and a body weight of 0.160 kg (Schwarzbach et al 1991), resulting in a LOAEL of 0.94 mg Aroclor 1254 /kgBW/day. Similar values were obtained by Peakall et al. (1972) for the ringed turtle dove, in which a dietary Aroclor 1254 concentration of 10 mg/kg adversely affected hatching success due to heavy embryonic mortality.

The results of the Peakall and Peakall (1973) and Peakall et al. (1972) studies were selected for use in this risk assessment due to the significance of the endpoints (reproductive success and behavior) and the specificity of the test chemical (PCBs only). Therefore, a LOAEL of 0.94 mg/kg BW/day and an estimated NOAEL of 0.094 mg/kg BW/day will be used in this risk assessment to evaluate the risk from PCBs to avian species.

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1.2.2 Polychlorinated Biphenyl Toxicity to Mammals

1.2.2.1 Acute Toxicity

In a preliminary study to determine the cause of reproductive complications in mink fed Great Lakes fish, adult breeder mink were fed a basal diet supplemented with 30 mg/kg of PCB for six months (181 days). All of the mink died, emaciated, by the end of the experimental period (Aulerich and Ringer 1977).

Adult body weights ranging from 0.454 to 2.31 kg have been reported (Mumford and Whitaker 1982, Nowak 1991). Food ingestion rates have been measured in several studies (Bleavins and Aulerich 1981; Aulerich et al. 1986; Heaton et al. 1995). Reported food ingestion rates range from 0.129 to 0.409 kg/day. A body weight of 0.454 kg and food ingestion rate of 0.409 kg were used to convert the exposure concentration to units of mg/kgBW/day. A concentration of 27 mg/kgBW/day was used to evaluate acute exposure of mammals to PCBs.

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1.2.2.2 Chronic Toxicity

Several studies were found pertaining to the dietary toxicity of PCBs to mink, most of which examined effects on reproduction, growth and survival. Since the mink is the most sensitive mammal species tested to date, these studies were the only studies reviewed to derive a TRV for mammals for this risk assessment.

In a preliminary study to determine the cause of reproductive complications in mink fed Great Lakes fish, adult breeder mink were fed a basal diet supplemented with 30 mg/kg of PCBs for six months (181 days). However, all of the mink died, emaciated, by the end of the experimental period (Aulerich

and Ringer 1977). As a result of the preliminary study, a long-term study was conducted to determine the effects of long-term, low-level consumption of PCBs on growth. Mink were fed a basal diet supplemented with 5 and 10 mg/kg of PCBs for a period of approximately 8.5 months. The basal diet plus 10 mg/kg of PCBs resulted in a significant 56% decrease in body weight gain after a period of 4 months. Body weight gain was reduced by 39% in the 5 mg/kg treatment group, but this reduction was not statistically significant. Both the 5 and 10 mg/kg treatment groups failed to produce offspring; the control group produced 17 live and 8 dead kits. Various degrees of embryotoxicity were observed during necropsy of the treated animals (Aulerich and Ringer 1977). The 5 and 10 mg/kg doses were converted to daily exposure concentrations by multiplying them by a food ingestion rate of 0.249 kg/day (U.S. EPA 1993) and dividing by a body weight of 1.13 kg (Merritt 1987). This yielded exposure concentrations of 1.1 and 2.2 mg/kg BW/day for the 5 and 10 mg/kg treatment groups, respectively.

Based on the results of the above experiment, another experiment was conducted to determine the effects of long-term consumption of low-level PCBs on reproduction. Fifteen mg/kg of Aroclor 1254 in the diet resulted in a complete inhibition of reproduction and 31% adult mortality, compared to 6% mortality in the controls. Five mg/kg of Aroclor 1254 resulted in a 95% reduction in the number of kits born live; the ratio of live kits to female adults was reduced by 87%. In an effort to determine the persistence of the impaired reproductive condition, 11 adult females that received 5 mg/kg of Aroclor 1254 for a period of six months were placed on a control diet for one year. The results indicate that the impaired reproductive performance of these females was not a permanent condition (Aulerich and Ringer 1977). The 5 and 15 mg/kg doses were converted to daily exposure concentrations using the conversion factors cited above, resulting in exposure concentrations of 1.1 and 3.3 mg/kg BW/day, respectively.

Eight month old mink fed a basal diet containing 1.0 mg/kg of Aroclor 1254 for a period of approximately six months exhibited no mortality or any significant changes in the thyroid, pituitary, adrenal glands, or serum T3 and T4 levels (Wren et al 1987a). Reproduction and kit development was evaluated under the same test conditions in a separate study (Wren et al. 1987b) by the same investigators. Male fertility and female offspring production were not affected by the 1.0 mg/kg Aroclor 1254 diet. However, growth rate of kits nursed by exposed mothers was significantly reduced. The investigators estimated the daily exposure concentrations to be 0.10 mg/kg BW/day for males and 0.18 mg/kg BW/day for females. Results from this study were not used to derive the TRV for this risk assessment, as growth is not an ecologically significant endpoint.

When Kubiak and Best (1991) fed mink a liver diet contaminated with PCBs , a concentration of 1.0 mg/kg PCBs resulted in reproductive impairment and a concentration of 5 mg/kg resulted in mortality. This dose was converted to a daily exposure concentration by multiplying it by an ingestion rate of 0.249 kg/day (U.S. EPA 1993) and dividing by a body weight of 1.13 kg (Merritt 1987). This resulting in a LOAEL of 0.22 mg/kg BW/day.

In another study, one-year-old mink were fed a diet of beef and cereal prepared from cows which had been given 10 consecutive daily oral doses of 1 and 10 mg/kg of Aroclor 1254 dissolved in an olive oil and dairy concentrate (Platanow and Karstad 1973). The cows did not exhibit any clinical, gross, or histopathological signs of PCB toxicity. The cows were killed 24 hours following the last dose, and the musculature, liver, and kidneys ground and mixed with commercial mink food cereal at a level of 24 % cereal. The resulting rations containing 0.64 and 3.57 mg/kg of total PCB were fed to mink for a period of 160 days. The mink were fed this diet *ad libitum* 2 months prior to the breeding season and continued for 160 days. All 16 mink that were fed 3.57 mg/kg of PCBs died by day 105. Two of the 16 mink that were fed 0.64 mg/kg died by days 122 and 129. The mink exhibited poor appetites, lethargy, and weakness before dying. Some passed tarry feces, indicating gastrointestinal hemorrhaging. At both treatment levels, males survived longer than females. An ingestion rate of 0.249 kg/day (U.S. EPA 1993) and a body weight of 1.13 kg (Merritt 1987) were used to convert the

exposure concentrations to units of mg/kgBW/day. This yielded exposure concentrations of 0.14 and 0.78 mg/kg BW/day for the 0.64 and 3.57 mg/kg doses, respectively.

In another study, male and female ranch-bred mink were acclimated to a diet consisting of ocean fish scraps, commercial mink cereal, and meat by-products. Ocean fish scraps made up 40 % of this diet. Dietary treatment levels were prepared by substituting 10, 20, and 40 % of the ocean fish scraps with PCB-contaminated carp from Saginaw Bay, Lake Huron. The mean dietary PCB concentrations were 0.015 mg/kg (control), 0.72 mg/kg (10 % carp), 1.53 mg/kg (20 % carp), and 2.56 mg/kg (40 % carp). Groups of 15 mink (3 males, 12 females) were assigned to one of the four treatment groups for a period of 12 weeks. Mink receiving the highest PCB-containing diet (40 % carp or 0.32 mg/kg BW/day, as reported by the investigators) exhibited a 42 % reduction in mean litter size, 86 % fewer live kits at birth, and no kits surviving beyond 24-hours post-partum. Even mink receiving the 10 % carp diet (or 0.13 mg/kg BW/day, as reported by the investigators) exhibited a 67 % reduction in kits surviving three to six weeks relative to the control (Heaton et al. 1995). This study cited a LOAEL of 0.13 mg/kgBW/day and a NOAEL of 0.004 mg/kgBW/day for exposure of mink to PCBs.

In a related study on multigenerational effects in mink fed the same Saginaw Bay PCB-contaminated carp, Restum et al.(1998) observed a significant reduction in kit body weights after parental exposure to 0.25 mg/kg, wet weight of PCBs in fish (0.05 mg/kgBW/day as reported by authors). A significant reduction in kit survival was observed at a parental exposure concentration of 0.5 mg/kg (0.1 mg/kgBW/day). The concentration of 0.1 mg/kg was selected as the LOAEL for this risk assessment, as effects on reproduction or survival were targeted as ecologically significant effects. Of note in this study was that adverse effects on kit survival were observed even several months after the parents had been placed on the control diet. The inference was that long-term effects on mink can be observed even after short exposure periods to a PCB-contaminated diet. A LOAEL of 0.1 mg/kgBW/day and a NOAEL of 0.05 mg/kgBW/day will be used to evaluate risk from exposure to PCBs for mammals.

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Appendix B: Receptor Species Life History and Exposure Profiles
Matteo Iron and Metal Site
July 2005

LIFE HISTORIES FOR MATTEO IRON AND METAL SITE

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1.0 AVIAN COMMUNITY

1.1 Great Blue Heron, (*Ardea herodias*): Piscivorous Bird

Life History

The great blue heron is the largest and most widely distributed American heron, inhabiting lakes, ponds, rivers, marshes and occasionally newly-plowed fields and meadows (Bull and Farrand 1977; Eckert 1987). The great blue heron is migratory in the northernmost portion of its range. Lingering birds usually fall prey to severe weather (Bull and Farrand 1977). Southward migration begins in early October; northward migration begins in March or early April (Eckert 1987). The great blue heron has a blue-grey back with blackish sides and a white and grey striped belly. The head has a white crown, cheeks and throat. A black stripe on the side of the crown merges into a long occipital crest. The bill is yellow and legs are a greenish-brown . The sexes have similar plumage, but females are smaller. With the exception of its breeding season, this species is solitary in its habits (Hancock and Kushlan 1984).

Great blue herons are primarily diurnal, but nocturnal foraging is common in tidal habitats (Hancock and Kushlan 1984). They feed anywhere they can locate prey (terrestrial or aquatic), but tbey primarily forage in shallow water less than 50 centimeters (cm) deep (Bent 1926; Bayer 1978). The great blue heron typically feeds either by standing motionless in the water waiting for prey, or by searching stealthily with a slow and careful walk. Their primary food item is fish, although frogs, small turtles, crustaceans, mice, voles, shrews, snakes, and ground-nesting birds are also consumed. Great blue herons generally capture fish ranging from 5 to 40 cm in length, although larger fish are occasionally consumed (Kirkpatrick 1940; Willard 1977). Almost without exception, the great blue heron will shake its bill in the water immediately after swallowing prey, perhaps to wash off debris. Although the digestive fluids of the heron are acidic enough to dissolve bone rapidly, an occasional undigested pellet of feathers and fur is regurgitated (Eckert 1987; Butler 1992).

Courtship occurs soon after the spring migration, with copulation usually occurring on the ground. Great blue herons are mostly monogamous, with new mates selected each year (Butler 1992). Colonial nests are placed on the uppermost branches of trees or shrubs. Occasionally a ground nest will be built if a secluded area is available. Successful nesting areas are usually returned to year after year. Three to seven pale greenish-blue eggs are incubated equally by both sexes for about 28 days (Eckert 1987). The chicks fledge at about 2 months of age. Nesting success depends on food supplies, and most nestling loss is due to starvation (Quinney 1982). Heron chicks weigh approximately 50 grams (g) at hatching, and will attain about 86 percent (%) of their adult weight by 45 days of age (Quinney 1982). Fish fed to chicks range in size from 7.8 cm to 22.8 cm (Hoffman 1978). Great blue herons do not reach sexual maturity until 2 years of age (DeGraaf and Yamasaki 2001).

Very few birds or animals will attack an adult great blue heron. Adult mortality due to attempting to swallow large fish, starvation, or entanglement in utility wires has been reported (Terres 1980). Crows, ravens, owls, eagles, gulls, bears and raccoons prey on the eggs and nestlings (Bent 1926; Hancock and Kushlan 1984). Mortality rates are 69% in the first year, decreasing thereafter (Bayer 1978); the maximum recorded lifespan for a great blue heron is 23 years, 3 months (Clapp et al. 1982).

Exposure Profile

For this risk assessment, conservative exposure parameters are the highest (ingestion rates) or lowest (body weight [BW], home range [HR] size) values located in the literature.

Adult great blue heron BW range from 2.09 to 3.64 kilograms (kg) (Hartman 1961; Palmer 1962; Alexander 1977; Hoffman 1978; Quinney 1982; Eckert 1987; Schramm et al. 1987; Butler 1992;

Environment Canada 1998). Males tend to be slightly larger than females. A conservative BW of 2.09 kg was used in exposure calculations.

Great blue herons are opportunistic predators, and will consume whatever prey are available. Fish are the preferred food item for this species. Based on stomach contents, Palmer 1962 reported a diet comprised of 71.6% fish, 8.2% insects, 8.9% crustaceans, 4.3% herptiles, and 4.7% small mammals. Cottam and Uhler 1945 reported a dietary composition of 43% non-game fish, 25% game or commercial fish, 8% insects, 8% crustaceans, 4% herptiles, and 5% small mammals. Kirkpatrick (1940) reported a dietary composition of 92% fish, 1.7% insects, 2% crustaceans, 4% herptiles and 0.3% small mammals delivered to nestlings by adults. Alexander (1977) reported a dietary composition of 94% fish, 1% crustaceans, 3% amphibians, and 1% bird and mammal, percentage by weight of stomach contents. For this risk assessment, it was assumed that great blue herons consume 100% fish.

Food ingestion rates ranging from 0.202 kilograms per day (kg/d) to 0.343 kg/d have been reported for this species (Powell 1983; Schramm et al. 1987; Hoy et al. 1989; Littauer 1990; Stickley et al. 1995; U.S. Department of Agriculture 1997). A conservative food ingestion rate of 0.343 kg/d will be used in this risk assessment.

A species-specific water ingestion rate could not be located for the great blue heron. Water ingestion rates were calculated using the allometric equation developed by Calder and Braun (1983): WI (liters per day [L/d]) = 0.059 $Wt^{0.67}$, where WI is the daily water ingestion rate and Wt is the BW in kg. Using the above BW, a conservative water ingestion rate of 0.097 L/d was calculated.

An incidental sediment ingestion rate for the great blue heron was not located in the literature; therefore, a predicted incidental ingestion rate for sediment that may be entrained in the digestive system of prey items was used for this risk assessment. Fish are the primary food source for the great blue heron; consumption of prey items containing sediment is assumed to be the primary mechanism by which a piscivorous bird such as the great blue heron would ingest sediment. In this model, the bluegill *(Lepomis machrochirus)* was used to represent fish eaten by the great blue heron.

Bluegills commonly reach a size of 12 ounces (oz) (Pflieger 1975). From this, the amount of sediment entrained in fish 12 oz (0.340 kg) in weight was predicted. A study evaluating the stomach contents of 153 bluegills reported the diet to contain an average of 9.6% detritus (Kolehmainen 1974). A daily food ingestion rate of 1.75% of the BW per day has been reported for the bluegill (Kolehmainen 1974). From this, the amount of food consumed by a 0.340 kg bluegill is calculated to be 0.00595 kg/d. If the assumptions are made that 9.6% of the material ingested is sediment, and that the amount of sediment contained in the digestive system of a fish remains constant over time, it can be predicted that a fish of this size may contain 0.0005712 kg of sediment in its digestive system. This value (0.0005712 kg) was divided by the predicted fish BW (0.340 kg) to express the sediment entrained in the fish digestive systems as 0.00168 kg sediment per kg fish BW. When this value is multiplied by the conservative food ingestion rate of the great blue heron (0.343 kg/d), the predicted sediment ingestion rate for a heron consuming 100% fish is approximately 0.00058 kg/d.

Feeding territory sizes have been reported for this species in terms of kilometers (km) shoreline length and area (in hectares [ha]). In addition, foraging distances from nesting colonies have been measured. Foraging distances ranging between 1.8 to 34.1 km from nesting colonies have been reported (Mathisen and Richards 1978; Thompson 1978; Peifer 1979; Dowd and Flake 1985). Dietary exposure to contaminants will occur within a feeding territory; the distance traveled to a feeding territory is not a factor. Therefore, feeding territory sizes as km shoreline length and measured feeding territory areas will be considered in this risk assessment. Actively defended foraging areas ranging from 0.129 to 4.1 km of shoreline length have been reported for this species (Bayer 1978; Peifer 1979; Dowd and Flake 1985). Measured mean feeding territory sizes of 0.6 and 8.4 ha were reported by Bayer 1978. For this risk assessment, it was assumed that a great blue heron would obtain 100% of its food from the Matteo Iron and Metals Site.

In summary, the food chain model parameters for the great blue heron are as follows:

Conservative Scenario:

BW:	2.09 kg
[1]Total ingestion:	0.343 kg/d
[1]Food ingestion:	0.34242 kg/d
Water ingestion:	0.097 L/d
Sediment ingestion, fish diet:	0.00058 kg/d

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1.2 Bald Eagle, (*Haliaeetus leucocephalus*): Piscivorous Bird

Life History

The bald eagle is one of the largest birds in the raptor family. It is generally a dark brown color with yellow eyes, bill and talons. The adult bald eagle is easily distinguished from other eagles by the white coloration of head, neck and tail feathers, usually acquired around their fifth year (Brown and Amadon 1968; Burton 1989). The bald eagle ranges from throughout North America south to southern Florida and the coast of Baja California (Johnsgard 1990). It tends to be restricted to coastal areas, or to areas near lakes and rivers. There is a size difference between the sexes, with females being larger than males. Sizes also vary geographically, with northern bald eagles being larger than those from southern regions (Green 1985).

In most locations, bald eagles do not migrate, but birds found in northern areas will migrate away from areas that become completely frozen over in winter, while birds from Florida often show a reverse migration, going north in the midsummer and returning to the south in the autumn or winter (Brown and Amadon 1968; Burton 1989). The typical home range (HR) area for nesting bald eagles is 660 ha per nesting pair (Johnsgard 1990).

Bald eagles locate food primarily by sight by observing the area beneath them either when perching or during flight. They are primarily carrion feeders but are known to be opportunistic, taking advantage of any available food source. The staple diet of the eagle is dead or dying fish (Palmer 1988). However, the eagles may catch large numbers of waterfowl, especially when the prey are in restricted areas, such as a small patch of open water surrounded by ice (Brown and Amadon 1968). Bald eagles have also been known to prey on small mammals in times of food shortage.

Bald eagle breeding pairs remain together as long as they live (Palmer 1988; Johnsgard 1990). The distance from human disturbance is important for nest selection. Nests are usually built in trees in old growth strands or on rocks where there are no trees. The nests are very large and made of sticks lined with a softer material such as pine needles. Nests are used over many years with new layers of materials added during each breeding season (Green 1985; Johnsgard 1990). The typical bald eagle nest can measure up to 2.4 meters wide and nearly the same depth (O'Gara 1994). They are often located in areas where the eagle has a commanding view, such as old growth strands of timber, typically taller than their surroundings (Palmer 1988). The nests are usually built near water; during the breeding season, eagles require a large foraging area near water. The breeding season varies with location. One to three eggs (usually 2) are laid; incubation lasts 5 weeks (Palmer 1988; Johnsgard 1990). Eagles lay one clutch per year, although they may lay a replacement clutch if the initial clutch is lost (Green 1985; Palmer 1988). Eggs are usually colored white, but sometimes have a slight blue coloration. The young are able to fly at just over 10 weeks old, but do not achieve the white head and tail feathers until 4 to 5 years of age (Palmer 1988; Johnsgard 1990).

The bald eagle is a federally designated endangered species. High mortality occurred prior to the 1970s due to hunting and from egg breakage from organochlorine pesticide exposure. Bald eagle numbers have rebounded significantly since 1970 and the species is currently under consideration for being delisted under the Endangered Species Act.

Eagle mortality is caused by a variety of factors, including widespread acid deposition, which affects the food supply, and the ingestion of lead shot in waterfowl carcasses that the eagles feed on as carrion (Green 1985; Palmer 1988). The average life span of a bald eagle is around 15-20 years in the wild (Green 1985).

Exposure Profile

For this risk assessment, conservative exposure parameters are the highest (ingestion rates) or lowest (body weight [BW], HR size) values located in the literature.

Adult eagles may weigh anywhere from 3.63 to 6.4 kg (Chura and Stewart 1967; Brown and Amadon 1968; Snyder and Wiley 1976; Palmer 1988; Gerrard 1992). Females are significantly larger than males, and body size increases with latitude. This weight difference is the basis for the distinction between the northern and southern subspecies. The lowest reported BW of 3.63 kg was used in this risk assessment.

Bald eagles are piscivorous, feeding primarily on birds and fish, though they will eat other animal matter (including carrion). The bald eagle often shows preference towards food sources that are readily or most easily attained. The bald eagle generally prefers eating dead or dying prey as opposed to hunting, and also tries to steal food, especially from other eagles, when given the opportunity. The bald eagle diet may vary greatly depending on the availability of prey at each location. In Texas, the bald eagle diet consisted of 30.1% fish, 5.5% mammals, 33.7% birds and 30.7% reptiles (Mabie 1995). In Arizona, however, the bald eagle diet was comprised of 75.5% fish, 14.3% mammals and 10.2% birds (Hunt 2002). Combining data from different regions, the bald eagle diet is comprised of approximately 51% birds, 39% fish, 7% mammals, and 3% reptiles (Dunstan and Harper 1975; McEwan and Hirth 1980; Fielder 1982; Todd 1982; Dugnoni 1986; Mabie 1995; Hunt 2002; Watson 2002). It should be noted, however, that the overall percentage of fish in the diet may be underestimated, since most of the above studies used the remains of prey in the nest as a basis for determining dietary composition. Such analyses may be biased because fish remains are less likely to be found than are remains of birds and mammals (Hunt 2002; Watson 2002). For the purposes of this risk assessment, the bald eagle was assumed to eat a 100% piscivorous diet.

Estimated fresh food ingestion rates for bald eagles range from 0.248 to 0.700 kg/d (Chura and Stewart 1967; Stewart 1970; Duke 1976; Stalmaster 1981; Stalmaster 1982; Stalmaster and Gessaman 1984; Craig et al. 1988; O'Gara 1994). The highest value (0.700 kg/day) was used as a conservative estimate of food ingestion.

A water ingestion rate for bald eagle was not located in the literature. Therefore, the allometric equation developed by Calder and Braun (1983) was used to estimate the water ingestion rate, as follows: Water Ingestion (L/d) = $0.059\ Wt^{0.67}$, where Wt is the weight in kg. Using the conservative BW of 3.63 kg, a water ingestion rate of 0.14 L/d was calculated.

An incidental sediment ingestion rate for the bald eagle was not located in the literature; therefore, a predicted incidental ingestion rate for sediment that may be entrained in the digestive system of prey items was used for this risk assessment. Consumption of prey items was assumed to be the primary mechanism by which a piscivorous bird such as the bald eagle may incidentally ingest sediment. In this model, the bluegill was used to represent fish eaten by the bald eagle.

Bluegills commonly reach a size of 12 oz (Pflieger 1975). From this, the amount of sediment entrained in fish 12 oz (0.340 kg) in weight was predicted. A study evaluating the stomach contents of 153 bluegills reported the diet to contain an average of 9.6% detritus (Kolehmainen 1974). A daily food ingestion rate of 1.75% of the BW per day has been reported for the bluegill (Kolehmainen 1974). From this, the amount of food consumed by a 0.340 kg bluegill is calculated to be 0.00595 kg/d. If the assumptions are made that 9.6% of the material ingested is sediment, and that the amount of sediment contained in the digestive system of a fish remains constant over time, it can be predicted that a fish of this size may contain 0.0005712 kg of sediment in its digestive system. This value (0.0005712 kg) was divided by the predicted fish BW (0.340 kg) to express the sediment entrained in the fish digestive systems as 0.00168 kg sediment per kg fish BW. When this value is multiplied by the conservative food ingestion rate of the bald eagle (0.700 kg/d), the predicted conservative sediment ingestion rate for a bald eagle consuming 100% fish is 0.00118 kg/d.

Home ranges values for the bald eagle vary from 400 to 6,392 ha (Haywood and Ohmhart 1983; Griffin and Baskett 1985; Gerrard 1992). The lowest value (400 ha) was used as a conservative estimate of HR size.

The average (1665 ha) was used as the representative estimate of HR size.

In summary, the food chain model parameters for the bald eagle are as follows:

Conservative estimates:

BW:	3.63 kg
[2]Total ingestion:	0.7 kg/d
[1]Food ingestion:	0.69882 kg/d
Water ingestion:	0.14 L/d
Soil ingestion:	0.00118 kg/d
HR size:	210 ha

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[2]The total ingestion rate is the measured (laboratory or field) food ingestion rate cited in the paragraph in the exposure profile. Soil ingestion is generally measured as a percent of food ingestion. Therefore, the food ingestion rate used in the food chain models is considered to be equal to the total ingestion rate (listed above) minus the soil ingestion rate.

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1.3 Wood Duck, (*Aix sponsa*): Omnivorous Bird

Life History

Wood ducks (*Aix sponsa*) are small in size, measuring 43 to 51cm. Male wood ducks exhibit greens, purples and blues with a white chin patch. They have red, long bills and long tails. Female wood ducks are grayish in color with a broad white eye-ring (Bull and Farrand 1977). The wood duck is a strictly North American species with two distinct populations; one on the east coast and a smaller population on the west coast. The wood duck winters as far north as Washington in the west and New Jersey in the east, but the winter range is primarily in the southern parts of its breeding range (Bent 1923).

Wood ducks require forested wetlands for both food and cover, although marshes are also used. Nesting and brooding habitat requires areas of flooded shrubs, trees, or both, or shrubs overhanging water will suffice. For example, border areas of brush are sufficient as are swampy areas with cypress and gum. The best habitat contains mast-producing hardwoods that border streams and permanent fresh-water lakes. Trees with nesting cavities and food near streams and fresh-water lakes are necessary for successful breeding (Jones *et al.* 1995). Wood ducks prefer sites with nest cavities within 0.5 km of water (Dugger and Fredrickson 1992)

Wood ducks are seasonally monogamous with courtship and pair formation beginning in the fall and continuing through winter. Both sexes can first breed as yearlings. After arrival on the breeding ground, females search for a suitable nest cavity. Wood duck females show exceptionally high fidelity to nesting areas and specific nest sites; they are likely to return to previous sites of successful nests (Hepp *et al.* 1987). Egg laying begins as early as January in the South, but may not begin until April in the northern part of the breeding range. The average clutch size is 12 eggs, ranging from 9 to 14 (Bellrose 1976). Larger clutches, sometimes with more than 30 eggs, are not uncommon in nest boxes. These clutches result from more than one female laying in the same nest, a behavior called "dump nesting". This behavior may be a response to competition for limited nest sites, or because wood ducks do not defend a territory during breeding. Incubation lasts 27 to 33 days. The young leave the nest the morning after hatching by jumping from the cavity to the ground; they do not return to the nest cavity (Terres 1980). Females tend their brood until the ducklings are three to five weeks old. Ducklings are able to fly by the age of eight or nine weeks. Wood ducks may renest after an early and successful nest, or if the first nest is disturbed (Palmer 1976).

The diet of a wood duck consists of mast (the fruit of trees and shrubs such as acorns, nuts, and berries), insects, aquatic invertebrates (molluscs and snails), aquatic plants, and seeds. Wood ducks feed primarily on plants during non-breeding season. Female wood ducks shift their diets to a high percentage of animal foods while breeding. Ducklings also consume a high percentage of animal foods, particularly during the first two weeks of life (Johnson 1971). Wood ducks are shallow water feeders; they obtain food primarily on or near the water surface. The optimum foraging depth is 8 to 45 cm (McGilvrey 1968). They also feed on land considerable distances from open water. Acorns are an important food item in the fall for wood ducks throughout their range (Delnicki and Reinecke 1986).

Because wood ducks are very mobile and migratory, it is difficult to define a home range. The average feeding radius is 25 - 30 miles every day. Annual migrations reach hundreds of miles (Jones et al. 1995).

Important predators of wood duck adults and ducklings include the great horned owl, mink, raccoon, fox, snapping turtle, and predacious fish such as northern pike and largemouth bass. Raccoons are important nest predators (McGilvrey 1968; Bull and Farrand 1977). Other factors that affect wood duck survival include development of forested wetland areas, cutting down nest trees, water level manipulations, and stream channelization that destroys overhanging cover (Funderburk *et al.* 1991). Average life expectancy after banding was 1.4 years for adult and 1.2 year for juveniles (McGilvrey 1969). Wood ducks have been documented to live as long as 16 years in the wild (Clapp *et al.* 1982).

Exposure Profile

Conservative exposure parameters reported here are the highest (ingestion rates) or lowest (BW, HR size) values located in the literature.

Adult wood ducks weigh 0.5 to 0.909 kg (Bellrose and Hawkins 1947; Nelson and Martin 1953; Drobney 1982; Delnicki and Reinecke 1986; Hepp *et al.* 1990; Blus *et al.* 1993; Hipes and Hepp 1995). Males tend to be heavier than females (Bellrose 1976). The lowest reported value (0.500 kg) will be used as a conservative measure of BW.

A food ingestion rate for this species could not be located in the literature. Using an allometric equation for omnivorous birds from Nagy (2001), a conservative food ingestion rate of 103 g/day (wet weight) was calculated for a 0.5 kg wood duck.

Although wood ducks feed primarily on plants during non-breeding season, animal foods are seasonally important, particularly for breeding females and ducklings. For this risk assessment, it was assumed that plants and invertebrates each comprised 50% of the wood ducks diet.

A water ingestion rate for the wood duck also could not be located in the literature. Using an allometric equation developed by Calder and Braun (1983), a water ingestion rate of 0.037 L/day was calculated for a 0.5 kg wood duck.

Mean and maximum sediment ingestion rates for wood ducks were reported by Beyer *et al.* (1997); these rates were less 2% and 6.3% of the dry diet, respectively. Using the food ingestion rate of 103 g/day calculated above, and the maximum sediment ingestion rate reported by Beyer *et al.* (1997), a sediment ingestion rate of 6.5 g/day was calculated.

No home range values were located for this species. For this risk assessment, an area use factor of one will be assumed.

In summary, the food chain model parameters for the wood duck are as follows:

Conservative Scenario:	
BW:	0.500 kg
Food ingestion:	0.103 kg wet weight
Water ingestion:	0.037 L/day
Soil ingestion:	0.0065 kg/day

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1.4 American Robin, (*Turdus migratorius*): Insectivorous Bird

Life History

The American robin (*Turdus migratorius*) occurs throughout most of the continental United States and Canada, wintering in the southern half of North America and into Central America (Bull and Farrand 1977; Peterson 1990). Given the increase in open habitat and lawns, the robin's breeding range has expanded in recent times (Collins and Boyaijan 1965; Ehrlich *et al.* 1988). Habitat requirements for breeding robins include access to fresh water, protected nesting sites, and productive foraging areas (Howell 1942; Ehrlich *et al.* 1988). These requirements are commonly met in moist forests, swamps, open woodlands, and other open areas (Bull and Farrand 1977). Non-breeding robins occupy similar habitats, although proximity to fruit bearing trees is of more importance.

Male robins are characterized by a dark grey to black head and back with a bright red to orange breast. Females and juveniles are similar to males in appearance but much duller in coloring, and juveniles have black spots on their breasts. The largest of the North American thrushes, both males and female robins grow to 9 to 11 inches long. Robin legs are classified as booted tarsi, a long leg with few scales (Collins and Boyaijan 1965).

The primary foraging technique for robins is to hop along the ground in search of ground-dwelling invertebrates, although they commonly search for insects and fruit in tree branches as well. The robin's diet during the breeding season consists mainly of invertebrates and some fruit, but fruit is the primary food consumed outside of the breeding season. Robins exhibit a low digestive efficiency for fruit, and they often consume more than their own BW in fruit to meet their metabolic needs (Hazelton *et al.* 1984).

The diet of the American robin consists of seasonally variable proportions of invertebrates (e.g., earthworms, snails, beetles, caterpillars, spiders) and fruit (e.g., dogwood, cherry, sumac, holly, hackberries, and juneberries) (Martin *et al.* 1951; Paszkowski 1982; Wheelwright 1986; Ehrlich *et al.* 1988). The ratio of % invertebrates to % fruit in the diet is reported to cbange from 94:6 in spring (nesting season) to 34:66 in summer to 4:96 in fall (migratory season) to 7:93 in winter (Wheelwright 1986). Year round, the diet of the robin averages 63% fruits and 37% invertebrates (Martin *et al.* 1951; Eiserer 1976; Wheelwright 1988). Robin diets are diverse; analysis of the stomach contents of 1900 robins showed that the birds consumed fruit from more than 50 plant genera and invertebrates from over 100 families (Wheelwright 1986).

Robins typically use the same foraging site for many weeks at a time but join a variety of roosts, usually within 2 km of the foraging area (Morrison and Caccamise 1990). During the breeding periods, male robins establish territories, the size of whicb is determined by population density: smaller territories are found where robin densities are high. Most foraging occurs within these territories; however, if food resources are limited, adult robins will leave temporarily to forage elsewhere. Breeding territories are vigorously defended; robins will attack man, snake or other enemies to defend its territory or nest, except in more remote locations (Howell 1942; Collins and Boyaijan 1965). Females lay eggs in nests made of mud, grass, and twigs, built 0.9 to 7.5 meters above the ground in trees, buildings, or shrubs. Eggs are characteristically bright blue, number from 3 to 6, and hatch in 12 to 14 days. Young juveniles leave two weeks after hatching and can live up to ten years in the wild, though most rarely survive past 14 months (Collins and Boyaijan 1965; Cassidy 1990).

Predators that feed on adult robins include cats, dogs, owls, and hawks. Crows, jays, grackles, snakes and squirrels are nest predators, attacking both eggs and nestlings. A robin that survives to adulthood has a life expectancy of 10 years (Eiserer 1976; Wauer 1999).

Exposure Profile

Conservative exposure parameters reported here are the highest (ingestion rates) or lowest (BW, HR size) values located in the literature.

Adult American robins weigh from 0.055 to 0.103 kg (Eiserer 1976; Clench and Leberman 1978; Hazelton *et al.* 1984; Skorupa and Hothem 1985; Wheelwright 1986; Wheelwright 1988; Wauer 1999). The lowest value (0.055 kg) was used as a conservative measure of BW; the average value (0.0771 kg) was used as a representative measure of BW.

The diet of the American robin primarily consists of fruit and invertebrates. Diet varies seasonally, and depends on habitat and time of day (Wheelwright 1988). The year-round diet is comprised of 37% invertebrates and 63% fruits (Martin *et al.* 1951; Eiserer 1976; Wheelwright 1988). For this risk assessment, however, the diet of the American robin was assumed to consist solely of invertebrates.

Food ingestion rates (FIR) for adult robins are highly dependant on whether fruits or invertebrate prey are consumed. Several studies were located that reported daily fresh fruit ingestion rates ranging from 0.0571kilograms per day (kg/d) to 0.1078 kg/d (Hazelton *et al.* 1984; Tobin 1984; Skorupa and Hothem 1985; Levey and Karasov 1989), with the average being 0.0753 kg/d. Only one study was located that reported a food ingestion rate for robins feeding on invertebrates; Levey and Karasov (1989) reported an ingestion rate of 0.024 kg/d for robins consuming crickets. In this risk assessment, assuming a diet consisting solely of invertebrates, robins consume 0.024 kg/d under both a conservative and representative scenario.

A species-specific water ingestion rate could not be located for the robin. Water ingestion rates were calculated using the allometric equation developed by Calder and Braun (1983): $WI\ (L/d) = 0.059\ Wt^{0.67}$, where WI is the daily water ingestion rate and Wt is the BW in kg. Using the above BW, a conservative water ingestion rate of 0.0085 L/d was calculated.

Soil ingestion for the American robin was derived from calculated values determined by (Beyer *et al.* 1994) for the American woodcock. Given that the diets of the woodcock and robin are similar, soil ingestion by the robin can be expected to be 10.4% of the diet. For robins eating only invertebrates, the soil ingestion rate of 10.4% was multiplied by the food ingestion rate of 0.024 kg/d to yield soil ingestion estimates of 0.0025 kg/d.

The reported HR size of the American robin ranges from 0.11 hectares (ha) to 0.42 ha (Howell 1942; Eiserer 1976; Stokes 1979; Pitts 1984; Wauer 1999). The smallest value (0.11 ha) was used as a conservative estimate of HR size; the average value (0.214 ha) was used as a representative estimate of HR size.

In summary, the food chain model parameters for the American robin are:

Conservative Scenario:	
BW:	0.055 kg
[3]Total ingestion:	
100% invert	0.024 kg/d

[3]The total ingestion rate is the measured (laboratory or field) food ingestion rate cited in the paragraph in the exposure profile. Soil ingestion is generally measured as a percent of food ingestion. Therefore, the food ingestion rate used in the food chain models is considered to be equal to the total ingestion rate (listed above) minus the soil ingestion rate.

[1]Food ingestion:	
100% invert	0.0215 kg/d
Water ingestion:	0.0085 L/d
Soil ingestion:	10.4%
100% invert	0.0025 kg/d
HR:	0.11 ha

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2.0 MAMMALIAN COMMUNITY

2.1 Mink, (*Mustela vison*): Piscivorous Mammal

Life History

Mink are distributed over much of boreal North America, southward throughout the eastern United States and in the west to California, New Mexico, and Texas (Jones and Birney 1988). They can be found in virtually any habitat containing permanent water; they are not commonly found in upland areas (Jones and Birney 1988). Although primarily nocturnal, their activity often extends into midday (Hoffmeister 1989).

Mink are characterized by dark chestnut brown fur with tails comprising one-third to one-half of their 46 to 70 cm length. The coat is thick and dense, with an oily underfur overlaid by long and coarse guard hairs. Males of the species are up to twice the weight of females. A long neck and thin body are supported by short sturdy legs. An occasional white spot appears on the undersides of the animals, and the ears are short and rounded, lying close to the head. The feet have five webbed toes used for swimming and capturing fish, and anal scent glands are well-developed (Godin 1977; Linscombe *et al.* 1982).

Dens are always near water, usually either in an old muskrat burrow or constructed by the mink itself (Jones and Birney 1988). Males tend to live in their own burrows that are less elaborate than ones occupied by females (Barbour and Davis 1974). The mink is a constant wanderer, and home ranges tend to be linear since mink often follow a shoreline (Jones and Birney 1988). Mink are solitary and mark their territories by spraying (Merritt 1987).

Seasonal food availability governs the mink dietary composition (Barbour and Davis 1974). Their diets may consist of crayfish, muskrats, frogs, fish, snakes, rodents, rabbits, and plants, among other items (Schwartz and Schwartz 1981; Jones and Birney 1988). Crayfish and muskrats are a major portion of the summer diet in many regions of North America (Barbour and Davis 1974; Merritt 1987; Jones and Birney 1988). Larger prey are killed by being bitten on the neck. Females have a difficult time handling larger prey such as muskrats, and their diet is usually more limited.

Breeding occurs from January to early April with gestation periods ranging from 40 to 75 days (Schwartz and Schwartz 1981; Merritt 1987). A single litter highly variable in size (consisting of from 1 to 17 young) may be produced (Schwartz and Schwartz 1981). Average litter sizes vary among regions (Barbour and Davis 1974; Schwartz and Schwartz 1981; Merritt 1987; Jones and Birney 1988; Hoffmeister 1989). Young are weaned at about five to six weeks of age, leave the nest at six to eight weeks, and are sexually mature by ten months (Schwartz and Schwartz 1981; Merritt 1987).

The mink has several predators. Great horned owls, foxes, coyotes, bobcats, and dogs are known to prey on mink (Schwartz and Schwartz 1981; Merritt 1987). There have been records of some mink individuals living up to six years, but mink seldom exceed two years of age in the wild (Schwartz and Schwartz 1981).

Exposure Profile

For the purpose of this risk assessment, conservative exposure parameters are the highest (ingestion rates) or lowest (BW, HR size) values located in the literature.

Adult mink weigh from 0.454 to 2.31 kg (Jackson 1961; Mitchell 1961; Soper 1973; Barbour and Davis 1974; Alexander 1977; Godin 1977; Sealander 1979; Bleavins and Aulerich 1981; Rue 1981; Schwartz and Schwartz 1981; Linscombe *et al.* 1982; Mumford and Whitaker 1982; Askins and Chapman 1983; Baker 1983; Hornshaw *et al.* 1983; Merritt 1987; Jones and Birney 1988; Nowak 1991). The lowest body weight of 0.454 kg was used for the conservative exposure profile.

Mink are opportunistic predators that hunt principally along shorelines and emergent vegetation (U.S. EPA 1993). Seasonal availability and regional preferences govern the primary constituents of the mink's diet. Mammals and crayfish are usually the most abundant prey items, but fish, amphibians, and young birds are also taken (Linscombe *et al.* 1982; Merritt 1987). Overall, the dietary composition of the mink consists of 52 percent (%) fish, 38% small mammals and birds, 5% crustaceans, 2% amphibians, 0.5% insects, 0.5% vegetation, and 3% other or unidentified matter (Korschgen 1952; Alexander 1977; Rue 1981). For this risk assessment, mink are assumed to be 100% piscivorous.

Food ingestion rates have been measured in several studies (Bleavins and Aulerich 1981; Aulerich *et al.* 1986; Heaton *et al.* 1995). Reported food ingestion rates range from 0.129 to 0.409 kg/day. A conservative food ingestion rate of 0.409 g/day was used for this risk assessment.

A water ingestion rate of 0.133 milliliters per gram BW per day (ml/g BW/day) was reported for adult female farm-raised mink (Farrel and Wood 1968). This value was converted to water ingestion rates in units of liters per day (L/d) by multiplying by the BWs above, yielding conservative and representative water ingestion rates of 0.0604 L/d.

An incidental sediment ingestion rate for the mink was not located in the literature; therefore, a predicted incidental ingestion rate for sediment that may be entrained in the digestive system of prey items was used for this risk assessment. Fish are one of the primary food sources for the mink; consumption of prey items containing sediment is assumed to be the primary mechanism by which a piscivorous mammal such as the mink would ingest sediment. In this model, the bluegill (*Lepomis machrochirus*) was used to represent fish eaten by the mink.

Bluegills commonly reach a size of 12 ounces (oz) (Pflieger 1975). From this, the amount of sediment entrained in fish 12 oz (0.340 kg) in weight was predicted. A study evaluating the stomach contents of 153 bluegills reported the diet to contain an average of 9.6% detritus (Kolehmainen 1974). A daily food ingestion rate of 1.75% of the BW per day has been reported for the bluegill (Kolehmainen 1974). From this, the amount of food consumed by a 0.340 kg bluegill is calculated to be 0.00595 kg/d. If the assumptions are made that 9.6% of the material ingested is sediment, and that the amount of sediment contained in the digestive system of a fish remains constant over time, it can be predicted that a fish of this size may contain 0.0005712 kg of sediment in its digestive system. This value (0.0005712 kg) was divided by the predicted fish BW (0.340 kg) to express the sediment entrained in the fish digestive systems as 0.00168 kg sediment per kg fish BW. When this value is multiplied by the conservative food ingestion rate of the mink (0.409 kg/d), the predicted sediment ingestion rate for mink consuming 100% fish approximately 0.000687 kg/d.

Reported HR sizes vary from 7.8 to 770 hectares (ha) (Mitchell 1961; Arnold and Fritzell 1987; Merritt

1987; Nowak 1991). A value of 7.8 ha was used as the conservative estimate for HR size, and an average value of 137 ha was used as the representative estimate of HR size (Merritt 1987).

In summary, the food chain model parameters for the mink are as follows:

Conservative estimates:

Body weight:	0.454 kg
[4]Total ingestion:	0.409 kg/d
[1]Food ingestion:	0.408313 kg/d
Water ingestion:	0.0604 L/d
Sediment ingestion:	0.000687 kg/d
Home range size:	7.8 ha

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[4]The total ingestion rate is the measured (laboratory or field) food ingestion rate cited in the paragraph in the exposure profile. Soil ingestion is generally measured as a percent of food ingestion. Therefore, the food ingestion rate used in the food chain models is considered to be equal to the total ingestion rate (listed above) minus the soil ingestion rate.

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2.2 Raccoon, (*Procyon lotor*): Omnivorous Mammal

Life History

The raccoon is the most abundant and widespread omnivore in North America. Measuring in total length from 60 to 105centimeters (cm) including a 20 to 40 cm tail, raccoons are characterized by a stout body and a black mask across the eyes and cheeks. The body fur is long, fine, thick, and grizzled in appearance. Fur ranges from a dull gray to a medium brown, and the tail is ringed with black and white stripes. The face is

whitish, and is framed by a grayish head and white-edged ears. Their long, flexible fingers are opposable to some degree and capable of delicate manipulations (Kaufmann 1982).

Raccoons are mostly nocturnal mammals inhabiting wooded areas near water, marshes, suburban areas, or virtually any place that can provide food, a den, and permanent water (Jones and Birney 1988; Hoffmeister 1989). Their dens are usually within 1,200 feet from a water supply but are situated in an area where the den can remain dry (Hoffmeister 1989). Dens may be in hollow trees, burrows, caves, crevices in rock, haystacks, chimneys, or under logs (Schwartz and Schwartz 1981; Hoffmeister 1989). During periods of heavy snow or ice, raccoons will den together for several days (Schwartz and Schwartz 1981); otherwise, they are normally solitary and remain active throughout the year (Jones and Birney 1988).

Raccoons are opportunistic omnivores, consuming various food items such as berries, fruit, nuts, corn, seeds, aquatic and terrestrial invertebrates, eggs, frogs, snakes, fish, muskrats, and young waterfowl (Schwartz and Schwartz 1981; Jones and Birney 1988). Seasonal and local food availability appears to dictate dietary composition, although as a general rule, plant matter comprises a greater portion of the diet than does animal matter (Barbour and Davis 1974). Animal matter consumption is greatest during spring, with crayfish being the most important food item (Kaufmann 1982).

Males may mate with several females during the breeding season. Breeding may occur from December through July, although most breeding occurs from January to March (Schwartz and Schwartz 1981; Jones and Birney 1988). About 40 percent (%) of females breed the spring following their birth; the remainder do not breed until their second year. Males are capable of breeding the spring following their birth, but probably have little opportunity (Schwartz and Schwartz 1981). Gestation lasts for approximately 63 days with litter sizes ranging from two to seven young, the usual number being four (Jackson 1961; Barbour and Davis 1974). The young are weaned at 10 to 12 weeks and forage with the mother well into the autumn.

Raccoons maintain fairly well-defined areas of activity (home ranges [HR]), but they do not actively defend territories (Stuewer 1943). Although they are solitary animals, raccoons will utilize areas that are also used at other times by other raccoons (their activity ranges may overlap; Stuewer 1943). Because they are omnivorous, raccoons are not as mobile as similar-sized carnivores. When food supplies and other habitat requirements are optimum, raccoons tend to have smaller HR sizes than when such environmental factors are limited (Baker 1983). Males generally have larger HR sizes than females.

Natural predators of the raccoon include owls, hawks, bobcats, coyotes (Schwartz and Schwartz 1981; Merritt 1987). Hunting and trapping by humans is a major source of mortality (Jackson 1961). Starvation and malnutrition can be a factor in late winter and early spring, especially for juveniles. Raccoons are susceptible to several diseases, including dog distemper, rabies, and raccoon encephalitis. Most raccoons in the wild live less than 5 years, but some may live 10 or 12 years. Raccoons in captivity have lived up to 17 years (Jackson 1961; Schwartz and Schwartz 1981).

Exposure Profile

For this risk assessment, conservative exposure parameters are the highest (ingestion rates) or lowest (body weight [BW], HR size) values located in the literature.

Adult BWs vary with location, age, and sex. Males are generally 10% larger than females (Baker 1983), and northern raccoons are generally larger than southern raccoons (Kaufmann 1982). Body weights of yearlings may overlap with adult body weights (Scheffer 1950). Body weights of adult raccoons range from 2.2 to 15 kg (Stuewer 1943; Scheffer 1950; Schoonover 1950; Cabalka *et al.* 1953; Marshall 1956; Kinard 1964; Wood and Odum 1964; Barbour and Davis 1974; Alexander 1977; Lehman 1977; Hardin 1978; Sealander 1979; McComb 1981; Sanderson and Hubert 1981; Schwartz and Schwartz 1981; Mumford and Whitaker 1982; Baker 1983; Moore 1983; Merritt 1987; Jones and Birney 1988). A conservative BW of 2.2 kg was used in this risk assessment.

The raccoon is an opportunistic feeder; seasonal and local food availability determines dietary composition. Based on review of numerous food habit studies (Dearborn 1932; Hamilton 1936; Giles 1939; Giles 1940; Hamilton 1940; Stuewer 1943; Yeager and Rennels 1943; Baker *et al.* 1945; Yeager and Elder 1945; Schoonover 1950; Tyson 1950; Hamilton 1951; Schoonover and Marshall 1951; Llewellyn and Uhler 1952; Cabalka *et al.* 1953; Tester 1953; Dorney 1954; Wood 1954; Stains 1956; Johnson 1970; Cowan 1973; Alexander 1977; McComb 1981; Mumford and Whitaker 1982; Tabatabai and Kennedy 1988), the average year round diet of the raccoon is comprised of 61% plant foods and 35% animal foods[5]. The percentage of the diet comprised of plant food was higher every season except spring, when 38% of the diet was made up of plant foods and 57% was comprised of animal foods. Corn and fruit were the most important plant food items, and crayfish was the most important animal food item. For this risk assessment, the raccoon was considered an omnivore that consumes a diet comprised of 50% plant matter and 50% animal matter.

Fresh food ingestion rates of captive raccoons were reported by Teubner and Barrett (1983) and Conover (1989). When necessary, values were derived from dry food ingestion rates using the water content of the diet (U.S. EPA 1993). The resulting ingestion rates range from 0.303 kilograms per day (kg/d) to 0.400 kg/d. A conservative food ingestion rate of 0.400 kg/d will be used for this risk assessment.

A species specific water ingestion rate could not be located for the raccoon. Water ingestion rates were calculated using the allometric equation developed by Calder and Braun (1983): WI (liters per day [L/d] = $0.099\ Wt^{0.90}$, where WI is the daily water ingestion rate and Wt is the BW in kg. Using the above body weight, a conservative water ingestion rate of 0.201 L/d was calculated.

Soil ingestion rates ranging from 0.2 to 9.4 % of the diet have been reported for this species (Yeager and Elder 1945; Schoonover 1950; Cowan 1973; Beyer *et al.* 1994). A conservative soil/sediment ingestion rate of 9.4% was used. Using the above food ingestion rates, a conservative soil ingestion rate of 0.0376 kg/d was calculated.

Home range sizes ranging from 4.71 to 814.6 hectares (ha) have been reported for adult raccoons (Stuewer 1943; Schoonover 1950; Ellis 1964; Urban 1970; Cowan 1973; Lehman 1977; Sherfy and Chapman 1980; Moore 1983). Males generally have larger HRs than females. Home range size is also affected by habitat quality; in good habitat, HRs tend to be smaller. A conservative HR size of 4.71 ha and a representative HR size of 133.3 ha were used for this risk assessment.

In summary, the food chain model parameters for the raccoon are as follows:

Conservative Scenario:

BW:	2.2 kg
[6]Total ingestion:	0.4 kg/d
[2]Food ingestion:	0.3624 kg/d
Water ingestion:	0.201 L/d
Soil ingestion:	0.0376 kg/d
HR:	4.71 ha

LITERATURE CITED

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[5]Dietary composition numbers do not add up to 100%. Several studies reviewed did not report dietary composition numbers that added up to 100%.

[6]The total ingestion rate is the measured (laboratory or field) food ingestion rate cited in the paragraph in the exposure profile. Soil ingestion is generally measured as a percent of food ingestion. Therefore, the food ingestion rate used in the food chain models is considered to be equal to the total ingestion rate (listed above) minus the soil ingestion rate.

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2.3 Short-tailed Shrew, (*Blarina brevicauda*): Insectivorous Mammal

The short-tailed shrew is common throughout the eastern and central portions of the United States (Jones and Birney 1988, Barbour and Davis 1974). It is a large, heavy-bodied, and extremely active shrew, dark gray in color, with a short tail, pointed nose, and tiny eyes (Merritt 1987). It occupies a variety of moist and dry habitats such as marshes, bogs, forest floors with ample decaying matter, brushland, fencerows, weedfields, and pastures (Barbour and Davis 1974; Merritt 1987; Jones and Birney 1988).

The home range of the short-tailed shrew varies with population density. In peak years, density may be greater than 25 individuals per acre (Schwartz and Schwartz 1981), while in other years, density may be only one individual per acre (Merritt 1987). Usually, home ranges are between 0.5 to 1 acre in size, though they can sometimes be up to 4.5 acres (Blair 1940; Blair 1940; Burt 1940; Fitch 1958; Buckner 1966; Platt 1976; Schwartz and Schwartz 1981; Merritt 1987). Using echolocation and scent-marking, short-tailed shrews rely heavily on their hearing and sense of smell to locate food and to move about (Schwartz and Schwartz 1981; Hoffmeister 1989). They are active both day and night, usually throughout the year, although they may undergo a period of torpor during harsh winters (Hoffmeister 1989). They rest a

considerable portion of each day, being active only 7-16 percent of the time, and most of their activity is subnivean (Merritt 1987). They construct elaborate systems of runways and tunnels at or near the ground surface, or use tunnels left by other species such as moles or voles (Merritt 1987). Tunnel systems include caching sites and dedicated latrines (Merritt 1987). Two types of nests are built by short-tailed shrews, a breeding nest and a resting nest. Both are built underground beneath a log, rock, or other cover and have multiple entrances. The breeding nest is typically larger than the resting nest (Merritt 1987).

Although short-tailed shrews strongly prefer to eat animal matter, they are opportunistic omnivores and will voraciously consume whatever food items are available, including earthworms, slugs, snails, arthropods, fungi, roots, fruits, seeds, snakes, salamanders, small mammals, and young birds (Barbour and Davis 1974; Jones and Birney 1988; Schwartz and Schwartz 1981). Plant matter is generally consumed to a greater extent in winter, and in some regions may constitute up to 25 percent of the shrew's diet (Schwartz and Schwartz 1981; Hamilton 1930; Barbour and Davis 1974). Prey items that are not consumed immediately are stored in a cache (Merritt 1987). The saliva of short-tailed shrews contains a toxin that allows shrews to paralyze their prey and cache it for later consumption; in this manner, fresh food is available for longer periods of time between hunting bouts (Merritt 1986).

The annual breeding period of the short-tailed shrew begins in early spring and extends into the fall, although in some regions, breeding may subside in early and midsummer but peak again in early fall (Hoffmeister 1989, Jones and Birney 1988). Females have from one to three litters per year (Schwartz and Schwartz 1981, Merritt 1987). Gestation periods are approximately 21 to 22 days and litters contain three to ten (average 5-7) young (Jones and Birney 1988, Schwartz and Schwartz 1981). The young are fully mature at about three months of age, and both sexes may breed their first spring (Schwartz and Schwartz 1981, Jones and Birney 1988, Barbour and Davis 1974, Merritt 1987).

Natural predators of the short-tailed shrew include fish, snakes, owls, hawks, shrikes, opossums, raccoons, foxes, coyotes, weasels, bobcats, skunks, and domestic cats, although many of these predators do not consume the shrew (or at least all of the shrew) because of its distasteful musk glands (Barbour and Davis 1974, Merritt 1987, Schwartz and Schwartz 1981). The life expectancy of a short-tailed shrew in the wild is approximately one to two years (Schwartz and Schwartz 1981, Merritt 1987).

Exposure Profile

Adult short-tailed shrews weigh from 12.5 to 22.5 g (U.S. EPA 1993). A conservative body weight of 12.5 g will be used for this risk assessment.

Food ingestion rates ranging from 0.49 to 0.62 g/g BW/day have been reported (U.S. EPA 1993). A conservative food ingestion rate of 0.62 g/gBW/day (7.8 g/day) will be used for this risk assessment.

Because short-tailed shrews are primarily carnivorous, a diet comprised of 100% invertebrates will be assumed for risk calculations for this species.

A water ingestion rate of 0.223 g/g BW/day has been reported for short-tailed shrews (U.S. EPA 1993). To express this value in units of ml/day, the water ingestion rate was multiplied by the conservative body weight cited above to yield a conservative water ingestion rates of 2.8 mL/day.

Home range sizes from less than 0.03 ha to 1.8 ha have been reported for this species (U.S. EPA 1993). A conservative home range size of 0.03 ha and a representative home range size of 0.4 ha will be used in risk calculations for this species.

A soil ingestion rate for the short-tailed shrew was not available from the literature, therefore, the soil ingestion rate of the opossum was used. The opossum's diet is similar to that of the short-tailed shrew since they are both opportunistic omnivores with a strong preference for animal matter (Schwartz and Schwartz

1981). A soil ingestion rate of 9.4 percent of the diet was reported for the opossum (Beyer *et al.* 1994). This value was multiplied by the conservative food ingestion rates (7.8 g/day) to yield a soil ingestion rate of 0.7 g/day.

Conservative Scenario:

BW:	0.0125 kg
Food ingestion:	0.0078 kg/d
Water ingestion:	0.0028 L/d
Soil ingestion:	0.0007 kg/d
HR:	0.03 ha

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2.4 Muskrat, (*Ondotra zibethicus*): Herbivorous Mammal

Life History

The muskrat is a large, semi-aquatic mammal with rich brown dorsal fur overlain with long guard hairs, a scaly tail, and partly webbed hind feet. It lives virtually anyplace where sufficient food and permanent water is present, including saltwater marshes (Schwartz and Schwartz 1981; Jones and Birney 1988). It can be found throughout most of the U.S., with the exception of Hawaii, Florida, south Texas, and parts of California (Merritt 1987; Schwartz and Schwartz 1981).

Muskrats are primarily nocturnal and are active throughout the year (Merritt 1987). Home range [HR] sizes vary from 10 to 180 meters' length of shoreline, depending on the size and shape of the water in which the animals live (Merritt 1987), or from 0.0484 hectare (ha) to 0.39 ha (Neal 1968; Proulx and Gilbert 1983). The home of a muskrat consists of a system of burrows dug into a bank and leading to underwater and above water openings, or a conical lodge comprised of a heap of vegetation and mud (Merritt 1987; Jones and Birney 1981). Each home is usually inhabited by several muskrats, most often members of the same family (Davis and Schmidly 1994). On occasion, other animals such as birds, reptiles, and amphibians may utilize these dens and lodges, even when muskrats are present (Schwartz and Schwartz 1981).

The breeding season of the muskrat varies with regional climate, with northern animals usually producing three to four litters per year and southern animals breeding year-round (Jones and Birney 1988). Gestation periods range from 22 to 31 days, and litters contain from 1 to 16 (averaging 3-8) individuals (Barbour and Davis 1974; Schwartz and Schwartz 1981). Litter sizes are larger in the north, where the average size is 7-8, compared with 6 or less in the south and central portions of the country (Barbour and Davis 1974). Weaning occurs between three and four weeks of age (Schwartz and Schwartz 1981). Sexual maturity is reached in 10 to 12 months (Davis and Schmidly 1994).

Although they may consume meat (including carrion) during times of food scarcity, muskrats are generally herbivorous (Davis and Schmidly 1994; Schwartz and Schwartz 1981). Aquatic vegetation, such as cattails, algae, and sedges, appears to be the favored food item (Davis and Schmidly 1994). Terrestrial vegetation, aquatic invertebrates, fish, frogs, clams, snails, reptiles, young birds, and other muskrats have also been reported to be consumed by muskrats (Jones and Birney 1988; Barbour and Davis 1974; Davis and Schmidly 1994; Schwartz and Schwartz 1981).

The mink is usually the main natural predator of muskrats in most areas (Barbour and Davis 1974; Jones and Birney 1988; Schwartz and Schwartz 1981). Raptors, owls, coyotes, foxes, dogs, cats, raccoons, weasels, large snakes, snapping turtles, and fish also prey on muskrats (Schwartz and Schwartz 1981). Muskrats also carry a heavy parasitic load and as a result may suffer population crashes (Jones and Birney 1988). Only about one-third of young muskrats survive to their first winter (Schwartz and Schwartz 1981). One tagged muskrat was reported to survive for four years in the wild (Schwartz and Schwartz 1981).

Exposure Profile

For the purpose of this risk assessment, conservative exposure parameters are the highest (ingestion rates) or lowest (body weight [BW], HR size) values located in the literature.

Adult muskrats weigh from 0.541kg to 1.814 kg, with the average being 1.191 kg (Dozier 1948; Beer and Meyer 1951; Fuller 1951; Stevens 1953; Reeves and Williams 1956; Wilson 1956; Donohoe 1961; Erickson 1963; Neal 1968; Soper 1973; Barbour and Davis 1974; Schacher and Pelton 1978; Parker and Maxwell 1980; McDonnell and Gilbert 1981; Schwartz and Schwartz 1981; Mumford and Whitaker 1982; Baker 1983; Parker and Maxwell 1984; Merritt 1987; Jones and Birney 1988; Davis and Schmidly 1994). Males are generally larger than females: males average 1.212 kg and females 1.178 kg. There is also regional variation in muskrat body size: muskrats are usually heavier in northern latitudes, although the smallest body sizes are found in Idaho (Reeves and Williams 1956). A conservative BW of 0.541 kg was used for this risk assessment.

Muskrats are primarily herbivorous, though they will eat animal matter on occasion (Jones and Birney 1988; Barbour and Davis 1974; Davis and Schmidly 1994; Schwartz and Schwartz 1981). Muskrats generally eat different plant foods in proportion to their availability in the habitat (Takos 1947). Often, one or two food items, the selection of which varies with habitat, will comprise 70-80 percent (%) of the diet. The diet of muskrats in Maryland was found to consist of approximately 50% green algae, 46% other green vegetation (primarily cattails, other rushes, and sedges), 3% corn, millet, and other seeds, and 1% other items (Willner et al. 1975). In other regions, cattails are reported to be the mainstay of the muskrat diet (Davis and Schmidly 1994; Schwartz and Schwartz 1981). For this risk assessment, muskrats were assumed to be entirely herbivorous.

Food ingestion rates measured for the muskrat range from 0.250 kilograms per day (kg/d) to 0.289 kg/day (Svihla and Svihla 1931). The highest value was used as a conservative estimate of food ingestion.

Water ingestion rates were calculated using the allometric equation developed by Calder and Braun (1983): WI (liters per day [L/d]) = 0.099 $Wt^{0.90}$, where Wl is the daily water ingestion rate and Wt is the body weight in kg. Using the above body weights, a conservative water ingestion rate of 0.057 L/d was calculated

for this risk assessment.

A soil ingestion estimate for the muskrat could not be found in the literature; however, Willner *et al.* (1975) reported that, on average, 1% of the muskrat diet was composed of material other than vegetation. This value will be assumed to represent the percentage of soil ingested by the muskrat. This value was multiplied by the conservative food ingestion rate for the muskrat to yield a soil ingestion rates of 0.00289 kg/d.

Muskrat HR sizes have been reported to vary from 0.0484 ha to 0.39 ha (Neal 1968; Proulx and Gilbert 1983).
In summary, the food chain model parameters for the muskrat are as follows:

Conservative estimates:

BW:	0.541 kg
[7]Total ingestion:	0.289 kg/d
[1]Food ingestion:	0.28611 kg/d
Water ingestion:	0.057 L/day
Soil ingestion:	1% or 0.00289 kg/d
HR size:	0.0484 ha

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[7]The total ingestion rate is the measured (laboratory or field) food ingestion rate cited in the paragraph in the exposure profile. Soil ingestion is generally measured as a percent of food ingestion. Therefore, the food ingestion rate used in the food chain models is considered to be equal to the total ingestion rate (listed above) minus the soil ingestion rate.

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Appendix C

Appendix C

Dry Weight to Wet Weight Conversions for Chemicals Evaluated in Food Chain Exposure Models

Table C-1 Dry Weight to Wet Conversions for Chemicals Detected in Soil and Evaluated in Food Chain Exposure Models

Table C-2 Dry Weight to Wet Conversions for Chemicals Detected in Sediment and Evaluated in Food Chain Exposure Models

Table C-1
Dry Weight to Wet Weight Conversions for Chemicals Detected in Soil and Evaluated in Food Chain Exposure Models
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Dry Weight Concentration	Percent Moisture	Wet Weight Concentration
Inorganics (mg/kg)			
Arsenic	8	17.9	6.6
Cadmium	9.5	17.9	7.8
Copper	292	17.9	240
Lead	10100	12.3	8858
Nickel	64.4	12.3	56
Silver	0.91	17.9	0.75
Zinc	13400	17.9	11001
PAHs (µg/kg)			
Acenaphthene	62	16	52
Acenaphthylene	160	12	141
Anthracene	150	14	129
Benzo(a)anthracene	1300	12	1144
Benzo(a)pyrene	440	12	387.2
Benzo(b)fluoranthene	1000	12	880
Benzo(g,h,i)perylene	370	12	325.6
Benzo(k)fluoranthene	700	12	616
Chrysene	980	12	862.4
Dibenzo(a,h)anthracene	59	12	52
Fluoranthene	210	16	176
Fluorene	210	12	185
Indeno(1,2,3-cd)pyrene	340	12	299.2
Phenanthrene	1000	12	880
Pyrene	540	12	475
Pesticides (µg/kg)			
4,4'-DDE	42	16	35.3
4,4'-DDT	250	16	210
beta-BHC	2.9	12	2.6
delta-BHC	72	16	60.5
gamma-chlordane	54	12	47.5
Dieldrin	32	16	26.9
Endrin	12	16	10.1
Heptachlor	5.6	16	4.7
Heptachlor Epoxide	120	16	100.8
PCB Aroclors (µg/kg)			
Aroclor 1248	3,400	16	2856
Aroclor 1254	1,200	32	816
Aroclor 1260	3,000	16	2520
Dioxins/furans (ng/kg)			
1,2,3,4,6,7,8-Hpcdd	1,290	13.7	1113
1,2,3,4,6,7,8-Hpcdf	309	13.7	267
1,2,3,4,7,8,9-Hpcdf	26.2	13.7	22.6
1,2,3,4,7,8-Hxcdd	4.4	13.7	3.8
1,2,3,4,7,8-Hxcdf	9.43	13.7	8.1
1,2,3,6,7,8-Hxcdd	42.4	13.7	36.6
1,2,3,6,7,8-Hxcdf	6.98	12	6.1
1,2,3,7,8,9-Hxcdd	5.2	13.7	4.5
1,2,3,7,8,9-Hxcdf	2.05	13.7	1.8
1,2,3,7,8-Pecdd	3.86	13.7	3.3
1,2,3,7,8-Pecdf	5.38	12	4.7
2,3,4,6,7,8-Hxcdf	6.8	12	6.0
2,3,4,7,8-Pecdf	7.46	12	6.6
2,3,7,8-Tcdd	1.96	13.7	1.7
2,3,7,8-Tcdf	12.3	13.7	10.6
Ocdd	11200	13.7	9666
Ocdf	2260	13.7	1950

Notes:
PAHs - polycyclic aromatic hydrocarbons
PCBs - polychlorinated biphenyls
mg/kg - milligrams per kilogram
ng/kg - nanograms per kilogram
µg/kg - micrograms per kilogram
wet weight concentrations converted as follow: ww = Cs x (1 - % moisture)
where:
ww - wet weight concentration
Cs - dry weight concentration in soil
% moisture - percent moisture

Table C-2
Dry Weight to Wet Weight Conversions for Chemicals Detected in Sediment and Evaluated in Food Chain Exposure Models
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Dry Weight Concentration	Percent Moisture	Wet Weight Concentration
Inorganics (mg/kg)			
Arsenic	42	59.7	17
Cadmium	8.6	62.9	3.2
Copper	158	61.5	61
Lead	6430	61.5	2476
Nickel	62.7	62.9	23
Selenium	8.1	62.9	3.0
Silver	4.6	62.9	1.7
Zinc	900	61.5	347
PCB Arclors (µg/kg)			
Aroclor 1248	340	65	119
Aroclor 1254	670	65	235
Aroclor 1268	150	47	80
Dioxins/furans (ng/kg)			
1,2,3,4,6,7,8-Hpcdd	40.1	53.6	19
1,2,3,4,6,7,8-Hpcdf	91.1	53.6	42
1,2,3,4,7,8,9-Hpcdf	2.3	53.6	1.1
1,2,3,4,7,8-Hxcdd	0.576	53.6	0.27
1,2,3,4,7,8-Hxcdf	2.88	53.6	1.3
1,2,3,6,7,8-Hxcdd	2.2	53.6	1.0
1,2,3,6,7,8-Hxcdf	3.79	53.6	1.8
1,2,3,7,8,9-Hxcdd	1.5	36.9	0.95
1,2,3,7,8,9-Hxcdf	0.936	53.6	0.43
1,2,3,7,8-Pecdd	0.548	53.6	0.25
1,2,3,7,8-Pecdf	0.909	36.9	0.57
2,3,4,6,7,8-Hxcdf	2.31	53.6	1.1
2,3,4,7,8-Pecdf	2.04	36.9	1.3
2,3,7,8-Tcdd	0.263	36.9	0.17
2,3,7,8-Tcdf	2.07	36.9	1.3
Ocdd	731	53.6	339
Ocdf	63	53.6	29
PCB Congeners (pg/g)			
2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (206)	80600	55	36270
2,2',3,3',4,4',5,5'-Octachlorobiphenyl (194)	9450	54	4347
2,2',3,3',4,4',5,6,6'-Nonachlorobiphenyl (207)	5100	55	2295
2,2',3,3',4,4',5,6-Octachlorobiphenyl (195)	3450	54	1587
2,2',3,3',4,4',5,6'-Octachlorobiphenyl (196)	5370	54	2470
2,2',3,3',4,4',5-Heptachlorobiphenyl (170)	13900	54	6394
2,2',3,3',4,4',6,6'-Octachlorobiphenyl (197)	2290	54	1053
2,2',3,3',4,4',6-Heptachlorobiphenyl (171)	5600	54	2576
2,2',3,3',4,4'-Hexachlorobiphenyl (128)	14300	54	6578
2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl (208)	38200	55	17190
2,2',3,3',4,5,5',6-Octachlorobiphenyl (198)	16000	55	7200
2,2',3,3',4,5,5'-Heptachlorobiphenyl (172)	2700	54	1242

Table C-2
Dry Weight to Wet Weight Conversions for Chemicals Detected in Sediment and Evaluated in Food Chain Exposure Models
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Dry Weight Concentration	Percent Moisture	Wet Weight Concentration
2,2',3,3',4,5',6,6'-Octachlorobiphenyl (201)	1840	54	846
2,2',3,3',4,5,6'-Heptachlorobiphenyl (174)	26600	54	12236
2,2',3,3',4,5',6-Heptachlorobiphenyl (175)	731	54	336
2,2',3,3',4',5,6-Heptachlorobiphenyl (177)	10900	54	5014
2,2',3,3',4,5-Hexachlorobiphenyl (129)	102000	54	46920
2,2',3,3',4,5'-Hexachlorobiphenyl (130)	6080	54	2797
2,2',3,3',4,6,6'-Heptachlorobiphenyl (176)	2720	54	1251
2,2',3,3',4,6-Hexachlorobiphenyl (131)	1450	54	667
2,2',3,3',4,6'-Hexachlorobiphenyl (132)	41000	54	18860
2,2',3,3',4-Pentachlorobiphenyl (82)	6580	54	3027
2,2',3,3',5,5',6,6'-Octachlorobiphenyl (202)	6180	55	2781
2,2',3,3',5,5',6-Heptachlorobiphenyl (178)	4360	54	2006
2,2',3,3',5,5'-Hexachlorobiphenyl (133)	1780	54	819
2,2',3,3',5,6,6'-Heptachlorobiphenyl (179)	10900	54	5014
2,2',3,3',5,6-Hexachlorobiphenyl (134)	7590	54	3491
2,2',3,3',5,6'-Hexachlorobiphenyl (135)	38700	54	17802
2,2',3,3',5-Pentachlorobiphenyl (83)	6710	54	3087
2,2',3,3',6,6'-Hexachlorobiphenyl (136)	13900	54	6394
2,2',3,3',6-Pentachlorobiphenyl (84)	46800	54	21528
2,2',3,3'-Tetrachorobiphenyl (40)	23600	54	10856
2,2',3,4,4',5,5',6-Octachlorobiphenyl (203)	9140	54	4204
2,2',3,4,4',5,5'-Heptachlorobiphenyl (180)	43000	54	19780
2,2',3,4,4',5,6-Heptachlorobiphenyl (181)	161	54	74.1
2,2',3,4,4',5,6'-Heptachlorobiphenyl (182)	169	54	77.7
2,2',3,4,4',5',6-Heptachlorobiphenyl (183)	14600	54	6716
2,2',3,4,4',5-Hexachlorobiphenyl (137)	4950	54	2277
2,2',3,4,4',6-Hexachlorobiphenyl (139)	2300	54	1058
2,2',3,4,4'-Pentachlorobiphenyl (85)	13700	54	6302
2,2',3,4',5,5',6-Heptachlorobiphenyl (187)	27200	54	12512
2,2',3,4,5,5'-Hexachlorobiphenyl (141)	20300	54	9338
2,2',3,4',5,5'-Hexachlorobiphenyl (146)	19800	54	9108
2,2',3,4',5,6,6'-Heptachlorobiphenyl (188)	56.1	54	25.8
2,2',3,4,5,6'-Hexachlorobiphenyl (143)	18.1	71	5.2
2,2',3,4,5',6-Hexachlorobiphenyl (144)	3760	54	1730
2,2',3,4',5,6-Hexachlorobiphenyl (147)	105000	54	48300
2,2',3,4',5,6'-Hexachlorobiphenyl (148)	289	54	133
2,2',3,4,5-Pentachlorobiphenyl (86)	59700	54	27462
2,2',3,4',5-Pentachlorobiphenyl (90)	123000	54	56580
2,2',3,4,6,6'-Hexachlorobiphenyl (145)	38.9	54	17.9
2,2',3,4',6,6'-Hexachlorobiphenyl (150)	241	54	111
2,2',3,4,6-Pentachlorobiphenyl (88)	21100	54	9706
2,2',3,4,6'-Pentachlorobiphenyl (89)	784	54	361
2,2',3',4,6-Pentachlorobiphenyl (98)	6230	54	2866
2,2',3,4-Tetrachlorobiphenyl (41)	975	54	449

Table C-2
Dry Weight to Wet Weight Conversions for Chemicals Detected in Sediment and Evaluated in Food Chain Exposure Models
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Dry Weight Concentration	Percent Moisture	Wet Weight Concentration
2,2',3,4'-Tetrachlorobiphenyl (42)	11300	54	5198
2,2',3,5,5'-Pentachlorobiphenyl (92)	28800	54	13248
2,2',3,5,6,6'-Hexachlorobiphenyl (152)	136	54	63
2,2',3,5,6-Pentachlorobiphenyl (93)	7640	71	2216
2,2',3,5,6'-Pentachlorobiphenyl (94)	1740	54	800
2,2',3,5',6-Pentachlorobiphenyl (95)	106000	54	48760
2,2',3,5-Tetrachlorobiphenyl (43)	2540	54	1168
2,2',3,5'-Tetrachlorobiphenyl (44)	56500	54	25990
2,2',3,6,6'-Pentachlorobiphenyl (96)	991	54	456
2,2',3,6-Tetrachlorobiphenyl (45)	8860	54	4076
2,2',3,6'-Tetrachlorobiphenyl (46)	3910	54	1799
2,2',3-Trichlorobiphenyl (16)	10700	54	4922
2,2',4,4',5,5'-Hexachlorobiphenyl (153)	82300	54	37858
2,2',4,4',5',6-Hexachlorobiphenyl (154)	2230	54	1026
2,2',4,4',5-Pentachlorobiphenyl (99)	48100	54	22126
2,2',4,4',6,6'-Hexachlorobiphenyl (155)	156	71	45.2
2,2',4,5',6-Pentachlorobiphenyl (103)	2680	54	1233
2,2',4,5-Tetrachlorobiphenyl (48)	4010	54	1845
2,2',4,5'-Tetrachlorobiphenyl (49)	48700	54	22402
2,2',4,6,6'-Pentachlorobiphenyl (104)	1770	71	513
2,2',4,6-Tetrachlorobiphenyl (50)	8970	54	4126
2,2',4-Trichlorobiphenyl (17)	20200	54	9292
2,2',5,5'-Tetrachlorobiphenyl (52)	70300	54	32338
2,2',5-Trichlorobiphenyl (18)	27900	54	12834
2,2',6,6'-Tetrachlorobiphenyl (54)	835	71	242
2,2',6-Trichlorobiphenyl (19)	5690	54	2617
2,2'-Dichlorobiphenyl (4)	12300	54	5658
2,3,3',4,4',5,5',6-Octachlorobiphenyl (205)	420	54	193
2,3,3',4,4',5,5'-Heptachlorobiphenyl (189)	587	54	270
2,3,3',4,4',5,6-Heptachlorobiphenyl (190)	2920	54	1343
2,3,3',4,4',5',6-Heptachlorobiphenyl (191)	570	54	262
2,3,3',4,4',5-Hexachlorobiphenyl (156)	9800	54	4508
2,3,3',4,4',6-Hexachlorobiphenyl (158)	12000	54	5520
2,3,3',4,4'-Pentachlorobiphenyl (105)	18400	54	8464
2,3,3',4,5,5'-Hexachlorobiphenyl (159)	866	54	398
2,3,3',4',5,5'-Hexachlorobiphenyl (162)	750	54	345
2,3,3',4',5',6-Hexachlorobiphenyl (164)	9040	54	4158
2,3,3',4',5-Pentachlorobiphenyl (107)	5910	54	2719
2,3,3',4,5'-Pentachlorobiphenyl (108)	2240	54	1030
2',3,3',4,5-Pentachlorobiphenyl (122)	457	54	210
2,3,3',4',6-Pentachlorobiphenyl (110)	114000	54	52440
2,3,3',4-Tetrachlorobiphenyl (55)	630	54	290
2,3,3',4'-Tetrachlorobiphenyl (56)	10800	54	4968
2,3,3',5,5',6-Hexachlorobiphenyl (165)	54.6	54	25.1

Table C-2
Dry Weight to Wet Weight Conversions for Chemicals Detected in Sediment and Evaluated in Food Chain Exposure Models
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Dry Weight Concentration	Percent Moisture	Wet Weight Concentration
2,3,3',5,5'-Pentachlorobiphenyl (111)	20.8	71	6.0
2,3,3',5-Tetrachlorobiphenyl (57)	990	54	455
2,3,3',5'-Tetrachlorobiphenyl (58)	516	54	237
2,3,3',6-Tetrachlorobiphenyl (59)	4090	54	1881
2,3,3'-Trichlorobiphenyl (20)	42400	54	19504
2,3',4,4',5,5'-Hexachlorobiphenyl (167)	3390	54	1559
2,3,4,4',5-Pentachlorobiphenyl (114)	977	54	449
2,3',4,4',5-Pentachlorobiphenyl (118)	70400	54	32384
2',3,4,4',5-Pentachlorobiphenyl (123)	762	54	351
2,3,4,4'-Tetrachlorobiphenyl (60)	1520	54	699
2,3',4,4'-Tetrachlorobiphenyl (66)	33400	54	15364
2,3',4,5,5'-Pentachlorobiphenyl (120)	352	54	162
2,3',4,5',6-Pentachlorobiphenyl (121)	169	71	49.0
2,3,4,5-Tetrachlorobiphenyl (61)	59100	54	27186
2,3,4',5-Tetrachlorobiphenyl (63)	1980	54	911
2,3',4,5-Tetrachlorobiphenyl (67)	3650	54	1679
2,3',4,5'-Tetrachlorobiphenyl (68)	1310	54	603
2,3,4',6-Tetrachlorobiphenyl (64)	11800	54	5428
2,3,4-Trichlorobiphenyl (21)	10500	54	4830
2,3,4'-Trichlorobiphenyl (22)	11500	54	5290
2,3',4-Trichlorobiphenyl (25)	9590	54	4411
2,3',5,5'-Tetrachlorobiphenyl (72)	1950	54	897
2,3',5',6-Tetrachlorobiphenyl (73)	344	71	99.8
2,3',5-Trichlorobiphenyl (26)	21200	54	9752
2',3,5-Trichlorobiphenyl (34)	482	54	222
2,3',6-Trichlorobiphenyl (27)	4900	54	2254
2,3-Dichlorobiphenyl (5)	828	54	381
2,3'-Dichlorobiphenyl (6)	16200	54	7452
2,4',5-Trichlorobiphenyl (31)	37000	54	17020
2,4',6-Trichlorobiphenyl (32)	9790	54	4503
2,4-Dichlorobiphenyl (7)	1050	54	483
2,4'-Dichlorobiphenyl (8)	23600	54	10856
2,5-Dichlorobiphenyl (9)	1670	54	768
2,6-Dichlorobiphenyl (10)	901	54	414
2-Chlorobiphenyl (1)	4910	54	2259
3,3',4,4',5,5'-Hexachlorobiphenyl (169)	50	55	22.5
3,3',4,4',5-Pentachlorobiphenyl (126)	64.9	55	29.2
3,3',4,4'-Tetrachlorobiphenyl (77)	1780	54	819
3,3',4,5,5'-Pentachlorobiphenyl (127)	3.05	71	0.885
3,3',4,5'-Tetrachlorobiphenyl (79)	660	54	304
3,3',4-Trichlorobiphenyl (35)	1410	55	635
3,3'-Dichlorobiphenyl (11)	1440	55	648
3,4,4'-Trichlorobiphenyl (37)	7400	54	3404
3,4,5-Trichlorobiphenyl (38)	42	55	18.9

Table C-2
Dry Weight to Wet Weight Conversions for Chemicals Detected in Sediment and Evaluated in Food Chain Exposure Models
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Dry Weight Concentration	Percent Moisture	Wet Weight Concentration
3,4',5-Trichlorobiphenyl (39)	240	54	110
3,4-Dichlorobiphenyl (12)	6070	54	2792
3,5-Dichlorobiphenyl (14)	69.6	55	31.3
3-Chlorobiphenyl (2)	562	54	259
4,4'-Dichlorobiphenyl (15)	23400	54	10764
4-Chlorobiphenyl (3)	4060	54	1868
Decachlorobiphenyl	133000	55	59850

Notes:
PCBs - polychlorinated biphenyls
mg/kg - milligrams per kilogram
ng/kg - nanograms per kilogram
pg/g - picograms per gram
µg/kg - micrograms per kilogram
wet weight concentrations converted as follow: ww = Cs x (1 - % moisture)
where:
ww - wet weight concentration
Cs - dry weight concentration in sediment
% moisture - percent moisture

Appendix D

Appendix D

Food Chain Exposure Models

Table D-1 Food Chain Exposure Model for the Bald Eagle
Table D-2 Food Chain Exposure Model for the Great blue Heron
Table D-3 Food Chain Exposure Model for the Mink
Table D-4 Food Chain Exposure Model for the Muskrat
Table D-5 Food Chain Exposure Model for the Wood Duck
Table D-6 Food Chain Exposure Model for the Raccoon
Table D-7 Food Chain Exposure Model for the Short-Tailed Shrew
Table D-8 Food Chain Exposure Model for the American Robin
Table D-9 Food Chain Exposure Model for the Red-Tailed Hawk
Table D-10 Food Chain Exposure Model for the Red Fox

Table D-1
Food Chain Exposure Model for the Bald Eagle
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Sediment			Fish			Food		Water			Site Foraging Factor	Body Weight	Dose	LOAEL		NOAEL	
	Concentration mg/kg w.w.	Ingestion Rate kg/day	Total Ingested Chemical mg/day	Biota-Sediment Accumulation Factor[1]	Concentration mg/kg w.w.	Percent of Diet	Ingestion Rate kg/day	Total Ingested Chemical mg/day	Concentration mg/L	Ingestion Rate L/day	Total Ingested Chemical mg/day		kg	mg/kg/day	Value mg/kg/day	Hazard Quotient	Value mg/kg/day	Hazard Quotient
Arsenic	17	0.0013	0.0220	0.12	2.0	100%	0.132	0.268	0.0466	0.137	0.0064	1	3.524	0.084	12.8	0.01	5.1	0.02
Cadmium	3.2	0.0013	0.0041	0.8	2.6	100%	0.132	0.337	0.0127	0.137	0.0017	1	3.524	0.097	20	0.005	1.45	0.07
Copper	61	0.0013	0.0791	1.0	60.8	100%	0.132	8.0	0.15	0.137	0.0206	1	3.524	2.3	61.7	0.04	47	0.05
Lead	2476	0.0013	3.2	0.18	445.6	100%	0.132	58.8	0.654	0.137	0.0896	1	3.524	17.6	11.3	**1.6**	1.13	**16**
Nickel	23	0.0013	0.0302	1.0	23.3	100%	0.132	3.1	0.229	0.137	0.0314	1	3.524	0.9	107	0.01	77.4	0.01
Selenium	3.0	0.0013	0.0039	1.0	3.0	100%	0.132	0.4	0.0032	0.137	0.0004	1	3.524	0.114	1.0	0.11	0.5	0.23
Silver	1.7	0.0013	0.0022	1.0	1.7	100%	0.132	0.225	0.001	0.137	0.0001	1	3.524	0.065	60.5	0.001	20.2	0.00
Zinc	347	0.0013	0.5	1.8	623.7	100%	0.132	82.33	2.21	0.137	0.3028	1	3.524	23.6	131	0.18	14.5	**1.6**
Aroclor 1248	0.119	0.0013	0.0002	2.3	0.274	100%	0.132	0.036	ND	0.137	0	1	3.524	0.010	1.8	0.01	0.18	0.06
Aroclor 1254	0.235	0.0013	0.0003	2.3	0.539	100%	0.132	0.071	ND	0.137	0	1	3.524	0.020	1.8	0.01	0.18	0.11
Aroclor 1268	0.080	0.0013	0.0001	2.3	0.183	100%	0.132	0.024	ND	0.137	0	1	3.524	0.007	1.8	0.004	0.18	0.04
Total PCB Congeners[2]	1.0	0.0013	0.0014	4.2	4.368	100%	0.132	0.577	ND	0.137	0	1	3.524	0.164	1.8	0.09	0.18	0.91
Total 2,3,7,8-TCDD TEQs[3]	0.000050	0.0013	0.000000065	0.2	0.0000099	100%	0.132	0.00000131	ND	0.137	0	1	3.524	0.00000039	0.00014	0.00279	0.000014	0.0279

Notes:
1 - biota-sediment accumulation factors are presented in Table 5-2
2 - Total sum of PCB congeners excludes those with dioxin-like effects which are evaluated along with dioxins/furans
3 - Includes the total sum of dioxin/furan and dioxin-like PCB congeners toxic equivalents
NOAEL - no observed adverse effect level
LOAEL - lowest observed adverse effect level
NA - Input variable not located
NC - Not calculated
ND - Not detected
kg - kilogram
kg/day - kilogram per day
mg/kg w.w. - milligram per kilogram wet weight
mg/kg/day - milligram per kilogram per day
mg/L - milligrams per liter
L/day - liters per day
Bold - indicates hazard quotient greater than threshold of one
wet weight concentrations converted as follow: ww = Cs x (1 - % moisture)
where:
ww - wet weight concentration
Cs - dry weight concentration in soil
% moisture - percent moisture
For example, dry weight concentration and % moisture for arsenic were 42 mg/kg and 59.7%, respectively.
ww = 42 x (1 - .597)
ww = 17 mg/kg

Table D-2
Food Chain Exposure Model for the Great Blue Heron
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Sediment			Fish			Food		Water			Site Foraging Factor	Body Weight	Dose	LOAEL		NOAEL	
	Concentration mg/kg w.w.	Ingestion Rate kg/day	Total Ingested Chemical mg/day	Biota-Sediment Accumulation Factor[1]	Concentration mg/kg w.w.	Percent of Diet	Ingestion Rate kg/day	Total Ingested Chemical mg/day	Concentration mg/L	Ingestion Rate L/day	Total Ingested Chemical mg/day		kg	mg/kg/day	Value mg/kg/day	Hazard Quotient	Value mg/kg/day	Hazard Quotient
Arsenic	17	0.0132	0.223	0.12	2.0	100%	0.401	0.814	0.0466	0.101	0.0047	1	2.229	0.468	12.8	0.04	5.1	0.09
Cadmium	3.2	0.0132	0.042	0.8	2.6	100%	0.401	1.0	0.0127	0.101	0.0013	1	2.229	0.479	20	0.02	1.45	0.33
Copper	61	0.0132	0.803	1.0	60.8	100%	0.401	24.4	0.15	0.101	0.0152	1	2.229	11.3	61.7	0.18	47	0.24
Lead	2476	0.0132	32.7	0.18	445.6	100%	0.401	178.7	0.654	0.101	0.0661	1	2.229	94.9	11.3	**8.4**	1.13	**84**
Nickel	23	0.0132	0.307	1.0	23.3	100%	0.401	9.3	0.229	0.101	0.0231	1	2.229	4.3	107	0.04	77.4	0.06
Selenium	3.0	0.0132	0.040	1.0	3.0	100%	0.401	1.2	0.0032	0.101	0.0003	1	2.229	0.559	1.0	0.56	0.5	**1.1**
Silver	1.7	0.0132	0.023	1.0	1.7	100%	0.401	0.684	0.001	0.101	0.0001	1	2.229	0.317	60.5	0.01	20.2	0.02
Zinc	347	0.0132	4.6	1.8	623.7	100%	0.401	250.1	2.21	0.101	0.2232	1	2.229	114.4	131	0.87	14.5	**7.9**
Aroclor 1248	0.119	0.0132	0.002	2.3	0.274	100%	0.401	0.110	ND	0.101	0	1	2.229	0.050	1.8	0.03	0.18	0.28
Aroclor 1254	0.235	0.0132	0.003	2.3	0.539	100%	0.401	0.216	ND	0.101	0	1	2.229	0.098	1.8	0.05	0.18	0.55
Aroclor 1268	0.080	0.0132	0.001	2.3	0.183	100%	0.401	0.073	ND	0.101	0	1	2.229	0.033	1.8	0.02	0.18	0.19

Notes:
1 - biota-sediment accumulation factors are presented in Table 5-2
NOAEL - no observed adverse effect level
LOAEL - lowest observed adverse effect level
NA - Input variable not located
NC - Not calculated
ND - Not detected
kg - kilogram
kg/day - kilogram per day
mg/kg w.w. - milligram per kilogram wet weight
mg/kg/day - milligram per kilogram per day
mg/L - milligrams per liter
L/day - liters per day
Bold - indicates hazard quotient greater than threshold of one
wet weight concentrations converted as follow: ww = Cs x (1 - % moisture)
where:
ww - wet weight concentration
Cs - dry weight concentration in soil
% moisture - percent moisture
For example, dry weight concentration and % moisture for arsenic were 42 mg/kg and 59.7%, respectively.
ww = 42 x (1 - .597)
ww = 17 mg/kg

Table D-3
Food Chain Exposure Model for the Mink
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Sediment			Fish			Food		Water			Site Foraging Factor	Body Weight	Dose	LOAEL		NOAEL	
	Concentration mg/kg w.w.	Ingestion Rate kg/day	Total Ingested Chemical mg/day	Biota-Sediment Accumulation Factor[1]	Concentration mg/kg w.w.	Percent of Diet	Ingestion Rate kg/day	Total Ingested Chemical mg/day	Concentration mg/L	Ingestion Rate L/day	Total Ingested Chemical mg/day		kg	mg/kg/day	Value mg/kg/day	Hazard Quotient	Value mg/kg/day	Hazard Quotient
Arsenic	17	0.020	0.339	0.12	2.0	100%	0.214	0.435	0.0466	0.097	0.0045	1	0.974	0.798	0.524	**1.5**	0.052	**15**
Cadmium	3.2	0.020	0.064	0.8	2.6	100%	0.214	0.546	0.0127	0.097	0.0012	1	0.974	0.628	7.419	0.08	0.742	0.85
Copper	61	0.020	1.2	1.0	60.8	100%	0.214	13.0	0.15	0.097	0.0146	1	0.974	14.6	15.4	0.95	11.7	**1.3**
Lead	2476	0.020	49.5	0.18	445.6	100%	0.214	95.4	0.654	0.097	0.0634	1	0.974	148.8	61.53	**2.4**	6.15	**24**
Nickel	23	0.020	0.465	1.0	23.3	100%	0.214	5.0	0.229	0.097	0.0222	1	0.974	5.6	61.53	0.09	30.77	0.18
Selenium	3.0	0.020	0.060	1.0	3.0	100%	0.214	0.643	0.0032	0.097	0.0003	1	0.974	0.722	0.254	**2.8**	0.154	**4.7**
Silver	1.7	0.020	0.034	1.0	1.7	100%	0.214	0.365	0.001	0.097	0.0001	1	0.974	0.410	6.02	0.07	0.6	0.68
Zinc	347	0.020	6.9	1.8	623.7	100%	0.214	133.5	2.21	0.097	0.2144	1	0.974	144.4	246.1	0.59	123.1	**1.2**
Aroclor 1248	0.119	0.020	0.002	2.3	0.274	100%	0.214	0.059	ND	0.097	0.0000	1	0.974	0.063	0.15	0.42	0.015	**4.2**
Aroclor 1254	0.235	0.020	0.005	2.3	0.539	100%	0.214	0.115	ND	0.097	0.0000	1	0.974	0.123	0.69	0.18	0.14	0.88
Aroclor 1268	0.080	0.020	0.002	2.3	0.183	100%	0.214	0.039	ND	0.097	0.0000	1	0.974	0.042	0.69	0.06	0.14	0.30
Total PCB Congeners[2]	1.0	0.020	0.021	4.2	4.368	100%	0.214	0.935	ND	0.097	0.0000	1	0.974	0.981	0.69	**1.4**	0.14	**7.0**
Total 2,3,7,8-TCDD TEQs[3]	0.0000075	0.020	0.00000015	0.2	0.0000015	100%	0.214	0.0000003	ND	0.097	0.0000	1	0.974	0.00000048	0.00000224	0.22	0.00000008	**6.0**

Notes:
1 - biota-sediment accumulation factors are presented in Table 5-2
2 - Total sum of PCB congeners excludes those with dioxin-like effects which are evaluated along with dioxins/furans
3 - Includes the total sum of dioxin/furan and dioxin-like PCB congeners toxic equivalents
NOAEL - no observed adverse effect level
LOAEL - lowest observed adverse effect level
NA - Input variable not located
NC - Not calculated
ND - Not detected
kg - kilogram
kg/day - kilogram per day
mg/kg w.w. - milligram per kilogram wet weight
mg/kg/day - milligram per kilogram per day
mg/L - milligrams per liter
L/day - liters per day
Bold - indicates hazard quotient greater than threshold of one
wet weight concentrations converted as follow: ww = Cs x (1 - % moisture)
where:
ww - wet weight concentration
Cs - dry weight concentration in soil
% moisture - percent moisture
For example, dry weight concentration and % moisture for arsenic were 42 mg/kg and 59.7%, respectively.
ww = 42 x (1 - .597)
ww = 17 mg/kg

Table D-4
Food Chain Exporsure Model for the Muskrat
Matteo & Sons, Inc Site
Thorofare, New Jersey

Chemcial	Sediment			Plants			Food		Water			Site Foraging Factor	Body Weight	Dose	LOAEL		NOAEL	
	Concentration mg/kg w.w.	Ingestion Rate kg/day	Total Ingested Chemical mg/day	Biota-Sediment Accumulation Factor[1]	Concentration mg/kg w.w.	Percent of Diet	Ingestion Rate kg/day	Total Ingested Chemical mg/day	Concentration mg/L	Ingestion Rate L/day	Total Ingested Chemical mg/day		kg	mg/kg/day	Value mg/kg/day	Hazard Quotient	Value mg/kg/day	Hazard Quotient
Arsenic	17	0.0431	0.730	0.036	0.609	100%	0.459	0.280	0.0466	0.130	0.0061	1	1.35	0.752	0.524	**1.4**	0.052	**14**
Cadmium	3.2	0.0431	0.138	0.364	1.2	100%	0.459	0.533	0.0127	0.130	0.0017	1	1.35	0.498	7.419	0.07	0.742	0.67
Copper	61	0.0431	2.6	0.4	24.3	100%	0.459	11.2	0.15	0.130	0.0195	1	1.35	10.2	15.4	0.66	11.7	0.87
Lead	2476	0.0431	106.7	0.045	111.4	100%	0.459	51.1	0.654	0.130	0.0850	1	1.35	117.0	61.53	**1.9**	6.15	**19**
Nickel	23	0.0431	1.0	0.032	0.744	100%	0.459	0.342	0.229	0.130	0.0298	1	1.35	1.0	61.53	0.02	30.77	0.03
Selenium	3.0	0.0431	0.130	0.016	0.048	100%	0.459	0.022	0.0032	0.130	0.0004	1	1.35	0.113	0.254	0.44	0.154	0.73
Silver	1.7	0.0431	0.074	0.4	0.683	100%	0.459	0.313	0.001	0.130	0.0001	1	1.35	0.287	6.02	0.05	0.6	0.48
Zinc	347	0.0431	14.9	0.0000000000012	0.0000000004	100%	0.459	0.0000000002	2.21	0.130	0.2873	1	1.35	11.3	246.1	0.05	123.1	0.09
Aroclor 1248	0.119	0.0431	0.005	0.01	0.001	100%	0.459	0.001	ND	0.130	0	1	1.35	0.004	0.15	0.03	0.015	0.28
Aroclor 1254	0.235	0.0431	0.010	0.01	0.002	100%	0.459	0.001	ND	0.130	0	1	1.35	0.008	0.69	0.01	0.14	0.06
Aroclor 1268	0.080	0.0431	0.003	0.01	0.001	100%	0.459	0.000	ND	0.130	0	1	1.35	0.003	0.69	0.004	0.14	0.02

Notes:
1 - biota-sediment accumulation factors are presented in Table 5-2
NOAEL - no observed adverse effect level
LOAEL - lowest observed adverse effect level
NA - Input variable not located
NC - Not calculated
ND - Not detected
kg - kilogram
kg/day - kilogram per day
mg/kg w.w. - milligram per kilogram wet weight
mg/kg/day - milligram per kilogram per day
mg/L - milligrams per liter
L/day - liters per day
Bold - indicates hazard quotient greater than threshold of one
wet weight concentrations converted as follow: ww = Cs x (1 - % moisture)
where:
ww - wet weight concentration
Cs - dry weight concentration in soil
% moisture - percent moisture
For example, dry weight concentration and % moisture for arsenic were 42 mg/kg and 59.7%, respectively.
ww = 42 x (1 - .597)
ww = 17 mg/kg

Table D-5
Food Chain Exposure Model for the Wood Duck
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Sediment			Mollusks			Plants			Food		Water			Site Foraging Factor	Body Weight	Dose	LOAEL		NOAEL	
	Concentration	Ingestion Rate	Total Ingested Chemical	Biota-Sediment Accumulation Factor[1]	Concentration	Percent of Diet	Bioaccumulation Factor	Concentration	Percent of Diet	Ingestion Rate	Total Ingested Chemical	Concentration	Ingestion Rate	Total Ingested Chemical				Value	Hazard Quotient	Value	Hazard Quotient
	mg/kg w.w.	kg/day	mg/day		mg/kg w.w.			mg/kg w.w.		kg/day	mg/day	mg/L	L/day	mg/day		kg	mg/kg/day	mg/kg/day		mg/kg/day	
Arsenic	17	0.004	0.0677	0.029	0.491	50%	0.036	0.609	50%	0.035	0.0193	0.0466	0.035	0.0016	1	0.454	0.195	12.8	0.02	5.1	0.04
Cadmium	3.2	0.004	0.0128	1.4	4.5	50%	0.364	1.2	50%	0.035	0.0985	0.0127	0.035	0.0004	1	0.454	0.246	20	0.01	1.45	0.17
Copper	61	0.004	0.2433	0.38	23.1	50%	0.4	24.3	50%	0.035	0.8303	0.15	0.035	0.0053	1	0.454	2.4	61.7	0.04	47	0.05
Lead	2476	0.004	9.9022	0.0046	11.4	50%	0.045	111.4	50%	0.035	2.1	0.654	0.035	0.0229	1	0.454	26.6	11.3	**2.4**	1.13	**24**
Nickel	23	0.004	0.0930	0.9	20.9	50%	0.032	0.744	50%	0.035	0.3794	0.229	0.035	0.0080	1	0.454	1.1	107	0.01	77.4	0.01
Selenium	3.0	0.004	0.0120	0.9	2.7	50%	0.016	0.048	50%	0.035	0.0482	0.0032	0.035	0.0001	1	0.454	0.133	1.0	0.13	0.5	0.27
Silver	1.7	0.004	0.0068	0.9	1.5	50%	0.4	0.683	50%	0.035	0.0388	0.001	0.035	0.0000	1	0.454	0.101	60.5	0.002	20.2	0.005
Zinc	347	0.004	1.3860	1.1	381.2	50%	0.0000000000012	0.000	50%	0.035	6.7	2.21	0.035	0.0774	1	0.454	17.9	131	0.14	14.5	**1.2**
Aroclor 1248	0.119	0.004	0.0005	4.7	0.559	50%	0.01	0.001	50%	0.035	0.0098	ND	0.035	0	1	0.454	0.023	1.8	0.01	0.18	0.13
Aroclor 1254	0.235	0.004	0.0009	4.7	1.1	50%	0.01	0.002	50%	0.035	0.0193	ND	0.035	0	1	0.454	0.045	1.8	0.02	0.18	0.25
Aroclor 1268	0.080	0.004	0.0003	4.7	0.374	50%	0.01	0.001	50%	0.035	0.0066	ND	0.035	0	1	0.454	0.015	1.8	0.01	0.18	0.08

Notes:
1 - biota-sediment accumulation factors are presented in Table 5-2
NOAEL - no observed adverse effect level
LOAEL - lowest observed adverse effect level
NA - Input variable not located
NC - Not calculated
ND - Not detected
kg - kilogram
kg/day - kilogram per day
mg/kg w.w. - milligram per kilogram wet weight
mg/kg/day - milligram per kilogram per day
mg/L - milligrams per liter
L/day - liters per day
Bold - indicates hazard quotient greater than threshold of one
wet weight concentrations converted as follow: ww = Cs x (1 - % moisture)
where:
ww - wet weight concentration
Cs - dry weight concentration in soil
% moisture - percent moisture
For example, dry weight concentration and % moisture for arsenic were 42 mg/kg and 59.7%, respectively.
ww = 42 x (1 - .597)
ww = 17 mg/kg

Table D-6
Food Chain Exposure Model for the Raccoon
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Sediment			Mollusks			Plants			Food		Water			Site Foraging Factor	Body Weight	Dose	LOAEL		NOAEL	
	Concentration mg/kg w.w.	Ingestion Rate kg/day	Total Ingested Chemical mg/day	Biota-Sediment Accumulation Factor[1]	Concentration mg/kg w.w.	Percent of Diet	Bioaccumulation Factor	Concentration mg/kg w.w.	Percent of Diet	Ingestion Rate kg/day	Total Ingested Chemical mg/day	Concentration mg/L	Ingestion Rate L/day	Total Ingested Chemical mg/day		kg	mg/kg/day	Value mg/kg/day	Hazard Quotient	Value mg/kg/day	Hazard Quotient
Arsenic	17	0.0158	0.267	0.029	0.491	50%	0.036	0.609	50%	0.168	0.092	0.0466	0.429	0.020	1	5.1	0.074	0.524	0.14	0.052	**1.4**
Cadmium	3.2	0.0158	0.050	1.4	4.5	50%	0.364	1.2	50%	0.168	0.4728	0.0127	0.429	0.005	1	5.1	0.104	7.419	0.01	0.742	0.14
Copper	61	0.0158	1.0	0.38	23.1	50%	0.4	24.3	50%	0.168	4.0	0.15	0.429	0.064	1	5.1	1.0	15.4	0.06	11.7	0.08
Lead	2476	0.0158	39.1	0.0046	11.4	50%	0.045	111.4	50%	0.168	10.3	0.654	0.429	0.281	1	5.1	9.7	61.53	0.16	6.15	**1.6**
Nickel	23	0.0158	0.368	0.9	20.9	50%	0.032	0.744	50%	0.168	1.8	0.229	0.429	0.098	1	5.1	0.4	61.53	0.01	30.77	0.01
Selenium	3.0	0.0158	0.047	0.9	2.7	50%	0.016	0.048	50%	0.168	0.231	0.0032	0.429	0.001	1	5.1	0.055	0.254	0.22	0.154	0.36
Silver	1.7	0.0158	0.027	0.9	1.5	50%	0.4	0.683	50%	0.168	0.186	0.001	0.429	0.0004	1	5.1	0.042	6.02	0.01	0.6	0.07
Zinc	347	0.0158	5.5	1.1	381.2	50%	1.2E-12	0.000	50%	0.168	32.0	2.21	0.429	0.948	1	5.1	7.5	246.1	0.03	123.1	0.06
Aroclor 1248	0.119	0.0158	0.002	4.7	0.559	50%	0.01	0.001	50%	0.168	0.047	ND	0.429	0	1	5.1	0.010	0.15	0.06	0.015	0.6
Aroclor 1254	0.235	0.0158	0.004	4.7	1.1	50%	0.01	0.002	50%	0.168	0.093	ND	0.429	0	1	5.1	0.019	0.69	0.03	0.14	0.14
Aroclor 1268	0.080	0.0158	0.001	4.7	0.374	50%	0.01	0.001	50%	0.168	0.031	ND	0.429	0	1	5.1	0.006	0.69	0.01	0.14	0.05

Notes:
1 - biota-sediment accumulation factors are presented in Table 5-2
NOAEL - no observed adverse effect level
LOAEL - lowest observed adverse effect level
NA - Input variable not located
NC - Not calculated
ND - Not detected
kg - kilogram
kg/day - kilogram per day
mg/kg w.w. - milligram per kilogram wet weight
mg/kg/day - milligram per kilogram per day
mg/L - milligrams per liter
L/day - liters per day
Bold - indicates hazard quotient greater than threshold of one
wet weight concentrations converted as follow: ww = Cs x (1 - % moisture)
where:
ww - wet weight concentration
Cs - dry weight concentration in soil
% moisture - percent moisture
For example, dry weight concentration and % moisture for arsenic were 42 mg/kg and 59.7%, respectively.
ww = 42 x (1 - .597)
ww = 17 mg/kg

Table D-7
Food Chain Exposure Model for the Short-tailed Shrew
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Soil			Invertebrates			Food		Water			Site Foraging Factor	Body Weight	Dose	LOAEL		NOAEL	
	Concentration	Ingestion Rate	Total Ingested Chemical	Bioaccumulation Factor[1]	Concentration	Percent of Diet	Ingestion Rate	Total Ingested Chemical	Concentration	Ingestion Rate	Total Ingested Chemical				Value	Hazard Quotient	Value	Hazard Quotient
	mg/kg w.w.	kg/day	mg/day		mg/kg w.w.		kg/day	mg/day	mg/L	L/day	mg/day		kg	mg/kg/day	mg/kg/day		mg/kg/day	
Arsenic	6.6	0.0004	0.0026	0.11	0.722	100%	0.00775	0.0056	0.0466	0.003	0.0001	1	0.0125	0.669	1.498	0.45	0.15	**5**
Cadmium	7.8	0.0004	0.0031	0.96	7.5	100%	0.00775	0.0580	0.0127	0.003	0.0000	1	0.0125	4.9	21.2	0.23	2.12	**2.3**
Copper	240	0.0004	0.0959	0.04	9.6	100%	0.00775	0.0743	0.15	0.003	0.0005	1	0.0125	13.7	44	0.31	33.4	0.41
Lead	8858	0.0004	3.5	0.03	265.7	100%	0.00775	2.1	0.654	0.003	0.0020	1	0.0125	448.4	175.83	**2.5**	17.58	**26**
Nickel	56	0.0004	0.0226	0.02	1.1	100%	0.00775	0.0088	0.229	0.003	0.0007	1	0.0125	2.6	175.83	0.01	87.91	0.03
Silver	0.75	0.0004	0.0003	0.22	0.1644	100%	0.00775	0.0013	0.001	0.003	0.0000	1	0.0125	0.126	6.02	0.02	0.6	0.21
Zinc	11001	0.0004	4.4	0.56	6160.8	100%	0.00775	47.7	2.21	0.003	0.0066	1	0.0125	4172.3	703.3	**5.9**	351.7	**12**
Acenaphthene	0.052	0.0004	0.00002	1.47	0.077	100%	0.00775	0.0006	ND	0.003	0	1	0.0125	0.049	656	0.0001	65.6	0.001
Acenaphthylene	0.141	0.0004	0.00006	22.90	3.224	100%	0.00775	0.0250	ND	0.003	0	1	0.0125	2.004	656	0.003	65.6	0.03
Anthracene	0.129	0.0004	0.0001	2.42	0.312	100%	0.00775	0.0024	ND	0.003	0	1	0.0125	0.198	656	0.0003	65.6	0.003
Benzo(a)anthracene	1.144	0.0004	0.0005	1.59	1.819	100%	0.00775	0.0141	0.00018	0.003	0.000001	1	0.0125	1.164	6.15	0.19	0.615	**1.9**
Benzo(a)pyrene	0.387	0.0004	0.0002	1.33	0.515	100%	0.00775	0.0040	0.00032	0.003	0.000001	1	0.0125	0.332	11.89	0.03	1.19	0.3
Benzo(b)fluoranthene	0.880	0.0004	0.0004	2.6	2.288	100%	0.00775	0.0177	0.00038	0.003	0.000001	1	0.0125	1.447	6.15	0.24	0.615	**2.4**
Benzo(g,h,i)perylene	0.326	0.0004	0.0001	2.94	0.957	100%	0.00775	0.0074	ND	0.003	0	1	0.0125	0.604	6.15	0.10	0.615	0.98
Benzo(k)fluoranthene	0.616	0.0004	0.0002	2.60	1.602	100%	0.00775	0.0124	0.00015	0.003	0.0000005	1	0.0125	1.013	6.15	0.16	0.615	**1.6**
Chrysene	0.862	0.0004	0.0003	2.29	1.975	100%	0.00775	0.0153	0.00032	0.003	0.000001	1	0.0125	1.252	6.15	0.20	0.615	**2**
Dibenzo(a,h)anthracene	0.052	0.0004	0.0000	2.31	0.120	100%	0.00775	0.0009	ND	0.003	0	1	0.0125	0.076	6.15	0.01	0.615	0.1
Fluoranthene	0.176	0.0004	0.0001	3.04	0.5	100%	0.00775	0.0042	ND	0.003	0	1	0.0125	0.338	6.15	0.05	0.615	0.5
Fluorene	0.185	0.0004	0.0001	9.57	1.8	100%	0.00775	0.0137	ND	0.003	0	1	0.0125	1.102	656	0.002	65.6	0.02
Indeno(1,2,3-cd)pyrene	0.299	0.0004	0.0001	2.86	0.856	100%	0.00775	0.0066	0.00015	0.003	0.0000005	1	0.0125	0.540	6.15	0.09	0.615	0.88
Phenanthrene	0.880	0.0004	0.0004	1.72	1.5	100%	0.00775	0.0117	ND	0.003	0	1	0.0125	0.967	656	0.001	65.6	0.01
Pyrene	0.475	0.0004	0.0002	1.75	0.832	100%	0.00775	0.0064	ND	0.003	0	1	0.0125	0.531	6.15	0.09	0.615	0.86
4,4'-DDE	0.035	0.0004	0.00001	1.26	0.044	100%	0.00775	0.0003	ND	0.003	0	1	0.0125	0.029	8.79	0.003	1.76	0.02
4,4'-DDT	0.210	0.0004	0.0001	1.26	0.265	100%	0.00775	0.0021	ND	0.003	0	1	0.0125	0.171	8.79	0.019	1.76	0.1
beta-BHC	0.003	0.0004	0.000001	6.34	0.016	100%	0.00775	0.0001	ND	0.003	0	1	0.0125	0.010	4.4	0.002	1.95	0.005
delta-BHC	0.060	0.0004	0.00002	6.34	0.383	100%	0.00775	0.0030	ND	0.003	0	1	0.0125	0.240	7.03	0.034	3.52	0.068
gamma-chlordane	0.048	0.0004	0.00002	7,925.7	376.63	100%	0.00775	2.9189	0.000027	0.003	0.00000008	1	0.0125	233.5	10.9	**21**	5.5	**42**
Dieldrin	0.027	0.0004	0.00001	14.7	0.40	100%	0.00775	0.0031	ND	0.003	0	1	0.0125	0.2	0.44	0.6	0.044	**6**
Endrin	0.010	0.0004	0.000004	1,296.6	13.07	100%	0.00775	0.1013	ND	0.003	0	1	0.0125	8.1	1.094	**7.4**	0.109	**74**
Heptachlor	0.005	0.0004	0.000002	1.4	0.01	100%	0.00775	0.0001	ND	0.003	0	1	0.0125	0.004	2.875	0.001	0.2875	0.01
Heptachlor Epoxide	0.101	0.0004	0.00004	1.0	0.1	100%	0.00775	0.0008	ND	0.003	0	1	0.0125	0.1	1	0.1	0.1	0.7
Aroclor 1248	2.856	0.0004	0.0011	1.1	3.23	100%	0.00775	0.0250	ND	0.003	0	1	0.0125	2.1	0.43	**5**	0.043	**49**
Aroclor 1254	0.8	0.0004	0.0003	1.13	0.9	100%	0.00775	0.0071	ND	0.003	0	1	0.0125	0.6	0.668	0.9	0.067	**9**
Aroclor 1260	2.52	0.0004	0.001	1.13	2.848	100%	0.00775	0.0221	ND	0.003	0	1	0.0125	1.846	0.668	**3**	0.067	**28**
Total 2,3,7,8-TCDD TEQs	0.0000324	0.0004	0.00000001	1.59	0.0001	100%	0.00775	0.0000	ND	0.003	0	1	0.0125	0.00003	0.000022	**1.5**	0.0000022	**15**

Notes:
1 - bioaccumulation factors are presented in Table 5-2
NOAEL - no observed adverse effect level
LOAEL - lowest observed adverse effect level
NA - Input variable not located
NC - Not calculated
ND - Not detected
kg - kilogram
kg/day - kilogram per day
mg/kg w.w. - milligram per kilogram wet weight
mg/kg/day - milligram per kilogram per day
mg/L - milligrams per liter
L/day - liters per day
Bold - indicates hazard quotient greater than threshold of one
wet weight concentrations converted as follow: ww = Cs x (1 - % moisture)
where:
ww - wet weight concentration
Cs - dry weight concentration in soil
% moisture - percent moisture
For example, dry weight concentration and % moisture for arsenic were 8 mg/kg and 17.9%, respectively.
ww = 8 x (1 - .179)
ww = 6.6 mg/kg

Table D-8
Food Chain Exposure Model for the American Robin
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Soil			Invertebrates			Food		Water			Site Foraging Factor	Body Weight	Dose	LOAEL		NOAEL	
	Concentration mg/kg w.w.	Ingestion Rate kg/day	Total Ingested Chemical mg/day	Bioaccumulation Factor[1]	Concentration mg/kg w.w.	Percent of Diet	Ingestion Rate kg/day	Total Ingested Chemical mg/day	Concentration mg/L	Ingestion Rate L/day	Total Ingested Chemical mg/day		kg	mg/kg/day	Value mg/kg/day	Hazard Quotient	Value mg/kg/day	Hazard Quotient
Arsenic	6.6	0.013	0.0858	0.11	0.726	100%	0.124	0.090	0.0466	0.0093	0.0004	1	0.0635	2.8	12.8	0.22	5.1	0.54
Cadmium	7.8	0.013	0.1014	0.96	7.5	100%	0.124	0.928	0.0127	0.0093	0.0001	1	0.0635	16.2	20	0.81	1.45	**11**
Copper	240	0.013	3.1	0.04	9.6	100%	0.124	1.2	0.15	0.0093	0.0014	1	0.0635	67.8	61.7	**1.1**	47	**1.4**
Lead	8858	0.013	115.2	0.03	265.7	100%	0.124	33.0	0.654	0.0093	0.0061	1	0.0635	2332.4	11.3	**206**	1.13	**2,064**
Nickel	56	0.013	0.7342	0.02	1.1	100%	0.124	0.140	0.229	0.0093	0.0021	1	0.0635	13.8	107	0.13	77.4	0.18
Silver	0.75	0.013	0.0097	0.22	0.164	100%	0.124	0.020	0.001	0.0093	0.0000	1	0.0635	0.474	60.5	0.01	20.2	0.02
Zinc	11001	0.013	143.0	0.56	6160.8	100%	0.124	763.9	2.21	0.0093	0.0206	1	0.0635	14283.1	131	**109**	14.5	**985**
Acenaphthene	0.052	0.013	0.0007	1.47	0.077	100%	0.124	0.009	ND	0.0093	0	1	0.0635	0.160	4550	0.00004	445	0.0004
Acenaphthylene	0.141	0.013	0.0018	22.90	3.224	100%	0.124	0.4	ND	0.0093	0	1	0.0635	6.325	4550	0.001	445	0.01
Anthracene	0.129	0.013	0.0017	2.42	0.312	100%	0.124	0.039	ND	0.0093	0	1	0.0635	0.636	4550	0.0001	445	0.001
Benzo(a)anthracene	1.144	0.013	0.0149	1.59	1.819	100%	0.124	0.226	0.00018	0.0093	0.0000017	1	0.0635	3.786	20	0.2	2	**2**
Benzo(a)pyrene	0.387	0.013	0.0050	1.33	0.515	100%	0.124	0.064	0.00032	0.0093	0.000003	1	0.0635	1.085	20	0.05	2	0.5
Benzo(b)fluoranthene	0.880	0.013	0.0114	2.6	2.288	100%	0.124	0.284	0.00038	0.0093	0.0000035	1	0.0635	4.6	20	0.2	2	**2**
Benzo(g,h,i)perylene	0.326	0.013	0.0042	2.94	0.957	100%	0.124	0.119	ND	0.0093	0	1	0.0635	1.936	20	0.1	2	0.97
Benzo(k)fluoranthene	0.616	0.013	0.0080	2.60	1.602	100%	0.124	0.199	0.00015	0.0093	0.0000014	1	0.0635	3.254	20	0.2	2	**1.6**
Chrysene	0.862	0.013	0.0112	2.29	1.975	100%	0.124	0.245	0.00032	0.0093	0.000003	1	0.0635	4	20	0.2	2	**2**
Dibenzo(a,h)anthracene	0.052	0.013	0.0007	2.31	0.120	100%	0.124	0.015	ND	0.0093	0	1	0.0635	0.245	20	0.01	2	0.1
Fluoranthene	0.176	0.013	0.0023	3.04	0.5	100%	0.124	0.066	ND	0.0093	0	1	0.0635	1.1	20	0.05	2	0.5
Fluorene	0.185	0.013	0.0024	9.57	1.8	100%	0.124	0.219	ND	0.0093	0	1	0.0635	3.5	4550	0.001	445	0.01
Indeno(1,2,3-cd)pyrene	0.299	0.013	0.0039	2.86	0.856	100%	0.124	0.106	0.00015	0.0093	0.0000014	1	0.0635	1.732	20	0.09	2	0.9
Phenanthrene	0.880	0.013	0.0114	1.72	1.5	100%	0.124	0.188	ND	0.0093	0	1	0.0635	3.1	4550	0.0007	445	0.01
Pyrene	0.475	0.013	0.0062	1.75	0.832	100%	0.124	0.103	ND	0.0093	0	1	0.0635	1.7	20	0.09	2	0.9
4,4'-DDE	0.035	0.013	0.0005	1.26	0.044	100%	0.124	0.01	ND	0.0093	0	1	0.0635	0.094	0.028	**3**	0.003	**31**
4,4'-DDT	0.210	0.013	0.0027	1.26	0.265	100%	0.124	0.03	ND	0.0093	0	1	0.0635	0.560	0.028	**20**	0.003	**187**
beta-BHC	0.003	0.013	0.00003	6.34	0.016	100%	0.124	0.002	ND	0.0093	0	1	0.0635	0.032	2.25	0.01	0.56	0.1
delta-BHC	0.060	0.013	0.0008	6.34	0.4	100%	0.124	0.05	ND	0.0093	0	1	0.0635	0.761	2.25	0.3	0.56	**1.4**
gamma-chlordane	0.048	0.013	0.0006	7,925.7	377	100%	0.124	46.70	0.000027	0.0093	0.0000003	1	0.0635	735.5	10.7	**69**	2.1	**350**
Dieldrin	0.027	0.013	0.0003	14.7	0.4	100%	0.124	0.05	ND	0.0093	0	1	0.0635	0.777	0.77	**1.0**	0.077	**10**
Endrin	0.010	0.013	0.0001	1,296.6	13.1	100%	0.124	1.62	ND	0.0093	0	1	0.0635	25.5	0.1	**255**	0.01	**2,552**
Heptachlor	0.005	0.013	0.0001	1.4	0.01	100%	0.124	0.001	ND	0.0093	0	1	0.0635	0.014	650	0.00002	65	0.0002
Heptachlor Epoxide	0.101	0.013	0.0013	1.0	0.1	100%	0.124	0.01	ND	0.0093	0	1	0.0635	0.217	650	0.0003	65	0.003
Aroclor 1248	2.856	0.013	0.0371	1.1	3.2	100%	0.124	0.4	ND	0.0093	0	1	0.0635	6.887	1.8	**4**	0.18	**38**
Aroclor 1254	0.8	0.013	0.0106	1.13	0.9	100%	0.124	0.114	ND	0.0093	0	1	0.0635	2	1.8	**1.1**	0.18	**11**
Aroclor 1260	2.52	0.013	0.0328	1.13	2.848	100%	0.124	0.353	ND	0.0093	0	1	0.0635	6.077	1.8	**3.4**	0.18	**34**
Total 2,3,7,8-TCDD TEQs	0.0000311	0.013	0.0000004	1.59	0.00005	100%	0.124	0.00001	ND	0.0093	0	1	0.0635	0.0001	0.00014	0.7	0.000014	**7**

Notes:
1 - bioaccumulation factors are presented in Table 5-2
NOAEL - no observed adverse effect level
LOAEL - lowest observed adverse effect level
NA - Input variable not located
NC - Not calculated
ND - Not detected
kg - kilogram
kg/day - kilogram per day
mg/kg w.w. - milligram per kilogram wet weight
mg/kg/day - milligram per kilogram per day
mg/L - milligrams per liter
L/day - liters per day
Bold - indicates hazard quotient greater than threshold of one
wet weight concentrations converted as follow: ww = Cs x (1 - % moisture)
where:
ww - wet weight concentration
Cs - dry weight concentration in soil
% moisture - percent moisture
For example, dry weight concentration and % moisture for arsenic were 8 mg/kg and 17.9%, respectively.
ww = 8 x (1 - .179)
ww = 6.6 mg/kg

Table D-9
Food Chain Exposure Model for the Red-tailed Hawk
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Soil			Small Mammals			Food		Water			Site Foraging Factor	Body Weight	Dose	LOAEL		NOAEL	
	Concentration	Ingestion Rate	Total Ingested Chemical	Bioaccumulation Factor[1]	Concentration[2]	Percent of Diet	Ingestion Rate	Total Ingested Chemical	Concentration	Ingestion Rate	Total Ingested Chemical				Value	Hazard Quotient	Value	Hazard Quotient
	mg/kg w.w.	kg/day	mg/day		mg/kg w.w.		kg/day	mg/day	mg/L	L/day	mg/day		kg	mg/kg/day	mg/kg/day		mg/kg/day	
Arsenic	6.6	0.0011	0.0074	NA	0.05	100%	0.113	0.0056	0.0466	0.060	0.0028	1	1.028	0.015	12.8	0.001	5.1	0.003
Cadmium	7.8	0.0011	0.0088	NA	0.82	100%	0.113	0.0931	0.0127	0.060	0.0008	1	1.028	0.100	20	0.005	1.45	0.07
Copper	240	0.0011	0.2709	NA	17	100%	0.113	1.9766	0.15	0.060	0.0090	1	1.028	2.2	61.7	0.04	47	0.05
Lead	8858	0.0011	10.0	NA	64	100%	0.113	7.2320	0.654	0.060	0.0392	1	1.028	16.8	11.3	**1.5**	1.13	**15**
Nickel	56	0.0011	0.0638	NA	5.4	100%	0.113	0.6148	0.229	0.060	0.0137	1	1.028	0.674	107	0.01	77.4	0.01
Silver	0.75	0.0011	0.0008	NA	0.004	100%	0.113	0.0004	0.001	0.060	0.0001	1	1.028	0.001	60.5	0.00002	20.2	0.0001
Zinc	11001	0.0011	12.4	NA	154	100%	0.113	17.3526	2.21	0.060	0.1326	1	1.028	29.1	131	0.22	14.5	**2.0**
Acenaphthene	0.052	0.0011	0.0001	0	0	100%	0.113	0	ND	0.06	0	1	1.028	0.0001	4550	0.00000001	445	0.0000001
Acenaphthylene	0.141	0.0011	0.0002	0	0	100%	0.113	0	ND	0.06	0	1	1.028	0.0002	4550	0.00000003	445	0.0000003
Anthracene	0.129	0.0011	0.0001	0	0	100%	0.113	0	ND	0.06	0	1	1.028	0.0001	4550	0.00000003	445	0.0000003
Benzo(a)anthracene	1.144	0.0011	0.0013	0	0	100%	0.113	0	0.00018	0.06	0.00001	1	1.028	0.0013	20	0.00006	2	0.0006
Benzo(a)pyrene	0.387	0.0011	0.0004	0	0	100%	0.113	0	0.00032	0.06	0.00002	1	1.028	0.0004	20	0.00002	2	0.0002
Benzo(b)fluoranthene	0.88	0.0011	0.0010	0	0	100%	0.113	0	0.00038	0.06	0.00002	1	1.028	0.0010	20	0.00005	2	0.0005
Benzo(g,h,i)perylene	0.326	0.0011	0.0004	0	0	100%	0.113	0	ND	0.06	0	1	1.028	0.0004	20	0.00002	2	0.0002
Benzo(k)fluoranthene	0.616	0.0011	0.0007	0	0	100%	0.113	0	0.00015	0.06	0.00001	1	1.028	0.0007	20	0.00003	2	0.0003
Chrysene	0.862	0.0011	0.0010	0	0	100%	0.113	0	0.00032	0.06	0.00002	1	1.028	0.0010	20	0.00005	2	0.0005
Dibenzo(a,h)anthracene	0.052	0.0011	0.0001	0	0	100%	0.113	0	ND	0.06	0	1	1.028	0.0001	20	0.000003	2	0.00003
Fluoranthene	0.176	0.0011	0.0002	0	0	100%	0.113	0	ND	0.06	0	1	1.028	0.0002	20	0.00001	2	0.0001
Fluorene	0.185	0.0011	0.0002	0	0	100%	0.113	0	ND	0.06	0	1	1.028	0.0002	4550	0.00000004	445	0.0000005
Indeno(1,2,3-cd)pyrene	0.299	0.0011	0.0003	0	0	100%	0.113	0	0.00015	0.06	0.00001	1	1.028	0.0003	20	0.00002	2	0.0002
Phenanthrene	0.88	0.0011	0.0010	0	0	100%	0.113	0	ND	0.06	0	1	1.028	0.0010	4550	0.0000002	445	0.000002
Pyrene	0.475	0.0011	0.0005	0	0	100%	0.113	0	ND	0.06	0	1	1.028	0.0005	20	0.00003	2	0.0003
4,4'-DDE	0.035	0.0011	0.00004	4.9	0.1729	100%	0.113	0.0195	ND	0.06	0	1	1.028	0.0190	0.028	0.68	0.003	**6**
4,4'-DDT	0.21	0.0011	0.0002	4.9	1.0290	100%	0.113	0.1163	ND	0.06	0	1	1.028	0.1133	0.028	**4**	0.003	**38**
beta-BHC	0.003	0.0011	0.000003	1	0.0026	100%	0.113	0.0003	ND	0.06	0	1	1.028	0.0003	2.25	0.0001	0.56	0.0005
delta-BHC	0.06	0.0011	0.0001	1	0.0605	100%	0.113	0.0068	ND	0.06	0	1	1.028	0.0067	2.25	0.003	0.56	0.01
gamma-chlordane	0.048	0.0011	0.0001	1.0	0.0475	100%	0.113	0.0054	0.000027	0.06	0.000002	1	1.028	0.0053	10.7	0.0005	2.1	0.003
Dieldrin	0.027	0.0011	0.00003	14.4	0.3871	100%	0.113	0.0437	ND	0.06	0	1	1.028	0.0426	0.77	0.06	0.077	0.6
Endrin	0.01	0.0011	0.00001	1.0	0.0101	100%	0.113	0.0011	ND	0.06	0	1	1.028	0.0011	0.1	0.01	0.01	0.1
Heptachlor	0.005	0.0011	0.00001	1.0	0.0047	100%	0.113	0.0005	ND	0.06	0	1	1.028	0.0005	650	0.000001	65	0.00001
Heptachlor Epoxide	0.101	0.0011	0.00011	1.0	0.1008	100%	0.113	0.0114	ND	0.06	0	1	1.028	0.0112	650	0.00002	65	0.0002
Aroclor 1248	2.856	0.0011	0.00323	1.0	2.8560	100%	0.113	0.3227	ND	0.06	0	1	1.028	0.3171	1.8	0.2	0.18	**2**
Aroclor 1254	0.8	0.0011	0.0009	1.0	0.8	100%	0.113	0.0922	ND	0.06	0	1	1.028	0.0906	1.8	0.05	0.18	0.5
Aroclor 1260	2.52	0.0011	0.0028	1.0	2.5200	100%	0.113	0.2848	ND	0.06	0	1	1.028	0.2798	1.8	0.2	0.18	**2**
Total 2,3,7,8-TCDD TEQs	0.0000311	0.0011	0.00000004	1.0	0.00003	100%	0.113	0.00000	ND	0.06	0	1	1.028	0.00000	0.00014	0.02	0.000014	0.2

Notes:
1 - bioaccumulation factors are presented in Table 5-2
2 - No bioaccumulation factors for soil to small mammals available for arsenic, cadmium, copper, lead, nickel, silver, and zinc; concentrations in small mammals estimated using regression equation per Table 4a in Attachment 4-1, Guidance for Developing Ecological Soil Screening Levels (EPA
NOAEL - no observed adverse effect level
LOAEL - lowest observed adverse effect level
NA - Input variable not located
NC - Not calculated
ND - Not detected
kg - kilogram
kg/day - kilogram per day
mg/kg w.w. - milligram per kilogram wet weight
mg/kg/day - milligram per kilogram per day
mg/L - milligrams per liter
L/day - liters per day
Bold - indicates hazard quotient greater than threshold of one
wet weight concentrations converted as follow: ww = Cs x (1 - % moisture)
where:
ww - wet weight concentration
Cs - dry weight concentration in soil
% moisture - percent moisture
For example, dry weight concentration and % moisture for arsenic were 8 mg/kg and 17.9%, respectively.
ww = 8 x (1 - .179)
ww = 6.6 mg/kg

CDM Smith

Table D-10
Food Chain Exposure Model for the Red Fox
Matteo & Sons, Inc. Site
Thorofare, New Jersey

Chemical	Soil			Small Mammals			Food		Water			Site Foraging Factor	Body Weight	Dose	LOAEL		NOAEL	
	Concentration	Ingestion Rate	Total Ingested Chemical	Bioaccumulation Factor[1]	Concentration[2]	Percent of Diet	Ingestion Rate	Total Ingested Chemical	Concentration	Ingestion Rate	Total Ingested Chemical				Value	Hazard Quotient	Value	Hazard Quotient
	mg/kg w.w.	kg/day	mg/day		mg/kg w.w.		kg/day	mg/day	mg/L	L/day	mg/day		kg	mg/kg/day	mg/kg/day		mg/kg/day	
Arsenic	6.6	0.013	0.0854	NA	0.05	100%	0.458	0.022	0.0466	0.288	0.0134	1	3.27	0.037	0.36	0.10	0.036	**1.0**
Cadmium	7.8	0.013	0.1014	NA	0.82	100%	0.458	0.377	0.0127	0.288	0.0037	1	3.27	0.148	5.094	0.03	0.509	0.29
Copper	240	0.013	3.1	NA	17	100%	0.458	8.0	0.15	0.288	0.0432	1	3.27	3.4	10.6	0.32	8.0	0.43
Lead	8858	0.013	115.2	NA	64	100%	0.458	29.3	0.654	0.288	0.1884	1	3.27	44.2	42.25	**1.0**	4.22	**10**
Nickel	56	0.013	0.7342	NA	5.4	100%	0.458	2.5	0.229	0.288	0.0660	1	3.27	1.007	42.25	0.02	21.12	0.05
Silver	0.75	0.013	0.0097	NA	0.004	100%	0.458	0.002	0.001	0.288	0.0003	1	3.27	0.004	6.02	0.001	0.6	0.01
Zinc	11001	0.013	143.0	NA	154	100%	0.458	70.3	2.21	0.288	0.6365	1	3.27	65.4	169	0.39	84.5	0.77
Acenaphthene	0.052	0.013	0.0007	0	0	100%	0.458	0	ND	0.288	0	1	3.27	0.000	656	0.0000003	65.6	0.000003
Acenaphthylene	0.141	0.013	0.0018	0	0	100%	0.458	0	ND	0.288	0	1	3.27	0.001	656	0.0000009	65.6	0.000009
Anthracene	0.129	0.013	0.0017	0	0	100%	0.458	0	ND	0.288	0	1	3.27	0.001	656	0.000001	65.6	0.00001
Benzo(a)anthracene	1.144	0.013	0.0149	0	0	100%	0.458	0	0.00018	0.288	0.0001	1	3.27	0.005	6.15	0.0007	0.615	0.007
Benzo(a)pyrene	0.387	0.013	0.0050	0	0	100%	0.458	0	0.00032	0.288	0.0001	1	3.27	0.002	2.86	0.0005	0.29	0.005
Benzo(b)fluoranthene	0.880	0.013	0.0114	0	0	100%	0.458	0	0.00038	0.288	0.0001	1	3.27	0.004	6.15	0.0006	0.615	0.006
Benzo(g,h,i)perylene	0.326	0.013	0.0042	0	0	100%	0.458	0	ND	0.288	0	1	3.27	0.001	6.15	0.0002	0.615	0.002
Benzo(k)fluoranthene	0.616	0.013	0.0080	0	0	100%	0.458	0	0.00015	0.288	0.00004	1	3.27	0.002	6.15	0.0004	0.615	0.004
Chrysene	0.862	0.013	0.0112	0	0	100%	0.458	0	0.00032	0.288	0.0001	1	3.27	0.003	6.15	0.0006	0.615	0.006
Dibenzo(a,h)anthracene	0.052	0.013	0.0007	0	0	100%	0.458	0	ND	0.288	0	1	3.27	0.000	6.15	0.00003	0.615	0.0003
Fluoranthene	0.176	0.013	0.0023	0	0	100%	0.458	0	ND	0.288	0	1	3.27	0.001	6.15	0.0001	0.615	0.001
Fluorene	0.185	0.013	0.0024	0	0	100%	0.458	0	ND	0.288	0	1	3.27	0.001	656	0.000001	65.6	0.00001
Indeno(1,2,3-cd)pyrene	0.299	0.013	0.0039	0	0	100%	0.458	0	0.00015	0.288	0.00004	1	3.27	0.001	6.15	0.0002	0.615	0.002
Phenanthrene	0.880	0.013	0.0114	0	0	100%	0.458	0	ND	0.288	0	1	3.27	0.003	656	0.000005	65.6	0.00005
Pyrene	0.475	0.013	0.0062	0	0	100%	0.458	0	ND	0.288	0	1	3.27	0.002	6.15	0.0003	0.615	0.003
4,4'-DDE	0.035	0.013	0.0005	4.9	0.1729	100%	0.458	0.0792	ND	0.288	0	1	3.27	0.024	2.11	0.01	0.42	0.06
4,4'-DDT	0.210	0.013	0.0027	4.9	1.0290	100%	0.458	0.4713	ND	0.288	0	1	3.27	0.145	2.11	0.07	0.42	0.3
beta-BHC	0.003	0.013	0.0000	1	0.0026	100%	0.458	0.0012	ND	0.288	0	1	3.27	0.000	1.06	0.0003	0.21	0.002
delta-BHC	0.060	0.013	0.0008	1	0.0605	100%	0.458	0.0277	ND	0.288	0	1	3.27	0.009	0.1	0.09	0.01	0.87
gamma-chlordane	0.048	0.013	0.00062	1.0	0.0475	100%	0.458	0.0218	0.000027	0.288	0.00001	1	3.27	0.007	2.6	0.003	1.3	0.01
Dieldrin	0.027	0.013	0.00035	14.4	0.3871	100%	0.458	0.1773	ND	0.288	0	1	3.27	0.054	0.106	0.5	0.011	**5**
Endrin	0.010	0.013	0.00013	1.0	0.0101	100%	0.458	0.0046	ND	0.288	0	1	3.27	0.001	0.263	0.006	0.026	0.06
Heptachlor	0.005	0.013	0.00006	1.0	0.0047	100%	0.458	0.0022	ND	0.288	0	1	3.27	0.001	0.687	0.001	0.069	0.01
Heptachlor Epoxide	0.101	0.013	0.00131	1.0	0.1008	100%	0.458	0.0462	ND	0.288	0	1	3.27	0.015	1	0.01	0.1	0.1
Aroclor 1248	2.856	0.013	0.03713	1.0	2.8560	100%	0.458	1.3080	ND	0.288	0	1	3.27	0.411	0.103	**4**	0.01	**41**
Aroclor 1254	0.8	0.013	0.0106	1.0	0.8160	100%	0.458	0.3737	ND	0.288	0	1	3.27	0.118	0.474	0.2	0.096	**1.2**
Aroclor 1260	2.52	0.013	0.0328	1.0	2.5200	100%	0.458	1.1542	ND	0.288	0	1	3.27	0.363	0.474	0.8	0.096	**4**
Total 2,3,7,8-TCDD TEQs	0.0000324	0.013	0.000000	1.0	0.00003	100%	0.458	0.0000	ND	0.288	0	1	3.27	0.000005	0.0000053	0.9	0.0000005	**9**

Notes:
1 - bioaccumulation factors are presented in Table 5-2
2 - No bioaccumulation factors for soil to small mammals available for arsenic, cadmium, copper, lead, nickel, silver, and zinc; concentrations in small mammals estimated using regression equation per Table 4a in Attachment 4-1, Guidance for Developing Ecological Soil Screening Levels (EPA 2005).
NOAEL - no observed adverse effect level
LOAEL - lowest observed adverse effect level
NA - Input variable not located
NC - Not calculated
ND - Not detected
kg - kilogram
kg/day - kilogram per day
mg/kg w.w. - milligram per kilogram wet weight
mg/kg/day - milligram per kilogram per day
mg/L - milligrams per liter
L/day - liters per day
Bold - indicates hazard quotient greater than threshold of one
wet weight concentrations converted as follow: ww = Cs x (1 - % moisture)
where:
ww - wet weight concentration
Cs - dry weight concentration in soil
% moisture - percent moisture
For example, dry weight concentration and % moisture for arsenic were 8 mg/kg and 17.9%, respectively.
ww = 8 x (1 - .179)
ww = 6.6 mg/kg