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June 1, 2004

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RE: Public Review Final Miami-Erie Canal Area Screening Level Ecological Risk Assessment

Dear Ms. Bennett,

Enclosed please find four copies of the Public Review Final Miami-Erie Canal Area Screening Level Ecological Risk Assessment (ERA). Please see that these reports are made available in the CERCLA Public Reading Room.

We hope to pin down a date for the public meeting tomorrow, June 2, 2004. Once a date is agreed upon I will send you a copy of the notice for public review and meeting for publication in the Dayton Daily News.

Thanks for all your help. If you have any questions or concerns feel free to contact me at (614) 791-3342 or (614)361-5969.

Sincerely,
SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

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SCREENING LEVEL ECOLOGICAL RISK ASSESSMENT

Miami-Erie Canal Area

Public Review Final

June 1, 2004

Department of Energy
Miamisburg Closure Project
Miamisburg, Ohio

Table of Contents

SECTION

1.0 INTRODUCTION 1-1

2.0 SCREENING LEVEL PROBLEM FORMULATION 2-1

2.1 ENVIRONMENTAL SETTING 2-1

2.1.1 Site History 2-1

2.1.2 Site Description 2-2

2.1.3 Site Ecology 2-3

2.1.4 Rare, Threatened, and Endangered Species 2-6

2.2 EXTENT OF CONTAMINATION 2-7

2.2.1 Soil 2-8

2.2.2 Surface Water and Sediment 2-8

2.3 CONTAMINATION AND TRANSPORT 2-8

2.4 POTENTIAL RECEPTORS 2-9

2.4.1 Target Terrestrial Receptors 2-9

2.5 TARGET AQUATIC RECEPTORS 2-13

2.6 COMPLETE EXPOSURE PATHWAYS 2-13

2.7 GENERAL ASSESSMENT ENDPOINTS 2-13

2.8 CONCEPTUAL MODEL 2-14

2.8.1 Miami-Erie Canal Habitat 2-14

2.8.2 South Pond and Overflow Creek Habitat 2-14

3.0 SCREENING-LEVEL ECOLOGICAL EFFECTS EVALUATION 3-1

3.1 CONSTITUENTS OF POTENTIAL CONCERN 3-1

3.1.1 Toxicological Profiles 3-1

3.2 DEVELOPMENT OF TOXICITY REFERENCE VALUES 3-5

3.2.1 Dose-based TRVs 3-6

3.2.2 Media-based TRVs 3-6

4.0 SCREENING-LEVEL EXPOSURE ESTIMATE 4-1

4.1 DOSE-BASED EXPOSURE 4-1

4.1.1 Radionuclide Exposure 4-1

4.2 MEDIA-BASED EXPOSURE 4-6

4.2.1 Radionuclide Exposure 4-6

4.2.2 Chemical Exposure 4-6

5.0 SCREENING-LEVEL RISK CHARACTERIZATION 5-1

5.1 RISK TO MIAMI-ERIE CANAL ECOLOGICAL RECEPTORS 5-2

5.1.1 Radionuclides 5-2
5.1.2 Chemicals 5-2
5.2 RISK TO SOUTH POND ECOLOGICAL RECEPTORS 5-11
5.2.1 Radionuclides 5-11
5.2.2 Chemicals 5-11
5.3 RISK TO OVERFLOW CREEK ECOLOGICAL RECEPTORS 5-23
5.3.1 Radionuclides 5-23
5.3.2 Chemicals 5-29
5.4 SUMMARY OF UNCERTAINTY 5-39
5.5 REFINEMENT OF PRELIMINARY COPCS 5-45
5.5.1 Canal 5-45
5.5.2 South Pond 5-52
5.5.3 Overflow Creek 5-53
5.6 RISK DESCRIPTION 5-53
6.0 REFERENCES 6-1

FIGURES (appended)

Figures 1-5 Mound Plant-Erie Canal Area

TABLES

Table 2-1 List of fish species captured in 1992 and 1993 in the South Pond, Overflow Pond, and Overflow Creek 2-4
Table 2-2 List of Fish and Macroinvertebrate Species Captured by Ohio EPA's Monitoring and Assessment Section: Overflow Creek 2-5
Table 2-3 Receptors of Concern 2-10
Table 2-4 Preliminary Assessment Endpoints 2-15
Table 2-5 Preliminary Ecological Conceptual Site Model 2-16
Table 5-1 Summary of Radionuclide Exposure and Risk 5-3
Table 5-2 Risk to Meadow Vole: Canal Soil 5-4
Table 5-3 Risk to Short-tailed Shrew: Canal Soil 5-7
Table 5-4 Risk to American Robin: Canal Soil 5-9
Table 5-5 Use of Single-Media and Multi-Media Benchmarks for the Calculation of Hazard Quotients (HQ) and Hazard Indices (HI), South Pond Surface Water 5-12

Table 5-6 Use of Single-Media and Multi-Media Benchmarks for the Calculation of Hazard Quotients (HQ) and Hazard Indices (HI) South Pond Sediment 5-13
Table 5-7 Risk to Muskrat: South Pond 5-14
Table 5-8 Risk to Mink: South Pond 5-17
Table 5-9 Risk to Mallard: South Pond 5-19
Table 5-10 Risk to Belted Kingfisher: South Pond 5-21
Table 5-11 Comparison of South Pond Surface Water Concentrations to Surface Water Benchmarks 5-24
Table 5-12 Comparison of South Pond Sediment Concentrations to Sediment Screening Values 5-25
Table 5-13 Use of Single-Media and Multi-Media Benchmarks for the Calculation of Hazard Quotients (HQ) and Hazard Indices (HI) South Pond Surface Water 5-27
Table 5-14 Use of Single-Media and Multi-Media Benchmarks for the Calculation of Hazard Quotients (HQ) and Hazard Indices (HI) South Pond Sediment 5-28
Table 5-15 Risk to Muskrat: Overflow Creek 5-30
Table 5-16 Risk to Mink: Overflow Creek 5-32
Table 5-17 Risk to Mallard: Overflow Creek 5-35
Table 5-18 Risk to Belted Kingfisher: Overflow Creek 5-37
Table 5-19 Comparison of Overflow Creek Surface Water Concentrations to Surface Water Benchmarks 5-40
Table 5-20 Comparison of Overflow Creek Sediment Concentrations to Sediment Benchmarks 5-41
Table 5-21 Refinement of COPCs: Receptors and COPCs with HQ >1 5-46
Table 5-22 Risk to Meadow Vole: 95% UCL Exposure Point Concentration 5-49
Table 5-23 Risk to Short-tailed Shrew: 95% UCL Exposure Point Concentration 5-50
Table 5-24 Risk to American Robin: 95% UCL Exposure Point Concentration 5-50

APPENDICES

APPENDIX A SCREENING OF CHEMICALS OF POTENTIAL CONCERN BY MEDIUM A-1
APPENDIX B TOXICITY REFERENCE VALUES B-1
APPENDIX C RADIOLOGICAL EXPOSURE DOSES C-1
APPENDIX D LOCATIONS EXCEEDING WILDLIFE PRGs D-1
APPENDIX E THREATENED AND ENDANGERED SPECIES INFORMATION E-1

1.0 INTRODUCTION

The Mount Plant in Miamisburg, Ohio is operated for the U.S. Department of Energy (DOE) by CH2M Hill. The plant started in operation in 1949 as an integrated research, development, and production facility operating in support of the DOE weapons and energy programs (DOE 1994). This screening level ecological risk assessment (SLERA) has been prepared for the Miami-Erie Canal site (Canal) adjacent to the Mound Plant.

Environmental cleanup of the Canal was completed in May 1998. The northern portion of the Canal property is owned by the City of Miamisburg, with a portion of the site to be used as a public park. The Miami Conservancy District (MCD) maintains ownership (and historical easements for flood control) of the southern portion of the Canal which historically served as the Mound Plant's main surface water drainage pathway. This SLERA evaluates the potential impacts of residual contamination in the Canal, the South Pond, and the Overflow Creek on ecological receptors inhabiting the site and adjacent areas.

A preliminary or screening-level risk evaluation is the initial ecological risk assessment screening at a hazardous waste site (EPA 1996). EPA (1997) defines a SLERA as "a preliminary risk assessment that can be conducted with limited site-specific data by defining assumptions for parameters that lack site-specific data." To ensure that sites that may pose an ecological risk are properly identified, EPA (1997) suggests that "values should be consistently biased in the direction of overestimating risk. Without this bias, a screening evaluation could not provide a defensible conclusion for an absence of ecological risk." In conjunction with the human health risk assessment, the ecological risk assessment forms the basis for determining the need for remedial activities at a site and serves as the justification for the selected remedial action.

Technical risk assessment guidance for the performance of the screening-level ecological risk assessment came primarily from:

- *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (EPA 1997).
- *Guidelines for Ecological Risk Assessment* (EPA 1998).

This screening-level ecological risk assessment consists of the following two steps:

- Screening-Level Problem Formulation and Screening-Level Ecological Effects Evaluation.
- Screening-Level Preliminary Exposure Estimate and Risk Calculation.

Based on this screening-level risk assessment, the ecological risk is within acceptable levels and no further action is necessary.

Each step of the screening-level ecological risk assessment for the Canal is presented in the following sections.

2.0 SCREENING LEVEL PROBLEM FORMULATION

The screening-level problem formulation step focuses on identifying categories of potential ecological receptors that may exist in the site area; identifying contaminants which may pose unacceptable risk to those receptors; and determining contaminant fate/transport and toxicity mechanisms (EPA 1996). It is a planning step that identifies the major factors (i.e., environmental setting, extent of contamination, contaminant fate and transport, potential receptors, and complete exposure pathways) to be considered in the screening-level ecological risk assessment.

2.1 Environmental Setting

The following subsection on the environmental setting is summarized from information presented in the *Operable Unit 9, Ecological Characterization Report* (DOE 1994), the *Miami-Erie Canal Verification Report* (DOE 1998), and the *On-Scene Coordinator (OSC) Report, OU-4 Miami-Erie Canal Removal Action* (DOE 1999a). In addition, observations made during a site walkover on 2 and 3 February 2000 are also discussed.

2.1.1 Site History

The Mound Plant was established in 1946 on a 728,000 square-meter (m^2) (182-acre) untillable portion of a farm consisting of two large hills (now referred to as the Main Hill and the SM/PP Hill), with a northeast-southwest trending valley separating them. In 1969, an underground waste line at the Mound Plant Facility ruptured and released plutonium-238, a radioactive material, to the surrounding soils. During cleanup of the spill, a severe rainstorm washed away some of the contaminated soil. Fine-grained clay particles, contaminated with plutonium, were carried away through the natural drainage courses off the plant site to the remnants of the historic Miami-Erie Canal and then into the Great Miami River. The Miami-Erie Canal was constructed in the 1800s as a north-south transportation route. The Canal is adjacent to the Miamisburg Community Park and the Mound Plant. Early studies indicated that the plutonium-238 did not pose a health hazard as long as it remained undisturbed in the Canal soil (Miami-Erie Canal Fact Sheets, May 1997 and May 1998).

In July 1995, after considerable study, the DOE issued a Removal Action Memorandum proposing excavation of the Miami-Erie Canal to remove contaminated soils and sediments. The planning phase of the project was completed in 1996 as documented in the *Removal Action Design Document* (DOE 1996a). The DOE began cleanup of the Canal in November 1996. Approximately 38,000 cubic yards of low level waste, principally contaminated soil, were removed from the Canal and its banks. Environmental cleanup of the Canal was completed in May 1998, and restoration of the site included replacing contaminated soil with clean soil, grading, replanting trees, reseeding the grass, and constructing a bike path. Excavation and grading during remediation transformed what was formerly a nearly vertical-sided drainage pathway having certain small stream characteristics, into a wide, grassy swale. Rerouting of the

Mound stormwater runoff (see following) transformed a riparian habitat into the dry swale. The Canal area is owned by the City of Miamisburg and MCD, though DOE maintains an historic easement. Future plans for the Canal area include transfer of ownership of the entire area to the City of Miamisburg and release of all historical flood control easements.

2.1.2 Site Description

The Miami-Erie Canal site includes six parts:

- The North section of the abandoned Miami-Erie Canal west of Mound Plant.
- The Runoff Hollow between the Conrail Railroad right-of-way to the east and the Dayton-Cincinnati Road to the west.
- The abandoned South section of the Canal.
- The Overflow Creek, which connects the Canal to the Great Miami River.
- The Plant Drainage Ditch from the plant boundary to the Canal.
- The South Pond within the Miamisburg Community Park.

Stream flow emanating from developed portions of the Mound Plant leaves the site via the plant drainage ditch, which separates the Main Hill and SM/PP Hill. Prior to 1996, water from the drainage ditch flowed over a concrete weir (upper weir) at the western plant boundary into the Miami-Erie Canal. The confluence of the drainage ditch and the Canal was known locally as the separation point between the North and South Canal. Originally, runoff into the Canal from the drainage ditch flowed both north and south, but in 1976, a flapper valve was installed that eliminated surface discharges from Mound Plant into the North Canal. Thus, all surface discharges from Mound Plant flowed into the South Canal after this date. A portion of the South Canal and Overflow Creek are mapped as being within the Great Miami River 100-year floodplain.

Since 1915, when the Miami-Erie Canal was decommissioned, water from the South Canal has been diverted over a concrete weir (lower weir) into the Overflow Creek, which connects to the Great Miami River. The Overflow Creek has a relatively straight, deeply entrenched channel, and substrate composed of gravel, small cobble, and silt/sand. Based on these characteristics and the presence of a faint berm along its eastern bank, it would appear the Overflow Creek channel has been deepened and straightened. The Overflow Creek may have been the lower end of the unnamed intermittent creek draining the South Property.

One of the first steps in remediating the Miami-Erie Canal involved construction of an underground pipe to divert water from Plant Drainage Ditch to the Overflow Creek. This pipe runs southward from the concrete settling basins adjacent to the upper weir, to an open, concrete-lined channel on the South Property. The southern end of the concrete channel connects to the lower weir.

2.1.3 Site Ecology

The Mound Plant is located in the Eastern Deciduous Forest Province in the transition zone between the beech-maple forest and oak-hickory forest plant associations (Bailey 1978). Much of the original farm property has been altered through construction and use; however, small tracts of forest and scrub-shrub vegetative communities occur on the slope of the SM/PP Hill and in the valley separating the two hills. Land use in the areas north, east, and west of the Mound Plant is largely residential with relatively low population density. In 1981, DOE purchased the undeveloped tract of land to the south, now known as the South Property. Since that time, access to the 501,828 m^2 (124-acre) South Property has been restricted. For nearly two decades, the only notable disturbances in this area were periodic mowing of the grasslands by facilities maintenance and occasional field training exercises by the Mound Plant.

A field investigation in support of the ecological risk assessment of the Canal remediation site was performed 2 and 3 February 2000. As part of this investigation, habitats in the study area were mapped with the aid of aerial photographs and construction diagrams from the remediation effort. A total of three habitat types were mapped in the study area (Figures 1-5). These habitats and area(s) where they were found, were:

1. Open water - South Pond, Overflow Pond, and wetted portion of concrete channel and Overflow Creek;

2. Riparian forest - Vegetated corridor along the Overflow Creek; and

3. Maintained lawn - Canal remediation site (North and South Canal), and Runoff Hollow.

Open water occurs in the South Pond, Overflow Pond, concrete channel on the South Property, and Overflow Creek. Physical habitats of streams at the Mound Plant were evaluated and quantified using the Ohio Environmental Protection Agency's (Ohio EPA) Qualitative Habitat Evaluation Index (QHEI) during the OU9 Ecological Characterization. The Miami-Erie Canal and the Overflow Creek have been channelized. When compared to state-wide values for channelized headwater streams, all of the permanent stream sampling locations in the Miami-Erie Canal and the Overflow Creek at the Mound Plant produced values greater than 48, which is within the Ohio EPA modified warmwater habitat (MWH) range of 38-56.

Remediation and restoration activities in the abandoned Miami-Erie Canal have changed a formerly nearly vertical-sided drainage pathway having certain small stream characteristics into a wide grassy swale. Rerouting of the Mound stormwater runoff transformed a riparian habitat into a dry swale. Thus, this surface water feature no longer provides modified warmwater habitat. Observations made of the Overflow Creek in February 2000 suggest that the habitat has remained unchanged since the 1992/1993 OU9 Ecological Characterization field studies.

In 1992 and 1993, three fish species were documented in the South Pond, one species was captured in the Overflow Pond, and 18 species were documented in the Overflow Creek. A list of fish species captured in each water body in 1992 and 1993 is presented in Table 2-1.

Table 2-1

List of fish species captured in 1992 and 1993 in the South Pond, Overflow Pond, and Overflow Creek
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Common Name	Scientific Name	South Pond	Overflow Pond	Overflow Creek
Gizzard shad	*Dorosoma cepedianum*			•
Stoneroller	*Campostoma anomalum*			•
Spotfin shiner	*Cyprinella spiloptera*			•
Carp	*Cyprinus carpio*			•
Striped shiner	*Luxilus chrysocephalus*			•
Golden shiner	*Notemigonus chrysoleucas*			•
Bluntnose minnow	*Pimephales notatus*			•
Blacknose dace	*Rhynichthys atratulus*			•
Creek chub	*Semotilus atromaculatus*			•
White sucker	*Catostomus commersoni*			•
Black bullhead	*Ameiurus melas*			•
Mosquitofish	*Gambusia affinis*			•
Green sunfish	*Lepomis cyanellus*		•	•
Orangespotted sunfish	*L. humilis*			•
Bluegill	*Lepomis macrochirus*	•		•
Longear sunfish	*L. megalotis*			•
Largemouth bass	*Micropterus salmoides*	•		•
Black crappie	*Pomoxis nigromaculatus*	•		
Yellow perch	*Perca flavescens*			•

Biotic sampling of the surface waters at the Mound Plant, including the Overflow Creek and the South Pond, was conducted as part of the OU 9 Ecological Characterization. Fish and macroinvertebrates were the two biota groups characterized during the aquatic investigations, and both spring and fall sampling events were conducted. The Index of Biotic Integrity (IBI) for fish in the Overflow Creek ranged from 18 to 32, with an average of 27. The Modified Warmwater Habitat (MWH) IBI criterion for the Eastern Corn Belt Plain (ECBP) ecoregion is 24. Invertebrate Community Index (ICI) values for the Overflow Creek ranged from 5 to 26, with an average of 15. The ECBP MWH criterion is 22. There are no criteria to evaluate fish and macroinvertebrate communities in ponds. A few fish, which represented three species, were collected from the South Pond. The macroinvertebrate community in the South Pond was comprised of taxa typical pond habitats, and a seasonal change in the macroinvertebrate community was not observed.

In 1995, the Ohio EPA Monitoring and Assessment Section (Ohio EPA 1996) conducted a biological survey of the Overflow Creek, which included fish and macroinvertebrate

investigations. Twenty-six taxa of macroinvertebrates and nineteen fish species were collected (Table 2-2). The QHEI score for the Overflow Creek was 51.0, with the fish community performing in the fair range. A use designation of MWH was recommended by the Ohio EPA for the Mound Overflow Creek (currently undesignated) due to the modified characteristics of the channel and the performance of the biological communities. The 1995 biological results showed partial attainment of the recommended MWH use designation in the Overflow Creek and full attainment of the existing WWH use designation in the Great Miami River mainstem downstream from the Mound outfall 001.

Table 2-2

List of Fish and Macroinvertebrate Species Captured by Ohio EPA's Monitoring and Assessment Section: Overflow Creek Miami-Erie Canal, Mound Plant Miamisburg, Ohio

Fish	Macroinvertebrates
Golden redhorse	*Turbellaria*
Central stoneroller	*Lirceus sp*
Spotfin shiner	*Cambarus (Cambaurs) ortmanni*
Common carp	*Calopteryx sp*
Striped shiner	*Aeshna sp*
Golden shiner	*Stalis sp*
Bluntnose minnow	*Cheumatopsyche sp*
Blacknose dace	*Diplectrona modesta*
Creek chub	*Hydropsyche depravata group*
White sucker	*Pelodytes sp*
Black bullhead	*Hydroporus sp*
Silverjaw minnow	*Psephenus herricki*
Green sunfish	*Stenelmis sp*
Channel catfish	*Tipula sp*
Bluegill sunfish	*Simulium sp*
Yellow bullhead	*Ablabesmyia mallochi*
Largemouth bass	*Conchapelopia sp*
Tadpole madtom	*Corynoneura lobata*
Pumpkinseed sunfish	*Thienemanniella xena*
Green SF x bluegill	*Paratendipes albimanus or P. duplicatus*
	Phaenopsectra flavipes
	Polypedilum (P.) illinoenses
	Polypedilum (P.) ophioides
	Chrysops sp
	Physella sp
	Sphaerium sp

Source: Ohio EPA 1996.

Riparian forest occurs along the Overflow Creek, between U.S. Highway 25 and the Great Miami River. This habitat unit has remained unchanged since the 1992/1993 study and, therefore, attributes described in the 1994 DOE report are still valid. Dominant overstory species described in 1994 for the Overflow Creek were American elm, hackberry, honeylocust, and white mulberry. Amur honeysuckle and boxelder dominated the middlestory and understory. Dominant herbaceous species consisted entirely of moisture loving, shade intolerant elements, including white snakeroot, bedstraw, common chickweed, and garlic mustard.

All areas within the Canal remediation fall within the habitat category described herein as **maintained lawn**. Following remediation, numerous shade trees were planted to enhance the park-like setting, and grasses typically used in this region for lawn cover were sown (e.g., fescue, Kentucky bluegrass). Mowing of the former Canal area has taken place subsequent to remediation.

2.1.4 Rare, Threatened, and Endangered Species

As part of the CERCLA Section 120 Federal Facility Agreement with the U.S. Environmental Protection Agency and the Ohio EPA, DOE conducted an ecological characterization of the Mound Plant. This work involved the identification of sensitive environments (e.g., wetlands), and seasonal studies of the following biota groups: vegetation, mammals, reptiles, amphibians, aquatic macroinvertebrates, fish, and birds. Seasonal ecological studies were initiated in June 1992 and were completed in 1994. These studies included the Miami-Erie Canal and Overflow Creek, as well as Parcel 4.

In preparation for the ecological characterization, the Ohio Department of Natural Resources-Division of Natural Areas and Preserves (ODNR-DNAP) and the U.S. Fish and Wildlife Service (USFWS) were contacted regarding rare, threatened, and endangered (RTE) species occurrences. Although information from these sources suggested a very low probability of RTE occurrence, onsite reconnaissance revealed the presence of limited specialized habitat that were believed capable of harboring protected species. While performing general systematic surveys of the site during OU9 ecological characterization study field surveys, two state-protected species were found – the dark-eyed junco (*Junco hyemalis*), a state-endangered bird and the inland rush (*Juncus interior*), a state-endangered grass. The dark-eyed junco is a common winter visitor throughout most of the eastern U.S. At the Mound Plant, numerous individuals were found in the fall and the winter in several areas on the North and South Properties. The inland rush was found in a seasonal grassland seepage on the South Property and is not expected to be a permanent part of the Mound Plant flora (DOE 1994).

The ODNR-DNAP was also contacted in May 2000 for updated information. Within the project area, the inland rush, a state threatened plant, has been recorded in the Natural Heritage database (Appendix E). This record appears to be at the same location as found during the OU9 ecological characterization. There are no existing or proposed state nature preserves or scenic rivers at the project site. There are no known unique ecological sites, geologic features, breeding

or non-breeding animal concentrations, champion trees, or state parks, forest, or wildlife area within a one-mile radius of the project area.

The USFWS was contacted in May 2000 for updated information regarding the occurrence or possible occurrence of Federally-listed threatened or endangered species in the vicinity of the Mound Plant (Appendix E). The site lies within the range of the Indiana bat, a Federally-listed endangered species, and the eastern massasauga, a docile rattlesnake that is declining throughout its national range and may soon receive status as a Federal candidate species. The snake is currently listed as endangered by the State of Ohio. The Indiana bat and the eastern massasuga are not expected to occur on the property for the following reasons:

- During the OU9 ecological characterization, the USFWS provided a letter to the Department of Energy indicating that although the Mound Plant lies within the range of the Indiana bat, no habitat for this species was present. Consequently, bat surveys were not conducted for the Indiana bat as part of the ecological characterization.

- Surveys for reptiles and amphibians during the ecological characterization revealed the occurrence of several species of snakes in and along the Miami-Erie Canal and Overflow Creek and on Parcel 4. However, the eastern massasauga was not found. In general, habitats within the study area ranged from moderately impacted (e.g., recently fallow farmland on Parcel 4) to significantly impacted (e.g., Miami-Erie Canal, Overflow Creek and riparian area). Consequently, potential habitat for the massasauga was very limited and the species is not considered to occur on or in the vicinity of the Miami Erie Canal and Overflow Creek.

2.2 Extent of Contamination

Historical operations and accidental releases from the Mound Plant have resulted in the discharge of contamination, consisting primarily of plutonium and tritium, into the Miami-Erie Canal. Since the potential for releases of non-radiological chemicals into the Plant Drainage Ditch may have existed at one time, past characterization investigations and verification sampling also investigated non-radiological contamination in the Canal.

Verification sampling was conducted as part of the Canal cleanup activities. The cleanup goal was to leave residual radioactivity with a 95% Upper Confidence Limit (UCL) of the mean of less than 75 pCi/g, and to remove all known spots greater than 150 pCi/g. The average residual concentration was 24 pCi/g, and all known spots with an activity greater than 75 pCi/g were removed.

The following information on the extent of residual contamination within the Canal is summarized from data presented in the *Verification Sampling Report* (DOE 1998). Information on removal activities and field sampling methods are presented in this document and the *OSC Report* (DOE 1999a). All Canal soil data used in this evaluation was obtained from these reports. In addition to data provided in the reports mentioned above, sediment and surface water data collected in 1994 and 1995 from the Overflow Creek and South Pond included in the OU *9 Surface Water and Sediment Investigation Report* (DOE 1996b) were used in this assessment. These areas were not remediated as part of the Canal remediation activities.

2.2.1 Soil

Verification samples were collected from the remaining surface contour to confirm that the cleanup goal was achieved. Samples were obtained from a depth of 0 to 6 inches. The entire Miami-Erie Canal remedial site was included in the post-removal sampling (i.e., Canal, runoff hollow, South Pond, Overflow Creek, and plant drainage ditch). Grids were overlain on 50-foot segments of the Canal, and five samples were randomly collected within each grid. All samples were analyzed for plutonium-238 by alpha spectrometry, while only the first sample in each segment was analyzed for all Canal analytes. The sample area also included four associated areas subject to verification sampling — the Runoff Hollow, the South Pond, the Overflow Creek, and the portion of the Plant Drainage Ditch between the plant boundary and the Canal. Six hundred and seventy-nine verification samples were collected and analyzed for plutonium-238. Of these 125 samples were also analyzed for the other potential contaminants on the target analyte list.

After cleanup, 35 locations with concentrations above 75 pCi/g plutonium-238 remain (but not above 150 pCi/g), and are distributed throughout the length of the Canal. No exceedances were observed for the Runoff Hollow, the South Pond, or the Overflow Creek.

2.2.2 Surface Water and Sediment

As a part of the Operable Unit (OU) 9 (Site-wide) Remedial Investigation, field studies addressed the chemistry of the surface water and sediment on the Mound Plant Site. These studies included the nature and extent of surface water and sediment contamination outside the plant boundary. Surface water and sediment for representative drainages within the zone of influence of Mound Plant air emissions were sampled, including the Overflow Creek and the South Pond. Surface water and sediment for representative drainages outside the zone of influence of Mound Plant air emissions (i.e., background locations) were also sampled.

The field team collected samples during a comprehensive, two-season (Fall and Spring) sampling effort. Fall sampling occurred from 4 September 1994 to 19 December 1994, and Spring sampling occurred from 17 April 1995 to 23 June 1995. The seasonal events provided a set of samples from a wet season (Spring) and another from a dry season (Fall) to give some indication of natural environmental variability. Surface water and sediment samples were collected in accordance with the Field Sampling Plan (DOE 1992) and ER Program Standard Operating Procedures (ER Program SOPs). Samples were analyzed for radionuclides, VOCs, SVOCs, pesticides/PCBs, inorganics, and anions.

2.3 Contamination and Transport

The primary source of contamination at the Canal site consists of residual soil contaminants. Radionuclide and chemical contaminants at this site can be transported to other media through the atmosphere, via surface water movement, via surface water runoff (and erosion), and through leaching to groundwater. In the atmosphere, radon (and daughters) released from impacted soils, along with contaminated dusts, can be suspended in the air by wind movement and thus be

transported off-site. The contaminated particles can be deposited on surfaces at considerable distances from the site.

Movement of surface water over contaminated soils or sediments can provide a means for transport of the contaminated materials. Infiltration of surface water can transport contaminated material in the soil into groundwater. Movement of contamination by surface water runoff during storms and/or erosion processes is suspected at the Canal site, since most of the Canal is within the Great Miami River floodplain. The natural surface drainage patterns have been altered by the remediation of the Canal. Although current drainage patterns have been altered, the ultimate destination of the surface runoff remains the Great Miami, either directly via overland flow or via subsurface drainage.

Contaminants may also be transferred through the food chain. Plants and soil-dwelling organisms can take up contaminants from surface and subsurface soil, and certain contaminants may biomagnify up the food chain. Aquatic organisms can bioconcentrate contaminants from surrounding surface water and/or sediment environments.

2.4 Potential Receptors

A field investigation in support of the ecological risk assessment of the Canal remediation site was performed 2 and 3 February 2000. The primary goal of the field investigation was to collect data for the ecological exposure assessment. To that end, the field investigators examined the Canal remediation site for plants, fish and/or wildlife that may be potentially exposed to the contaminants of concern. Target species were selected for an effect assessment based on several criteria including, but not limited to, recreational importance, sensitivity to ecological change, sensitivity to contaminants, and importance to the well being of protected and recreationally important species. At the time the field investigation was conducted, the Mound Plant and vicinity was experiencing typical cold, winter weather. The South Pond, Overflow Pond, and much of the Overflow Creek were covered with ice, precluding fish sampling. Thus, information on the fish community in these water bodies was gleaned from the *Operable Unit 9, Ecological Characterization Report* (DOE 1994). This report, summarizing multi-seasonal studies conducted between spring 1992 and fall 1993, provides detailed, quantitative and qualitative data on several biota groups, including plants, birds, small and large mammals, herptiles (reptiles and amphibians), fish, and aquatic macroinvertebrates. Careful examination of the South Pond, Overflow Pond, and Overflow Creek indicate no significant physical changes have occurred to these water bodies since completion of the Operable Unit 9, Ecological Characterization study. For this reason, it is assumed that all species inventoried in 1992 and 1993 are still present at roughly the same abundance. On 2 and 3 February, several hundred fish were observed in those reaches of the Overflow Creek not covered with ice, suggesting its biotic integrity has not changed significantly since the 1992/1993 surveys.

2.4.1 Target Terrestrial Receptors

Exposure of terrestrial wildlife (i.e., mammals, birds, amphibians, and reptiles) to chemicals of potential concern (COPCs) occurs primarily when animals feed in areas impacted by site

contamination. Plants are the major biotic component of the terrestrial environment and serve as the major source of food and shelter for other living forms within the terrestrial ecosystem. Earthworms and other soil-dwelling organisms also serve as a major food source for other living organisms. These organisms are directly exposed to contaminants in their soil environment, and earthworms directly ingest soil. In this screening-level evaluation, several target terrestrial receptors from several trophic levels (e.g., herbivores, insectivores, and piscivores) were selected to represent animal populations that inhabit the site and the surrounding areas (Table 2-3).

Table 2-3 Receptors of Concern
Miami-Erie Canal Mound Plant
Montgomery County, Ohio

Terrestrial Habitat
Birds
Herbivore (i.e., mallard)
Piscivore (i.e., belted kingfisher)
Insectivores (i.e., American robin)
Mammals
Herbivore (i.e., meadow vole; muskrat)
Piscivore (i.e., mink)
Insectivore (i.e., short-tailed shrew)
Reptiles/Amphibians
Aquatic Habitat
Fish and other aquatic organisms
Benthic invertebrates

Meadow vole

Meadow voles (*Microtus pennsylvanicus*) are small rodents (172 to 259 mm in length) that usually have long, soft fur that usually is dull chestnut-brown above, and silvery-gray below. The ears are small, as are the eyes, and the tail is short (32 to 63 mm). Meadow voles inhabit low moist areas or high grasslands with rank growths of vegetation and also occur near streams, lakes, and open swamps. They forage both during the day and at night, and feed on a variety of green plants, both monocots and dicots. They also eat some insects, though not to the extent that *Peromyscus* (mice) does. The meadow vole occurs throughout most of northern North America, including all of Ohio. It is a prolific species, capable of rapid population increase under favorable conditions. With their high reproductive potential and their colonizing ability, they can adapt well to frequent changes in agricultural land use. At the Mound Plant, a single meadow vole was captured in 1992 in a live trap set on the lower slope of the Main Hill. Based on these life history aspects, it is expected the meadow vole is a common inhabitant of the former Miami-Erie Canal and other grassy or brushy habitats associated with the plant drainage system.

Short-tailed shrew

The short-tailed shrew (*Blarina brevicauda*) is a small insectivore 93 to 134 mm in length. It is dark gray to black with a pointed nose, tiny eyes, and concealed ears. As the name suggests, the tail is very short (19 to 30 mm). The only other species of shrew in the vicinity of Mound Plant that has a short tail is *Cryptotus parva*, the least shrew. The short-tailed shrew is primarily nocturnal, but occasionally is active during the day. It prefers moist forests, but is found in brushy areas, along fence rows, and in pastures throughout the eastern United States. Like other shrews, *Blarina* is primarily a meat eater. Its diet includes other small mammals such as meadow voles and deer mice as well invertebrates, such as grasshoppers and crickets. In 1992, short-tailed shrews were collected at the Mound Plant from a seepage area at the base of the southern slope of the Main Hill, and in the scrub/shrub vegetation community near the crest of the SM/PP Hill. Given the species' ability to exist in a wide variety of habitats, it is entirely likely that short-tailed shrews also occur in grassy and brushy habitats along the path of the former Miami-Erie Canal and plant drainage system.

Muskrat

The muskrat (*Ondatra zibethicus*) is a large, brown, aquatic vole, with a long, black, compressed (vertically flattened) tail. Its belly fur is silvery, and its dense, luxurious underfur is overlain by shiny guard hairs. The muskrat occurs over much of boreal and temperate North America, from Alaska and Labrador south through most of the Unites States to northernmost Mexico. It is found throughout Ohio, and was observed in 1992 in the concrete settling basins on the lower end of the Plant Drainage ditch. The muskrat is semiaquatic, inhabiting streams, rivers, marshes, sloughs, ponds, lakes - almost any place where sufficient food and permanent water are present. Foods include stems, leaves, bulbs, and roots of aquatic plants; animals such as fish, frogs, crayfish, and snails also are eaten, especially in winter. Along small streams, such as the Overflow Creek, they dig bank burrows with an entrance usually beneath water level.

Mink

The mink (*Mustela vison*) is a secretive, relatively large weasel-like mammal. Color is uniformly dark brown except for white blotches on chin, throat, and sometimes chest and belly. The pelage is long and glossy. It is found throughout most of the United States including all of Ohio. Mink are successful on land and in water, moving and hunting effectively in both habitats without extreme specialization for either. Only heavily wooded habitats are avoided, but areas around lakes, ponds, impoundments, streams, river, and marshes are preferred. Almost strictly carnivorous, mink have a varied diet reflecting their life style. Muskrats (especially young), voles, mice, and cottontails are staple items, but birds, fish, crayfish and other invertebrates, frogs, snakes, squirrels, shrews, and even some plant material also are eaten. Dens are located usually near water. These may be fashioned by the animal itself or they may use the den of another mammal. Their home range tends to be somewhat linear because they follow shorelines. Home range of females range from 20 to 50 acres, whereas the range of males is much larger. Mink have never been confirmed as occurring on the Mound Plant, the Miami-Erie Canal, or Overflow Creek, although a large, unidentified weasel-like mammal was observed on the South

Property in 1992 during the Operable Unit 9 ecological characterization. Habitat and prey for this species occurs in and along the Overflow Creek. Consequently, it is likely that mink occur either occasionally or regularly in the study area but as a result of its secretive nature, its occurrence has not been established.

Belted Kingfisher

The belted kingfisher (*Ceryl alcyon*) stands from 11 to 14 inches tall, and has a wingspread of 21 to 23 inches. It has a stout bill, longer than the head, and the head has a double-pointed crest. The upperparts and a wide band across the breast are blue-gray. The underparts are white. Female belted kingfishers have an additional band of russet across and down the sides of the belly. Belted kingfishers are common and conspicuous along rivers and brooks, ponds and lakes, and estuaries. Its breading range includes most of northern North America, and year-round it occurs in the southern half of the United States south to Mexico. In Ohio, the belted kingfisher breeds throughout the state but winters only in the southern half. The belted kingfisher nests underground, in a horizontal (or slightly upward-sloping) burrow in a vertical bank near water. It prefers soil with high sand, low clay composition. Its diet is almost strictly fish, although it may occasionally take aquatic invertebrates, amphibians, reptiles, insects, young birds, mice, and rarely berries. At the Mound Plant, during the Operable Unit 9 ecological characterization, a single male of this species was seen during all sampling periods, almost always around the concrete settling basins and the Overflow Pond. In fall 1992, a female belted kingfisher was observed leaving the Overflow Pond with a small fish, and on 1 and 2 February 2000, a belted kingfisher was observed perched over the water along the Overflow Creek.

Northern Robin

The northern robin (*Turdus migratorius*) is one of North America's most recognizable birds. Standing from 9 to 10 ½ inches tall, the top and sides of the head are black, and the underparts are mouse gray or deep mouse gray. The tail is dark, and tipped with white, and the throat is white, and streaked with black. The chest, breast, upper abdomen, sides, flanks, and under wing-coverts are plain, deep cinnamon-rufous in color. The robin is considered a habitat generalist, being found in woodlands, gardens, and parks. The northern robin's distribution includes all of eastern and northern North America, and it is a year-round resident in Ohio. It nests on buildings, and any structures offering sufficient support, including trees and shrubs. The diet includes earthworms, snails, and other invertebrates, and much fruit. The young are fed insects. In 1992, it was found at the Mound Plant site during all sampling periods of the Operable Unit 9 ecological characterization study, and it was confirmed nesting in several areas of the Main Hill and South Property. The Amur honeysuckle thickets on the SM/PP Hill were found to provide refuge during the winter for large numbers (several hundred) of robins.

Mallard

The mallard (*Anas platyrhynchos*) is perhaps the most recognizable species of waterfowl. The male has a green head and neck and a narrow white ring below. The female has a brownish head and neck, and both sexes have a bluish violet speculum (wing patch) bordered before and behind

by a white bar. The mallard is widely distributed in the Northern Hemisphere, breeding in North America from the Arctic coast of Alaska, south to Virginia, Ohio, Illinois, Kansas, southern Texas, New Mexico, and lower California. The mallard constructs its nest of cattails, reeds, grass, concealed by vegetation, and usually near water. Its diet consists of seeds and shoots of sedge, grass, and aquatic vegetation, grain, acorns, insects and aquatic invertebrates. In the Dayton area, the mallard is a common migrant, locally common winter resident, and a fairly common breeder. At the Mound Plant, during the 1992 Operable Unit 9 ecological characterization, two groups of young (26 individuals) were seen in the asphalt-lined pond during the summer sampling period. The hens had nested in the cattails at the northwest corner of the pond. Mallards were seen at the Mound Plant during all sampling periods in 1992. On 1 and 2 February 2000, mallards were observed using the Overflow Creek.

2.5 Target Aquatic Receptors

Aquatic invertebrates were selected as receptors because of their close association with a benthic (i.e., sediment) environment. Fish and other aquatic biota were selected as receptors inhabiting a surface water environment. In this screening-level evaluation, the target aquatic receptors are those plant and animal populations inhabiting the South Pond and the Overflow Creek.

2.6 Complete Exposure Pathways

For an exposure pathway to be complete, a contaminant must be able to travel from the source to ecological receptors and to be taken up by the receptors via one or more exposure routes (EPA 1998). For terrestrial animals, there are three basic chemical exposure routes: ingestion, inhalation, and dermal absorption. Little information is available for quantifying the inhalation or dermal absorption exposure pathways for terrestrial animals. Although these exposure pathways may be complete, the risk is considered minimal when compared to ingestion. While reptiles and amphibians may be exposed to site contamination, evaluation of these receptor groups is not considered due to the lack of exposure and toxicity data for these organisms.

For terrestrial plants, root absorption of contaminants in soil or leaf absorption of contaminants evaporating from the soil are potential exposure routes. For soil-dwelling organisms, direct contact with the dermis and ingestion of contaminated soil are the primary exposure routes. For aquatic organisms, direct contact with water or sediment with the gills or dermis and ingestion of water, food, and sediments are the primary exposure routes. For all ecological receptors, there is also the potential for direct gamma radiation resulting from the radioactive decay of plutonium-238 and the other radionuclide COPCs. For radionuclides, internal exposure (via ingestion and inhalation) and external exposures are the primary exposure routes for ecological receptors.

2.7 General Assessment Endpoints

Assessment endpoints are "explicit expressions of the environmental value that is to be protected" (EPA 1998). The ecological resources selected to represent management goals for environmental protection are reflected in the assessment endpoint. Assessment endpoints link the risk assessment to management concerns and they are central to conceptual model development

(EPA 1998). The following principal criteria are used when selecting assessment endpoints (EPA 1998):

- The contaminants present and their concentrations.
- Mechanisms of toxicity of the contaminants to different groups of organisms.
- Ecologically relevant receptor groups that are potentially sensitive or highly exposed to the contaminant and attributes of their natural history.
- Potentially complete exposure pathways.

The preliminary assessment endpoints for the Canal site are presented in Table 2-4.

2.8 Conceptual Model

The conceptual model establishes the complete exposure pathways that are evaluated in the ecological risk assessment and the relationship of the measurement endpoints to the assessment endpoints (EPA 1997). The conceptual model for the Canal site is presented in Table 2-5.

Based on the conceptual site model, the following exposure scenarios, which are based on the presence of adequate habitat for the selected receptor species, were included in the environmental evaluation of the site.

2.8.1 Miami-Erie Canal Habitat

- A primary consumer (herbivore) hazard quotient evaluation for mammalian species, where cumulative internal (i.e., consumption of vegetation, incidental ingestion of soil, inhalation of dust (radiological only)) and external exposure is compared with published or derived toxicity reference values.

- A secondary consumer (carnivore/insectivore) hazard quotient evaluation for an avian and mammalian species, where cumulative internal (i.e., consumption of insects/earthworms, incidental ingestion of soil, inhalation of dust (radiological only)) and external exposure is compared with published or derived toxicity reference values.

2.8.2 South Pond and Overflow Creek Habitat

- A primary consumer (herbivore) hazard quotient evaluation for avian and mammalian species, where cumulative exposure (i.e., consumption of vegetation, incidental ingestion of sediment and surface water) is compared with published or derived toxicity reference values.

- A secondary consumer (piscivore) hazard quotient evaluation for an avian and a mammalian species, where cumulative exposure (i.e., consumption of fish, incidental ingestion of sediment and surface water) is compared with published or derived toxicity reference values.

- Aquatic community hazard quotient evaluation for fish and benthic organisms that are directly exposed to chemical and radiological COPCs in surface water and sediment, where media concentrations are compared with surface water and sediment quality benchmarks.

Table 2-4

Preliminary Assessment Endpoints
Miami-Erie Canal Mound Plant
Montgomery County, Ohio

Preliminary Assessment Endpoint
Miami-Erie Canal Potential reduction of mammal and avian populations resulting from chronic exposure to COPCs in soil along the former Canal. COPC bioacccumulation and biomagnification in flora and fauna associated with potential adverse effects.
Overflow Creek Potential reduction of mammal and avian populations resulting from chronic exposure to COPCs in sediment and surface water in the Overflow Creek. COPC bioacccumulation and biomagnification in flora and fauna associated with potential adverse effects. Changes in aquatic community (i.e., fish and benthic invertebrates) structure and function attributable to COPCs measured in surface water and sediment in the Overflow Creek.
South Pond Potential reduction of mammal and avian populations resulting from chronic exposure to COPCs in sediment and surface water in the South Pond. COPC bioacccumulation and biomagnification in flora and fauna associated with potential adverse effects. Changes in aquatic community (i.e., fish and benthic invertebrates) structure and function attributable to COPCs measured in surface water and sediment in the South Pond.

Table 2-5

Preliminary Ecological Conceptual Site Model
Miami-Erie Canal Mound Plant
Montgomery County, Ohio

Exposure Medium	Exposure Route	Birds	Mammals	Reptiles / Amphibians	Fish	Macrobenthos
Soil	Ingestion	X	X	Δ	--	--
Miami-Erie Canal	Dermal contact	O	O	Δ	--	--
	Inhalation	O	O	Δ	--	--
	External	X	X	Δ	--	--
	Food/Prey	X	X	Δ	--	--
Sediment	Ingestion	X	X	Δ	O	X
Overflow Creek; South Pond	Dermal contact	O	O	Δ	O	X
	External	O	O	Δ	X	X
	Food/Prey	X	X	Δ	O	X
Surface water	Ingestion	X	X	Δ	X	O
Overflow Creek; South Pond	Dermal contact	O	O	Δ	X	O
	External	O	O	Δ	X	X
	Inhalation	O	O	Δ	X	O
	Food/Prey	X	X	Δ	X	O

X = Potential exposure route determined to be significant for this receptor.
O = Potential exposure route determined to be insignificant for this receptor.
Δ = Potential exposure route cannot be quantified due to lack of exposure and toxicity data.
-- = Potential exposure route not of concern for this receptor.

3.0 SCREENING-LEVEL ECOLOGICAL EFFECTS EVALUATION

The screening-level ecological effects evaluation focuses on developing toxicity reference values (TRVs) for COPCs, as well as determining the complete exposure pathways that exist at the site (EPA 1996).

3.1 Constituents of Potential Concern

Plutonium-238 and all other radionuclides in soil, surface water, and sediment above site-specific background levels are considered to be radiological constituents of potential concern (COPCs). To determine COPCs in Canal soils, South Pond sediments, and Overflow Creek sediments, the maximum detected concentration of a contaminant was compared to U.S. EPA Region V Ecological Data Quality Levels (EDQLs) (EPA 1999a) and site-specific background levels. To determine COPCs in South Pond and Overflow Creek surface water, the maximum detected concentration of a contaminant was compared to Ohio EPA outside mixing zone average water quality standards. If a state standard was not available, Region V surface water EDQLs or federal water quality criteria were used for screening. The results of the screening are provided in Appendix A, including a summary of the site-specific background levels. Ecological receptors are not expected to be exposed to soil deeper than about 2 feet below ground surface (bgs); thus, soils collected below this depth were not evaluated.

3.1.1 Toxicological Profiles

Radionuclides

Ionizing radiation exists as background radiation from terrestrial sources, building materials, food, and cosmic sources to name a few. Acute doses of ionizing radiation at high levels are known to produce biological effects from chromosomal changes to cell death. A low level chronic radiation dose of 1 rem increases the risk of cancer in humans by $2x10^{-4}$. Ionizing radiation affects cells directly by breaking chromosome or indirectly by forming radicals. The amount of dose (measured in mrem), dose rate, type of radiation, energy of radiation, and type of cell are all factors in the affects radiation has on cells. Generally, larger acute doses of radiation to cells undergoing division have more of a biological effect. Radioisotopes naturally decay causing a decrease in their activities or concentrations. Each radioisotope has a unique half-life that is a measure of how long it will take for the half of the radioactive isotope to decay.

Tritium (Hydrogen-3)

Tritium is an isotope of hydrogen with one proton and two neutrons. Tritium is naturally occurring with levels of 6-24 pCi/liter of water (H_2O) prior to the advent of bomb testing. Tritium emits a low energy beta particle. It decays with a half-life of 12 years, but the body eliminates the radionuclide with approximately a 10 day (4-18) biological half-life. Tritium does not concentrate in any organ and is metabolized as water.

Thorium-228

Thorium-228 (Th-228) is a naturally occurring isotope as a member of the thorium-232 decay series. Th-228 emits an alpha particle and decays into radium-224. Th-228 also emits gamma rays following 2% of all disintegrations. Thorium-228 will have the same metabolic properties as Th-230 including biological half-life and target organs.

Thorium-230

Thorium-230 (Th-230) is a naturally occurring isotope as a member of the Uranium-238 decay series. The average amount of thorium-230 in the body is 3 pCi from natural sources. Th-230 emits an alpha particle and decays into radium-226. It has a half-life of 8×10^4 years with a biological half-life of 8×10^3 days in bone and 700 days for all other organs. Seventy percent of thorium when taken in the body will deposit in the bone, while 4% deposits in the liver and 16% in all remaining organs.

Thorium-232

Thorium-232 is also naturally occurring and is the start of the thorium decay series. The average amount of thorium-232 intake from natural sources is 5×10^{-7} g/day with a total amount in the body of 1.4 pCi. Th-232 emits an alpha particle and decays into radium-228. It has a half-life of 1.41×10^{10} years. Thorium-232 will have the same metabolic properties as Th-230 including biological half-life and target organs.

Uranium-234

Uranium-234 is naturally occurring as a member of the uranium-238 decay series. U-234 emits an alpha particle and is the precursor of thorium-230. It has a half-life of 4.51×10^9 years. Uranium-234 will have the same metabolic properties as U-235 including biological half-life and target organs.

Uranium-235

Uranium-235 is naturally occurring and is the start of the uranium-235 decay series. The average amount of uranium-235 intake from natural sources is 1.9×10^{-6} g/day with a total amount in the body of 9×10^{-6} g natural uranium. U-235 emits an alpha particle and decays into thorium-231. U-235 has a half-life of 7.04×10^8 years with a biological half-life of 8×10^3 days in the kidney and two components of biological half life in the skeleton of 20 and 5000 days. Chemical effects to the kidney are likely to be more important than radiation effects to the body. Radiation effects to the kidneys and lungs must be considered if the uranium is enriched (higher percentage of U-235).

Uranium-238

Uranium-238 is naturally occurring and is the start of the uranium-238 decay series. U-238 emits an alpha particle and decays into thorium-234. It has a half-life of 4.51×10^9 years. Uranium-238 will have the same metabolic properties as U-235 including biological half-life and target organs.

Plutonium-238

Plutonium-238 emits an alpha particle and decays into uranium-234. It has a half-life of 87.7 years. Since U-234 has a much longer half-life than Pu-238, the build up of uranium-234 activity from Pu-238 decay is small. Pu-238 has a 100-year biological half-life in bone and 40 years in the liver. When plutonium is taken into the body, 45% will deposit in bone, mostly on endosteal surfaces, and 45% will deposit in the liver.

Plutonium-239

Plutonium-239 emits an alpha particle and decays into uranium-235. Pu-239 is produced in thermal nuclear reactors when uranium-238 absorbs a neutron. It has a half-life of 2.4×10^4 years. Since U-235 has a much longer half-life, the build up of uranium-235 activity is small. Plutonium-239 will have the same metabolic properties as Pu-238.

Plutonium-240

Plutonium-240 emits an alpha particle and decays into uranium-236. It has a half-life of 6537 years. Since U-236 has a much longer half-life, the build up of uranium-236 activity is small.

Chemicals

Polycyclic aromatic hydrocarbons (PAHs)

PAHs are composed of carbon and hydrogen atoms that are arranged in the form of two or more fused aromatic (benzene) rings. Low-molecular weight PAHs (LPAHs) are defined as compounds with two or three aromatic rings, and high-molecular weight PAHs (HPAHs) contain four or more rings (Neff 1985). Concern about PAHs in the environment is due to their persistence and to the fact that some are known to be potent mammalian carcinogens. In contrast, the environmental effects of most noncarcinogenic PAHs are poorly understood (Eisler 1987a). Benzo(a)pyrene, a HPAH, is the best studied individual PAH. The noncarcinogenic PAHs are generally associated with growth reductions and impaired survival. PAHs vary substantially in their toxicity aquatic organisms; with toxicity generally increasing with increasing molecular weight (Eisler 1987a). Uptake of PAHs can be substantial, but metabolism is usually rapid except in some species of invertebrates (Eisler 1987a). Biomagnification is not of concern for PAHs.

Phthalates

Phthalates are man-made chemicals that are added to plastics to make them flexible (ATSDR 1991). They are also common laboratory contaminants. Animal data show that bis-2-(ethylhexyl)phthalate (BEHP) can have effects on the liver, testes, kidney, thyroid, and pancreas. Cancer of the liver has also been observed in rodents exposed to high concentrations of BEHP over a lifetime. It tends to sorb strongly to soil and sediments and to bioconcentrate in aquatic organisms. While phthalates have relatively high octanol-water partition coefficients, rapid metabolism in higher organsims seems to prevent biomagnification in the food chain (ATSDR 1991).

Heavy Metals

The metals of concern at this site include antimony, arsenic, barium, cadmium, chromium, copper, lead, mercury, selenium, thallium, vanadium, and zinc. Antimony is naturally present in the earth's crust. Anthropogenic sources include metal smelting, coal-fired power plants, and refuse incineration. Antimony does not appear to appreciably bioconcentrate in fish and aquatic organisms. Uptake from soil is minor, and is correlated with the amount of available antimony. Antimony bioconcentration has been measured in small mammals, though biomagnification from lower to higher trophic levels in the food chain has not been suggested (ATSDR 1990a).

Arsenic is a relatively common element. In general, inorganic arsenic is more toxic than organic compounds, and trivalent species are more toxic than pentavalent species (Eisler 1988a). Episodes of arsenic poisoning are either acute or subacute; cases of chronic arsenosis are rarely encountered (Eisler 1988a). Arsenic is a teratogen and carcinogen that can traverse placental barriers and produce fetal death and malformations in many species of mammals (Eisler 1988a). Arsenic is bioconcentrated by organisms, but it is not biomagnified in the food chain (Eisler 1988a).

Barium enters the environment from both natural and industrial processes. In aquatic systems, barium is likely to precipitate out of solution as an insoluble salt. Barium is concentrated by aquatic organisms and can be taken up by vegetation. However, the extent to which plants bioconcentrate barium from soil or to which uptake occurs in terrestrial animals is not well characterized (ATSDR 1990b).

Aquatic and terrestrial organisms bioaccumulate **cadmium** at all levels of the food chain (Eisler 1985a). Mammals are less susceptible to the acute toxic effects of cadmium than aquatic insects and fish. Sublethal effects in birds and other species include growth retardation, anemia, and testicular damage (Eisler 1985a). Teratogenic effects on animals appears to be greater for cadmium than for other metals (Eisler 1985a). Cadmium does not biomagnify.

Toxic effects of **chromium** are primarily expressed at lower trophic levels (Eilser 1986). Under laboratory conditions, chromium is mutagenic, carcinogenic, and teratogenic (Eisler 1986). Potential endpoints include growth reductions and impaired survival (Eisler 1986). Trivalent chromium is generally less toxic than hexavalent chromium (Eisler 1986). In animals, hexavalent chromium is readily converted to trivalent chromium (Eisler 1986). For aquatic life, younger life stages are more sensitive than older organisms. Chromium does not biomagnify.

Copper is an essential element for hemoglobin synthesis and oxidative enzymes, and is well regulated by the body (Talmage and Walton 1991). There is inadequate animal data from assays of copper compounds for carcinogenicity and equivocal mutagenicity data (IRIS 1999). Copper does not appear to bioconcentrate very much in the edible portion of freshwater aquatic species (EPA 1986).

Lead is neither essential nor beneficial to living organisms. Existing data indicate that its metabolic effects are adverse (Eisler 1988b). Lead accumulates in algae, macrophytes, and benthic organisms, but the inorganic forms do not biomagnify (Eisler 1988b). In higher level

organisms, lead toxicity has been associated with ingestion of lead shot and organolead, and with food chain exposure. Potential endpoints of toxicity include behavior, reproduction, growth reduction, and impaired survival (Eisler 1988b).

Elemental **mercury** has no known normal metabolic function (Eisler 1987b). Mercury is a mutagen, teratogen, and carcinogen, and causes embryocidal, cytochemical, and histopathological effects (Eisler 1987b). Methylmercury can be bioconcentrated and biomagnfied through food chains (Eisler 1987b). For all organisms, early developmental stages are the most sensitive, and organomercury compounds are more toxic than inorganic forms (Eisler 1987b).

Although **selenium** occurs naturally in the environment, it also can be released by both natural and manufacturing processes (ATSDR 1994). While selenium deficiency is not as well documented as selenium poisoning, it may be equally significant (Eisler 1985b). Minimum toxic concentrations fed to rats resulted in liver changes. High bioconcentration and accumulation of selenium from water has been found for algae, fish, and invertebrates (Eisler 1985b). When the environment favors soluble forms of selenium (alkaline and oxidizing conditions), these forms can be accumulated by plants (ATSDR 1994).

Thallium is a heavy metallic element that exisits in the environment mainly combined with other elements (primarily oxygen, sulfur, and the halogens. It is quite stable in the environment, since it is neither transformed nor biodegraded. Thallium may be bioconcentrated by organisms from water. Plants can absorb thallium from soil, and thereby enter the terrestrial food chain (ATSDR 1990). No information is available on the potential for biomagnification of thallium in the food chain (ATSDR 1990c).

Vanadium enters the environment from both natural and anthropogenic sources. Some marine organisms bioconcentrate very efficiently. In general marine plants and invertebrates contain higher levels of vanadium than terrestrial plants and animals. Vanadium does not appear to concentrate in aboveground portion of plants. While no data are available regarding biomagnification of vanadium, studies suggest that this is unlikely (ATSDR 1990d).

Zinc is an essential trace element for all living organisms. The balance between zinc excess and insufficiency is important. Zinc deficiency occurs in many plant and animal species, and has severe adverse effects on all stages of growth, development, reproduction, and survival (Eisler 1993). Zinc has its primary adverse effect on zinc-dependent enzymes that regulate RNA and DNA. The pancreas and bone are primary targets in birds and mammals, while the gill epithelium is a primary target site in fish.

3.2 Development of Toxicity Reference Values

For each COPC with a potentially complete exposure pathway, a screening-level toxicity reference value (TRV) was developed from a review of literature. TRVs based on dose are used for bird and mammal receptors and TRVs based on media concentrations are used for fish and benthic organisms.

3.2.1 Dose-based TRVs

Chemicals

For chemicals, toxicity reference values based on no-observed-adverse-effect-levels (NOAELs) were developed for each receptor class (i.e., birds and mammals). NOAEL-based TRVs represent values believed to be nonhazardous for the listed wildlife species, and is lowest exposure level shown not to produce adverse effects in a potential receptor. Most dose-based toxicity data were obtained from EPA (1999b) and Sample et al. (1996). If a TRV was not directly available from toxicity studies, a TRV was extrapolated from available studies following methods recommended by EPA (1999b). TRVs could not be developed for all chemicals; those with no available toxicity data are discussed in the Uncertainty Analysis (Subsection 5.4).

If a chronic NOAEL was not available for a constituent, uncertainty factors were used to adjust the available toxicity data to a chronic NOAEL. A factor of 10 was used to adjust from a LOAEL to a NOAEL, and to adjust from an acute to chronic value (EPA 1999a). Studies have found that the ratio of an LD_{50} to a chronic NOAEL typically ranges from 10 to 10,000 (Sample et al. 1996). An uncertainty factor of 100 was used to adjust an LD_{50} to a chronic NOAEL (EPA 1999b). To account for differences between test species and the receptor species, a body-weight scaling factor was used, following methodology developed in Sample et al. (1996). A scaling factor of 1 is assumed for avian species and species-specific scaling factors for mammals are presented in Appendix B. The dose-based TRVs for the receptors of concern are also presented in Appendix B.

Radionuclides

For radionuclides, the International Atomic Energy Agency (IAEA) recommends limiting the dose for terrestrial organisms to 100 mrad/day (IAEA 1992; Sample et al. 1997). This dose limit is based on studies evaluating reproductive success and survival. A dose rate of 1 rad/day is generally considered protective of plant and invertebrate populations (IAEA 1992; Barnthouse 1995; Sample et al. 1997). This dose limit is based on studies of productivity and community characteristics. Invertebrates tend to be less radiosensitive than plants or vertebrates, and indirect responses to radiation-induced vegetation changes (e.g., habitat alteration) appear to be more critical than direct effects (e.g., mortality) from radiation (IAEA 1992; Sample et al. 1997). The recommended acceptable dose rate to natural populations of aquatic biota is 1 rad/day based on results of the reviews summarized in NCRP Report No. 109 (NCRP 1991; BJC 1998). This limit was intended to apply to the most radiosensitive populations of aquatic organisms (BJC 1998).

3.2.2 Media-based TRVs

Chemicals

As a means of characterizing aquatic toxicity, ambient water quality criteria (AWQC) have been developed for the protection of 95 percent of all aquatic life where sufficient data are available (EPA 1992). Not only fish, but also aquatic invertebrates and plants are protected (EPA 1986a). The Ohio EPA has established water quality standards to protect aquatic life habitat (Ohio

Administrative Code, Chapter 3745-1). For metals, most water quality criteria are hardness-dependent. Surface water data were used to calculate hardness values and hardness-dependent criteria for each water body.

Various agencies (CCME 1999; Long et al. 1995; Jones et al. 1996) have developed sediment quality criteria and benchmarks for the assessment of toxicological effects on sediment-associated biota. Note that these benchmarks are not remediation goals; remediation goals must consider the adverse effects on habitat and remobilization of contaminants caused by removal or remediation of sediments (Jones et al. 1996). The sediment benchmarks should not be considered as the sole measure of sediment toxicity; rather, field studies and toxicity tests are primary indicators of sediment toxicity (Jones et al. 1996). The sediment benchmarks provide a means to determine which chemicals are most likely causing toxicity as presented in Jones et al. (1996). "The use of multiple benchmarks also provides an indication of the likelihood and nature of effects. For example, exceedance of only one conservatively estimated benchmark may provide weak evidence of real effects, whereas exceedance of mulitple benchmarks of varying conservatism may provide strong evidence of real effects."(Jones et al. 1996).

The Canadian Council of Ministers of the Environment (Smith et al. 1996; CCME 1999) has developed a set of environmental quality guidelines that include sediment quality guidelines for the protection of aquatic life. The guidelines include a threshold effect level (TEL), which represent the concentration below which adverse effects were expected to occur rarely, and the probable effect level, which is defined as the level above which adverse effects were expected to occur frequently. The TEL is also generally recommended as the interim freshwater sediment quality guideline (ISQG). Concentrations that fall between the range of TEL and PEL are occasionally expected to be associated with adverse biological effects.

The National Oceanic and Atmospheric Administration (NOAA) has developed sediment effect ranges to determine concentrations of chemicals which are likely to result in effects based upon available sediment data collected primarily in marine and estuarine environments throughout the United States (Long et al. 1995). The Effects Range-Low (ER-L) values represent the lower tenth percentile of the range of concentrations in which effects were observed or predicted. The Effects Range-Median (ER-M) values represent median concentrations.

Radionuclides

Using methods presented in Blaylock et al. (1993), the Bechtel Jacobs Company (BJC) (1998) has developed benchmarks for radionculides in sediment and surface water that result in a total dose rate of 1 rad/day for fish. Two types of benchmarks were derived: single-media benchmarks and multimedia benchmarks. The benchmarks include exposures from parent isotopes and all short-lived daughter products. They also include exposures from all major alpha, beta, and gamma emissions for each isotope. The single-media benchmarks are based on exposures to radionuclides in one medium but not the other. The Water benchmarks include internal and external exposures from water only. The Sediment benchmarks include only external exposures from sediment. These benchmarks are intended for use when both water and sediment data are available. That is, measured sediment concentrations should be compared to the sediment values and collocated water measurements should be compared to the water values (BJC 1998).

The multimedia benchmarks are for use when only one medium was sampled at a site. The water benchmarks account for internal exposures, external exposures to water, and external exposures to sediment. The sediment concentrations are estimated from the water concentrations using the radionuclide-specific soil-water partition coefficients (Kd). The sediment benchmarks account for external exposures to sediment plus internal exposures, which were estimated based on the radionuclide-specific transfer factors (i.e., the Kd and BCF). Due to the uncertainty associated with use of generic transfer factors, the single-media benchmarks are considered to be more reliable than the multimedia benchmarks (BJC 1998).

4.0 SCREENING-LEVEL EXPOSURE ESTIMATE

The screening-level total effective dose equivalent (TEDE) involves the selection of exposure parameters for use in calculating a daily exposure dose or exposure concentration. Measured environmental medium concentrations (e.g., surface water, sediment, and soil) are used for estimating TEDE of terrestrial and aquatic wildlife to site contaminants.

4.1 Dose-Based Exposure

4.1.1 Radionuclide Exposure

To estimate radionuclide exposure by ecological receptors (i.e., plants, earthworms, and terrestrial wildlife), a radiation dose rate in millirads per day (mrad/d) was calculated for each receptor group following the methodology described in *Methods and Tools for Estimation of the Exposure of Terrestrial Wildlife to Contaminants (*Sample et al. 1997). This methodology uses radionuclide exposure point concentrations in environmental media such as surface water, soil, and sediment, and radionuclide-, media-, receptor- and pathway-specific factors to calculate doses from alpha, beta, and gamma emissions and includes dose rates from all short-lived daughter products. Dose rates from each radionculide (plus appropriate daughters) are then summed over all exposure routes and all radionuclides to calculate an estimate of the TEDE received for each receptor (Sample et al. 1997).

Exposure routes evaluated for radionuclides include external exposure through direct radiation from soil (both aboveground and belowground) and internal exposure through ingestion of soil, prey, and water and through inhalation of contaminated dust. Radionuclide exposure concentrations and doses are presented in Appendix C.

<u>External Exposure: Direct Radiation from Soil</u>

The equation for aboveground dose from external exposures for a plant or wildlife receptor is (Sample et al. 1997):

$$D\ abovegrd = F\ above \times F\ ruf \sum C\ soil,i \times DF\ grd,i \times CFb \times ECF$$

Where:

D abovegrd	=	External dose rate to receptor from aboveground exposures to contaminated soil above ground (mrad/d).
F above	=	Dose rate reduction factor accounting for the fraction of time the receptor spends above ground (unitless).

F ruf	=	Dose rate reduction factor accounting for ground roughness (unitless) [Representative average of 0.7 (Eckerman and Ryman 1993) is reasonable default].
C soil,i	=	Activity of radionuclide *i* in surface soil (pCi/g).
DF grd,i	=	Dose coefficient for radionuclide *i* in soil contaminated to given depth (Eckerman grd,iand Ryman 1993) (Sv/sec per Bq/min).
CFb	=	Conversion factor to change Sv/sec per Bq/min to mrad g/pCi d (Equals 5.12×10^{14}).
ECF	=	Elevation correction factor to adjust dose coefficients to value representative of effective height of animal aboveground.

The equation for below ground external exposures of earthworms and wildlife receptors is (Sample et al. 1997):

$$D\ belowgrd = 1.05\ F\ below \sum C\ soil,i \times \varepsilon i \times CFa$$

Where:

D belowgrd	=	External dose rate to earthworm or wildlife receptor in burrow from contaminated soil (mrad/day).
F below	=	Dose rate reduction factor accounting for the fraction of time the receptor spends below ground (unitless).
C soil, i	=	Activity of radionuclide *i* in surface soil (pCi/g).
εi	=	Energy for gamma emissions by nuclide *i* (MeV/nuclear disintegrations (nt)) 1.05 = conversion factor to account for immersion in soil vs. water (estimated value; Keith Eckerman, Health Sciences Research Division, Oak Ridge National Laboratory, personal communication, June 1996).
CFa	=	Conversion factor to go from MeV/nt to g mrad/pCi day (5.12×10^{-2}).

Alpha particles have low penetration ability and are not considered for external exposure. The effective dose coeffients used incorporate both high energy beta and gamma emissions (Sample et al. 1997). Below-ground exposure assumes immersion in a continuous soil medium. The exposure fractions reflect the fraction of time the receptor spends above- and belowground. For this analysis, values of 1 were conservatively applied for both above- and belowground exposure. In addition, all default exposure parameters presented in Sample et al. (1997) were used to estimate external exposure.

Internal Exposure: Ingestion

Wildlife receptors may receive internal radiation doses after ingesting contaminated prey, soil, or water. Internal exposure for wildlife that consume a variety of prey types, ingesting soil, and drinking water, as well as plants and invertebrates taking up contaminants directly from the soil can be estimated as (Sample et al. 1997):

$$D\ ing = \sum QF \times C\ tissue \times \varepsilon i \times CFa \times AF$$

Where:

D ing	=	Internal dose rate received after ingestion of contaminated prey and soil (mrad/day).
QF	=	Quality factor to account for the greater biological effectiveness of α particles (20 for α; 1 for β and γ emissions; unitless).
C tissue	=	Activity (pCi/g) of radionuclide *i* in tissue of organism.
εi	=	Energy for α, β, or γ emissions by nuclide *i* (MeV/nt).
CFa	=	Conversion factor to go from MeV/nt to g mrad/pCi day (5.12×10^{-2}).
AF	=	Absorption factor (unitless).

Intake of contaminants via surface water was not considered for the terrestrial receptors at the Canal because they can obtain water from various sources, including their food supply, dew, and intermittent puddles. Surface water was collected from the South Pond and the Overflow Creek. However, due to the distance between these waterbodies and the Canal, wildlife receptors may not frequent these waterbodies. In addition, no surface water samples were collected from residual standing water within the remediated canal.

Radionuclide activity in tissue was estimated from soil activity using uptake factors and bioaccumulation factors presented in Sample et al. (1997). Absorbed energy fractions for alpha and beta radiation was conservatively assumed to be one for all receptors. Beta absorption fractions may be less than one for plants and earthworms, since some fraction may have sufficient energy to pass through smaller organisms. For gamma radiation, absorption fractions presented in Sample et al. (1997) were used. In addition, all default exposure parameters presented in Sample et al. (1997) were used to estimate ingestion exposure.

Internal Exposure: Inhalation

Wildlife species that use burrows may receive an additional internal dose from inhalation of dust originating from contaminated soil, especially since they may spend a large portion of their time

in belowground burrows. Intake of radionuclides by inhalation is estimated as (DOE 1995b, as cited in Sample et al. 1997):

$$D\ inh = QF \times F\ below \sum C\ soil,i \times A \times AD \times \varepsilon i \times CFa \times AF$$

Where:

D inh	=	Internal dose rate from inhalation of contaminated soil (mrad/day).
F below	=	Dose reduction factor for fraction of time receptor spends below ground (unitless).
Csoil,i	=	Activity of radionuclide *i* in surface soil (pCi/g)
A	=	Mass of respirable dust per volume of air breathed (0.1 g/m^3 ; DOE 1995b).
AD	=	Air density (1200 g/m^3; Eckerman and Ryman 1993).
εi	=	Energy for α, β, or γ emissions by nuclide *i* (MeV/nt).
CFa	=	Conversion factor to go from MeV to mrad g/pCi/day (5.12×10^{-2}).
AF	=	Absorption factor (unitless).

The exposure fraction reflects the fraction of time the receptor spends above- and belowground. For this analysis, a value of 1 was conservatively applied for inhalation exposure. In addition, all default exposure parameters presented in Sample et al. (1997) were used to estimate inhalation exposure.

Chemical Exposure

To estimate chemical exposure by avian and mammalian ecological receptors, exposure doses were estimated for the selected target species using the following general equation:

$$\text{Dose} = (C_{medium} \times IR \times FI) / BW$$

Where:

Dose	=	Daily dose through exposure route, e.g., soil, surface water, prey (mg/kg-day).
IR	=	Ingestion rate of the medium (kg/day or L/day).

C_{medium}	=	Chemical concentration in soil, surface water, or prey (mg/kg or mg/L).
FI	=	Fraction ingested from contaminated source (unitless).
BW	=	Body weight (kg).

Total exposure to a receptor organism can be determined by summing the dose received by soil, food, and water. To ensure that sites which may pose an ecological risk are properly identified, the EPA suggests that exposure values should be consistently biased in the direction of overestimating risk. "Without this bias, a screening evaluation could not provide a defensible conclusion for an absence of ecological risk" (EPA 1996). Conservative assumptions were used to estimate exposure levels in this assessment, including:

- Maximum COPC concentrations at exposure point.
- 100% bioavailability of contaminants.
- 100% of diet consisting of most contaminated food item.
- Minimum body weights and maximum ingestion rates.
- Most sensitive life stage.
- Home range lies entirely within site.

Birds and mammals representing several trophic levels were proposed as the target receptors for this evaluation. Exposure of aquatic wildlife to COPCs occurs primarily when animals feed in areas impacted by site contamination. The species selected as receptors of concern represent a range of feeding relationships within the Canal, the South Pond, and the Overflow Creek. Receptors evaluated include herbivores, insectivores, and carnivores.

The chemical concentration in food (i.e., plants, earthworms, and fish) was estimated using chemical-specific bioconcentration factors (BCFs). Chemical concentrations in plants were estimated by multiplying chemical-specific plant uptake factors (PUFs) by measured soil or sediment concentrations. Bioaccumulation factors (BAFs) were used to estimate earthworm concentrations from soil exposure. To estimate the chemical concentration in fish consumed by piscivores, an aquatic life BAF was applied, which incorporates both water and food consumption. BAFs were predicted by multiplying the aquatic life BCF (i.e., the ratio of the concentration in water to the concentration in fish) by a food chain multiplying factor. For inorganics, BCFs and BAFs are assumed to be equal (EPA 1995a).

4.2 Media-Based Exposure

4.2.1 Radionuclide Exposure

Using methods presented in Blaylock et al. (1993), BJC (1998) has developed benchmarks for radionculides in sediment and surface water that result in a total dose rate of 1 rad/day for fish. Two types of benchmarks were derived: single-media benchmarks and multimedia benchmarks. These benchmarks were used to estimate radionculide exposure by aquatic life in the South Pond and the Overflow Creek.

4.2.2 Chemical Exposure

Chemical exposure by sediment-dwelling organisms and aquatic life such as fish are evaluated in this assessment through direct comparison to ecological benchmarks rather than dose calculations. To estimate chemical exposure by sediment-dwelling organisms and aquatic life, sediment and surface water concentrations are compared directly to toxicity benchmarks (e.g., sediment effects range concentrations and ambient water quality criteria).

5.0 SCREENING-LEVEL RISK CHARACTERIZATION

The screening-level risk characterization integrates information from the screening-level problem formulation, screening-level ecological effects evaluation, and the screening-level exposure estimate to predict the nature and extent of ecological risk or threat, as well as the environmental impact of previous site activities. The hazard quotient (HQ) approach is used as an indicator of the risks posed to surrogate ecological receptors from exposure to site-related contaminants (EPA 1996). The hazard quotient compares exposure values to TRVs, and can be expressed as the ratio of a potential exposure level to the TRV:

$$HQ = \text{Exposure} / \text{TRV}$$

where:

HQ	=	Hazard quotient (unitless).
Exposure	=	Exposure concentration at the exposure point (e.g., mg-contaminant/kg-sediment or pCi/g) or estimated contaminant exposure dose at the exposure point (mg contaminant/kg body weight/day or mrad/day).
TRV	=	Toxicity reference value, i.e. effect dose or effect criteria (in units that match the exposure concentration).

Exposure to the same chemical or radionculide (plus daughters) through multiple exposure routes (e.g., sediment ingestion, prey ingestion) is assumed to be cumulative. Consequently, a total hazard index (HI) for a specific COPC examines the potential risk posed by the COPC through more than one exposure route:

$$HI = \sum HQ_i$$

Where:

HI	= Hazard index (unitless).
HQ_i	= Hazard quotient for exposure route i (unitless).

A hazard quotient (HQ) or HI exceeding 1.0 indicates the species of interest (or the species for which the toxicity data was based on) may be at risk of an adverse effect from the particular COPC, exposure route, or medium on which the HQ (or HI) was based. Further evaluation may be needed in terms of site-specific toxicity data for a given target receptor.

For aquatic life exposure to radionculides, the concentrations of radionculides in water or sediment were screened against single-media and multi-media benchmarks by calculating a HQ. The radiological benchmarks are normalized in an attempt to account for the biological

effectiveness of the different types of radiation, which allows for the calculation of an HI. The HI is the measure of the total dose rate to the organism and accounts for all three exposure pathways: total internal dose, total external dose from water, and total external dose from sediment (BJC 1998).

5.1 Risk to Miami-Erie Canal Ecological Receptors

5.1.1 Radionuclides

Terrestrial organisms may be exposed to radionuclide concentrations in soil via external exposure through direct radiation, via internal exposure through ingestion of soil and food, and via internal exposure through inhalation of contaminated dust. Maximum detected radionuclide concentrations were applied in exposure models to estimate total radionuclide exposure doses. These doses were compared to IAEA-recommended dose limits for terrestrial organisms (e.g., mammals and birds) and plant and invertebrate populations. The total hazard indices for these receptor groups are presented in Table 5-1. The HI is the sum of all exposure routes and all radioncuclides (plus daughters). Due to the conservative method for estimating exposure doses, these risks may be overestimated as discussed further in the Uncertainty Analysis (Section 5.4).

For all receptors, total HIs do not exceed unity, suggesting that the radionuclides measured in the Canal pose a negligible risk to terrestrial biota.

5.1.2 Chemicals

Meadow vole

The meadow vole may be exposed to chemical COPCs through ingestion of plants and soil. The estimated daily dose and the potential risk to a vole are presented in Table 5-2. There is a potential for adverse effects to a vole from exposure to chemical COPCs in Miami-Erie Canal soil. Benzo(a)anthracene and numerous metals were found to be of potential concern. For cadmium and copper, a hazard quotient greater than unity is due to plant ingestion only. For vanadium, a hazard quotient greater than one is due to soil ingestion only. For chromium, a hazard quotient greater than unity is due to soil plus plant ingestion. For benzo(a)anthracene, antimony, barium, iron, lead, silver, and thallium, hazard quotients greater than unity are due to both soil and plant ingestion. Due to the conservative method for estimating exposure doses, these risks may be overestimated as discussed further in the Uncertainty Analysis (Section 5.4).

Of these constituents, antimony, iron, lead, and silver had a hazard quotient greater than 10. An uncertainty factor of 10 is typically used to extrapolate from a no observable adverse effect level (NOAEL) to a lowest observable effect level (LOAEL) (EPA 1997; EPA 1999b). The more conservative NOAEL is the preferred screening exposure level to determine a level that is unlikely to adversely impact populations and to ensure that risk is not underestimated. If a LOAEL value is exceeded, there is more certainty that the contaminants may be adversely impacting ecological receptors.

Table 5-1 Summary of Radionuclide Exposure and Risk
Miami-Erie Canal, Mound Plant

Pathways for Below Ground Receptors	A plants + insects	B Small mammals	C Small-medium mammals	D Medium mammals	E Large mammals	B Small birds	C Small-medium birds	D Medium birds	E Large birds
External									
Below Ground	1.09E+00	1.09E+00	1.09E+00	1.09E+00	1.09E+00	1.09E+00	1.09E+00	1.09E+00	1.09E+00
Ingestion									
Soil	4.58E+00	4.85E+00	6.51E-03						
Food		5.12E-01	5.26E-01	5.33E-01	5.82E-01	5.52E-01	5.66E-01	5.73E-01	6.22E-01
Inhalation	1.02E-01	1.02E-01	1.02E-01	1.02E-01	1.02E-01	1.02E-01	1.02E-01	1.02E-01	1.02E-01
Total Effective Dose Equivalent (mrad/day)	5.67E+00	6.45E+00	1.62E+00	1.62E+00	1.67E+00	1.64E+00	1.66E+00	1.66E+00	1.71E+00
Benchmark (mrad/day)	1.00E+03	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02
Hazard Index	5.67E-03	6.45E-02	1.62E-02	1.62E-02	1.67E-02	1.64E-02	1.66E-02	1.66E-02	1.71E-02

Pathways for Above Ground Receptors	A plants + insects	B Small mammals	C Small-medium mammals	D Medium mammals	E Large mammals	B Small birds	C Small-medium birds	D Medium birds	E Large birds
External									
Above Ground	4.11E-01	4.11E-01	4.11E-01	4.11E-01	4.11E-01	4.11E-01	4.11E-01	4.11E-01	4.11E-01
Ingestion									
Soil	4.58E+00	4.85E+00	6.51E-03						
Food		5.12E-01	5.26E-01	5.33E-01	5.82E-01	5.52E-01	5.66E-01	5.73E-01	6.22E-01
Total Effective Dose Equivalent (mrad/day)	4.99E+00	5.26E+00	4.18E-01	4.11E-01	4.11E-01	4.11E-01	4.11E-01	4.11E-01	4.11E-01
Benchmark (mrad/day)	1.00E+03	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02	1.00E+02
Hazard Index	4.99E-03	5.26E-02	4.18E-03	4.11E-03	4.11E-03	4.11E-03	4.11E-03	4.11E-03	4.11E-03

Table 5-2 Risk to Meadow Vole: Canal Soil
Miami-Erie Canal
Mound Plant, Miamisburg, Ohio

Intake = [(Cs * IRs) + ((Cs * PUF) * IRp)] / BW
HQ = Intake / TRV

Constituent	Soil Concentration	log Kow	Plant Uptake Factor		Plant Concentration	Intake			TRV	Hazard Quotient		
						Soil	Plant	Total		Soil	Plant	Total
Organics												
Benzoic acid	0.22	1.9	3.0889	a,e	0.680	0.011367781	1.4839041	1.4952719	NTV	--	--	--
Bis(2-ethylhexyl)phthalate	44	5.205	0.0380	a	1.670947006	2.273556231	3.6487645	5.9223207	108	0.021	0.034	0.055
Butylbenzylphthalate	0.38	4.8	0.0651	a,e	0.024739083	0.019635258	0.0540215	0.0736568	NTV	--	--	--
Carbazole	1.1	3.2	0.5475	a,e	0.602272017	0.056838906	1.3151517	1.3719906	NTV	--	--	--
Dibenzofuran	0.76	4.21	0.1428	a,d	0.108500963	0.039270517	0.2369282	0.2761987	NTV	--	--	--
Di-n-butylphthalate	4.3	4.6	0.0850	a,e	0.3653158	0.22218845	0.7977221	1.0199105	537.35	0.0004135	0.0014845	0.0018980
Benzo(a)anthracene	7.3	5.679	0.0202	a	0.147523382	0.377203647	0.3221395	0.6993432	0.163	2.314	2.0	4.3
Benzo(a)pyrene	7.9	6.129	0.0111	a	0.087713227	0.408206687	0.191535	0.5997417	0.977	0.418	0.2	0.6
Chrysene	8.1	6.2	0.0101	a	0.081824813	0.418541033	0.1786768	0.5972178	NTV	--	--	--
Naphthalene	0.44	3.2	0.5475	a,e	0.240908807	0.022735562	0.5260607	0.5487962	29.34	0.0008	0.0179	0.0187
Inorganics												
Antimony	81.1	NA	0.2000	a	16.2	4.190577508	35.418813	39.60939	0.1188	35.274	298.1	333.4
Arsenic	27	NA	0.0360	a	0.972	1.395136778	2.1225084	3.5176452	5.54	0.252	0.4	0.6
Barium	234	NA	0.150	a	35.1	12.09118541	76.646137	88.737322	9.18	1.317	8.3	9.7
Cadmium	4.2	NA	0.364	a	1.53	0.217021277	3.3383651	3.5553863	0.977	0.222	3.4	3.6
Chromium	116	NA	0.008	e	0.9	5.993920973	1.899776	7.893697	6.3	0.951	0.3	1.3
Copper	141	NA	0.400	a	56.4	7.285714286	123.15789	130.44361	28.2	0.258	4.4	4.6
Iron	46800	NA	0.0040	b	187.2	2418.237082	408.7794	2827.0165	72	33.587	5.7	39.3
Lead	8190	NA	0.045	a	368.55	423.1914894	804.78443	1227.9759	7.816	54.144	103.0	157.1
Mercury	1.3	NA	0.038	a	0.0	0.067173252	0.106453	0.1736262	2.37	0.028	0.04	0.07
Selenium	2.2	NA	0.016	a	0.0352	0.113677812	0.0768645	0.1905423	0.1954	0.582	0.4	1.0
Silver	11.2	NA	0.400	a	4.48	0.578723404	9.7827548	10.361478	0.366	1.581	26.7	28.3
Thallium	3.2	NA	0.004	a	0.0128	0.165349544	0.0279507	0.1933003	0.0236	7.006	1.2	8.2
Vanadium	34.4	NA	0.0049	C	0.2	1.777507599	0.3680761	2.1455837	0.378	4.702	0.97	5.7
Zinc	481	NA	0.121	c	58	24.85410334	127.09065	151.94475	288	0.086	0.4	0.5

Table 5-2 (cont.)

Constituent	Soil Concentration	log Kow	Plant Uptake Factor	Plant Concentration	Intake			TRV	Hazard Quotient		
					Soil	Plant	Total		Soil	Plant	Total
Anions											
Bismuth	6.1		0.0350 b	12	0.315197568	27.055431	27.370629	NTV	--	--	--
Chloride	354	NA	--	--	18.29179331	--	18.291793	NTV	--	--	--
Nitrate/Nitrite	34.9	NA	--	--	1.803343465	--	1.8033435	1146	0.002	--	0.002
Sulfate	1160	NA	--	--	59.93920973	--	59.93921	NTV	--	--	--

Symbol	Parameter	Value	Source
Cs	Soil concentration (mg/kg)	--	--
IRs	Soil intake rate (kg dw/day)	0.0017	EPA 1993
IRp	Plant intake rate (kg dw/ day)	0.0718	EPA 1993
PUF	Plant uptake factor (unitless)	Chemical-specific	--
BW	Body weight (kg)	0.0329	EPA 1993
TRV	Toxicity reference value (mg/kg/day)	Chemical-specific	Appendix B
log Kow	Octanol-water partition coefficient	Chemical-specific	--

a = EPA 1999b
b = Baes et al. 1984 (based on Bv).
c = Efroymson et al. 1997
d = Montgomery 1991.
e = TNRCC 1996.
NA = Not applicable.
NTV = No toxicity value available.

No mammal TRVs were available for several organic contaminants measured in surface soil, which may contribute to the ecological risk. The uncertainty associated with the lack of screening values is discussed in the Uncertainty Analysis.

Short-tailed Shrew

The short-tailed shrew may be exposed to chemical COPCs through ingestion of earthworms and soil. The estimated daily dose and the potential risk to a shrew are presented in Table 5-3. There is a potential for adverse effects to a shrew from exposure to chemical COPCs in Miami-Erie Canal soil. Bis(2-ethylhexyl)phthalate, di-n-butylphthalate, benzo(a)anthracene and numerous metals were found to be of potential concern. For bis(2-ethylhexyl)phthalate and di-n-butylphthalate, barium, cadmium, selenium, silver, and vanadium, a hazard quotient greater than unity is due to earthworm ingestion only. For benzo(a)anthracene, a hazard quotient greater than unity is due to earthworm plus soil ingestion. For antimony, iron, lead, and thallium, vanadium, hazard quotients greater than unity are due to both soil and earthworm ingestion. Due to the conservative method for estimating exposure doses, these risks may be overestimated as discussed further in the Uncertainty Analysis (Section 5.4).

Of these constituents, bis(2-ethyhexyl)phthalate, antimony, iron, lead, and thallium had a hazard quotient greater than 10. An uncertainty factor of 10 is typically used to extrapolate from a no observable adverse effect level (NOAEL) to a lowest observable effect level (LOAEL) (EPA 1997; EPA 1999b). The more conservative NOAEL is the preferred screening exposure level to determine a level that is unlikely to adversely impact populations and to ensure that risk is not underestimated. If a LOAEL value is exceeded, there is more certainty that the contaminants may be adversely impacting ecological receptors.

No mammal TRVs were available for several organic contaminants measured in surface soil, which may contribute to the ecological risk. The uncertainty associated with the lack of screening values is discussed in the Uncertainty Analysis.

Northern Robin

A robin may be exposed to chemical COPCs through ingestion of earthworms and soil. The estimated daily dose and the potential risk to a robin are presented in Table 5-4. There is a potential for adverse effects to a robin from exposure to chemical COPCs in Miami-Erie Canal soil. Bis(2-ethylhexyl)phthalate, di-n-butylphthalate, benzo(a)anthracene, benzo(a)pyrene, chrysene, naphthalene, and numerous metals were found to be of potential concern. For bis(2-ethylhexyl)phthalate, di-n-butylphthalate, naphthalene, barium, and cadmium, a hazard quotient greater than unity is due to earthworm ingestion only. For chromium, a hazard quotient greater than unity is due to soil ingestion only. For benzo(a)anthracene, benzo(a)pyrene, chrysene, lead, and thallium, hazard quotients greater than unity are due to both soil and earthworm ingestion. Due to the conservative method for estimating exposure doses, these risks may be overestimated as discussed further in the Uncertainty Analysis (Section 5.4).

Table 5-3 Risk to Short-tailed Shrew: Canal Soil
Miami-Erie Canal, Mound Plant Miamisburg, Ohio

Intake = [(Cs * IRs) + ((Cs * BAF) * IRew)] / BW
HQ = Intake / TRV

Constituent	Soil Concentration	log Kow	Earthworm BAF		Earthworm Concentration	Intake			TRV	Hazard Quotient		
						Soil	Earthworm	Total		Soil	Earthworm	Total
Organics												
Benzoic acid	0.22	1.9	2.57	a	0.565617295	0.002678824	0.2994445	0.3021233	NTV	--	--	--
Bis(2-ethylhexyl)phthalate	44	5.205	1309	a	57590.07929	0.535764706	30488.866	30489.401	127.8	0.004	239.0	239.0
Butylbenzylphthalate	0.38	4.8	610	a	231.7307123	0.004627059	122.68097	122.68559	NTV	--	--	--
Carbazole	1.1	3.2	29.8	a	32.82408928	0.013394118	17.377459	17.390853	NTV	--	--	--
Dibenzofuran	0.76	4.21	200	a	152.3363664	0.009254118	80.648665	80.657919	NTV	--	--	--
Di-n-butylphthalate	4.3	4.6	418	a	1798.326134	0.052358824	952.05501	952.10737	632.5	0.0001	1.5	1.5
Benzo(a)anthracene	7.3	5.679	0.03	a	0.219	0.088888235	0.1159412	0.2048294	0.192	0.5	0.6	1.1
Benzo(a)pyrene	7.9	6.129	0.07	a	0.553	0.096194118	0.2927647	0.3889588	1.15	0.1	0.3	0.3
Chrysene	8.1	6.2	0.04	a	0.324	0.098629412	0.1715294	0.2701588	NTV	--	--	--
Naphthalene	0.44	3.2	29.8	a	13.12963571	0.005357647	6.9509836	6.9563413	34.719	0.0002	0.20	0.20
Inorganics												
Antimony	81.1	NA	0.22	a	17.842	0.987511765	9.4457647	10.433276	0.141	7.0	67.0	74.0
Arsenic	27	NA	0.11	a	2.97	0.328764706	1.5723529	1.9011176	6.54	0.050	0.24	0.29
Barium	234	NA	0.22	a	51.48	2.849294118	27.254118	30.103412	10.86	0.3	2.5	2.8
Cadmium	4.2	NA	0.96	a	4.032	0.051141176	2.1345882	2.1857294	1.15	0.04	1.9	1.9
Chromium	116	NA	0.01	a	1.16	1.412470588	0.6141176	2.0265882	7.455	0.2	0.08	0.27
Copper	141	NA	0.04	a	5.64	1.716882353	2.9858824	4.7027647	33.24	0.05	0.09	0.14
Iron	46800		0.0608	b	2845.44	569.8588235	1506.4094	2076.2682	85.2	7.0	18.0	24.0
Lead	8190	NA	0.03	a	245.7	99.72529412	130.07647	229.80176	9.2	11.0	14.0	25.0
Mercury	1.3	NA	0.04	E	0.052	0.015829412	0.0275294	0.0433588	2.798	0.006	0.010	0.015
Selenium	2.2	NA	0.22	a	0.484	0.026788235	0.2562353	0.2830235	0.23	0.1	1.1	1.2
Silver	11.2	NA	0.22	a	2.464	0.136376471	1.3044706	1.4408471	0.431	0.3	3.0	3.3
Thallium	3.2	NA	0.22	a	0.704	0.038964706	0.3727059	0.4116706	0.0279	1.4	13.0	15.0
Vanadium	34.4	NA	0.22	a	7.568	0.418870588	4.0065882	4.4254588	0.4473	0.9	9.0	10.0
Zinc	481	NA	0.56	a	269.36	5.856882353	142.60235	148.45924	340.8	0.017	0.42	0.44

Table 5-3 (cont.)

Constituent	Soil Concentration	log Kow	Earthworm BAF	Earthworm Concentration	Intake			TRV	Hazard Quotient		
					Soil	Earthworm	Total		Soil	Earthworm	Total
Anions (mg/kg)											
Bismuth	6.1	NA	--	--	0.074276471	--	0.0742765	NTV	--	--	--
Chloride	354	NA	--	--	4.310470588	--	4.3104706	NTV	--	--	--
Nitrate/Nitrite	34.9	NA	--	--	0.424958824	--	0.4249588	1354	0.0003	--	0.0003
Sulfate	1160	NA	--	--	14.12470588	--	14.124706	NTV	--	--	--

Symbol	Parameter	Value	Source
Cs	Soil concentration (mg/kg)	--	--
IRs	Soil intake rate (kg dw/day)	2.07E-04	EPA 1999b
IRew	Earthworm intake rate (kg wet/ day)	0.009	EPA 1999b
BAF	Bioaccumulation factor (unitless)	Chemical-specific	--
BW	Body weight (kg)	0.017	EPA 1993
TRV	Toxicity reference value (mg/kg/day)	Chemical-specific	Appendix B

NA = Not applicable.

NTV = No toxicity value.

a = EPA 1999b

b = Beyer and Stafford 1993.

Table 5-4 Risk to American Robin: Canal Soil
Miami-Erie Canal, Mound Plant

Intake = [(Cs * IRs) + ((Cs * BAF) * IRew)] / BW
HQ = Intake / TRV

Constituent	Soil Concentration	log Kow	Earthworm BAF		Earthworm Concentration	Intake			TRV	Hazard Quotient		
						Soil	Earthworm	Total		Soil	Earthworm	Total
Organics												
Benzoic acid	0.22	1.9	2.57	a	0.56562	0.00314	0.249	0.252	NTV	--	--	--
Bis(2-ethylhexyl)phthalate	44	5.205	1309	a	57590.07929	0.62700	25339.635	25340.262	1.11	0.6	22828.5	22829.1
Butylbenzylphthlate	0.38	4.8	610	a	231.7307123	0.00542	101.962	101.967	NTV	--	--	--
Carbazole	1.1	3.2	29.8	a	32.82408928	0.01568	14.443	14.458	NTV	--	--	--
Dibenzofuran	0.76	4.21	200	a	152.3363664	0.01083	67.028	67.039	NTV	--	--	--
Di-n-butylphthalate	4.3	4.6	418	a	1798.326134	0.06128	791.263	791.325	0.11	0.6	7193.3	7193.9
Benzo(a)anthracene	7.3	5.679	0.03	a	0.219	0.10403	0.096	0.200	0.00079	131.7	122.0	253.7
Benzo(a)pyrene	7.9	6.129	0.07	a	0.553	0.11258	0.243	0.356	0.001	112.6	243.3	355.9
Chrysene	8.1	6.2	0.04	a	0.324	0.11543	0.143	0.258	0.001	115.4	142.6	258.0
Naphthalene	0.44	3.2	29.8	a	13.12963571	0.00627	5.777	5.783	3.47	0.0018	1.7	1.7
Inorganics												
Antimony	81.1	NA	0.22	a	17.842	1.2	7.9	9.0	NTV	--	--	--
Arsenic	27	NA	0.11	a	2.97	0	1.3	1.7	2.46	0.16	0.53	0.69
Barium	234	NA	0.22	a	51.48	3.3345	22.6512	25.9857	20.826	0.16	1.09	1.25
Cadmium	4.2	NA	0.96	a	4.032	0.0599	1.7741	1.8339	1.45	0.04	1.22	1.26
Chromium	116	NA	0.01	a	1.16	1.6530	0.5104	2.1634	1.0	1.65	0.51	2.16
Copper	141	NA	0.04	a	5.64	2.0093	2.4816	4.4909	46.97	0.04	0.05	0.10
Iron	46800	NA	0.0608	b	2845.44	666.9	1252.0	1918.9	NTV	--	--	--
Lead	8190	NA	0.03	a	245.7	116.7075	108.1080	224.8155	1.13	103.3	95.7	199.0
Mercury	1.3	NA	0.04	a	0.052	0.0185	0.0229	0.0414	3.25	0.006	0.007	0.013
Selenium	2.2	NA	0.22	a	0.484	0.0314	0.2130	0.2443	0.5	0.06	0.43	0.49

Table 5-4 (cont.)

Constituent	Soil Concentration	log Kow	Earthworm BAF		Earthworm Concentration	Intake			TRV	Hazard Quotient		
						Soil	Earthworm	Total		Soil	Earthworm	Total
Silver	11.2	NA	0.22	a	2.464	0.160	1.084	1.244	178	0.001	0.006	0.007
Thallium	3.2	NA	0.22	a	0.704	0.046	0.310	0.355	0.35	0.13	0.89	1.02
Vanadium	34.4	NA	0.22	a	7.568	0.4902	3.3299	3.8201	11.4	0.04	0.29	0.34
Zinc	481	NA	0.56	a	269.36	6.8543	118.5184	125.3727	130.9	0.05	0.91	0.96
Anions												
Bismuth	6.1	NA	--			0.087	0.000	0.087	NTV	--	--	--
Chloride	354	NA	--			5.045	0.000	5.045	NTV	--	--	--
Nitrate/Nitrite	34.9	NA	--			0.497	0.000	0.497	NTV	--	--	--
Sulfate	1160	NA	--			16.530	0.000	16.530	NTV	--	--	--

Symbol	Parameter	Value	Source
Cs	Soil concentration (mg/kg)	--	--
IRs	Soil intake rate (kg dw/day)	1.14E-03	EPA 1999b
IRew	Earthworm intake rate (kg wet/ day)	0.0352	EPA 1999b
BAF	Bioaccumulation factor (unitless)	Chemical-specific	--
BW	Body weight (kg)	0.08	EPA 1999
TRV	Toxicity reference value (mg/kg/day)	Chemical-specific	Appendix B

NA = Not applicable.
NTV = No toxicity value available.
a = EPA 1999b
b = Beyer and Stafford 1993.

Of these constituents, bis(2-ethyhexyl)phthalate, di-n-butylphthalate, benzo(a)anthracene, benzo(a)pyrene, chrysene, and lead had a hazard quotient greater than 10. An uncertainty factor of 10 is typically used to extrapolate from a no observable adverse effect level (NOAEL) to a lowest observable effect level (LOAEL) (EPA 1997; EPA 1999b). The more conservative NOAEL is the preferred screening exposure level to determine a level that is unlikely to adversely impact populations and to ensure that risk is not underestimated. If a LOAEL value is exceeded, there is more certainty that the contaminants may be adversely impacting ecological receptors.

No avian TRVs were available for several organic and inorganic contaminants measured in surface soil, which may contribute to the ecological risk. The uncertainty associated with the lack of screening values is discussed in the Uncertainty Analysis.

5.2 Risk to South Pond Ecological Receptors

5.2.1 Radionuclides

Aquatic organisms may be exposed to radionuclide concentrations in sediment and surface water through internal exposure to water and external exposures to water and sediment. Single-media and multimedia benchmarks were used to calculate hazard quotients and hazard indices (Table 5-5 and 5-6). The screening HQs and HI do not exceed unity, suggesting that the radionuclides measured in the South Pond pose a negligible risk to aquatic biota.

5.2.2 Chemicals

Muskrat

A muskrat may be exposed to chemical COPCs in the South Pond through ingestion of plants, sediment, and surface water. The estimated daily dose and the potential risk to a muskrat are presented in Table 5-7. There is a limited potential for adverse effects to a muskrat from exposure to chemical COPCs in South Pond sediments. Only aluminum was found to be of potential concern through sediment and plant ingestion. Due to the conservative method for estimating exposure doses, this risk may be overestimated as discussed further in the Uncertainty Analysis (Section 5.4).

The total HI for aluminum (20.2) exceeded 10. An uncertainty factor of 10 is typically used to extrapolate from a no observable adverse effect level (NOAEL) to a lowest observable effect level (LOAEL) (EPA 1997; EPA 1999b). The more conservative NOAEL is the preferred screening exposure level to determine a level that is unlikely to adversely impact populations and to ensure that risk is not underestimated. If a LOAEL value is exceeded, there is more certainty that the contaminants may be adversely impacting ecological receptors.

No mammal TRVs were available for several organic contaminants measured in sediment, which may contribute to the ecological risk. The uncertainty associated with the lack of TRVs is discussed in the Uncertainty Analysis.

Table 5-5
Use of Single-Media and Multi-Media Benchmarks for the Calculation of Hazard Quotients (HQ) and Hazard Indices (HI), South Pond Surface Water
Miami-Erie Canal, Mound Plant

COPC	Surface Water Concentration	Water single media benchmark (pCi/l)		Water multimedia benchmark (pCi/l)		HQ based on single-media benchmarks		HQ based on multi-media benchmarks	
	pCi/l	small fish	large fish	small fish	large fish	small fish	large fish	small fish	large fish
Bismuth-210m	**0.73**	--	--	--	--	--	--	--	--
Polonium-210	0.73	--	--	--	--	--	--	--	--
Potassium-40	420	7.61E+02	7.27E+02	7.61E+02	7.27E+02	5.52E-01	5.78E-01	5.52E-01	5.78E-01
Thorium-228+D	0.14	6.01E+02	6.01E+02	5.93E+01	5.93E+01	2.33E-04	2.33E-04	2.36E-03	2.36E-03
Thorium-230	0.21	4.13E+02	4.13E+02	4.13E+02	4.13E+02	5.08E-04	5.08E-04	5.08E-04	5.08E-04
Radium-226+D	0.24	1.60E+02	2.60E+02	1.60E+02	1.60E+02	1.50E-03	9.23E-04	1.50E-03	1.50E-03
Strontium-90+D	0.69	6.29E+04	5.77E+04	5.80E+04	5.77E+04	1.10E-05	1.20E-05	1.19E-05	1.20E-05
Tritium	846.00	3.45E+09	3.45E+09	3.45E+09	3.45E+09	2.45E-07	2.45E-07	2.45E-07	2.45E-07
Uranium-234	0.64	4.04E+03	4.04E+03	4.04E+03	4.04E+03	1.58E-04	1.58E-04	1.58E-04	1.58E-04
Uranium-238+D	0.39	4.55E+03	4.55E+03	4.55E+03	4.55E+03	8.57E-05	8.57E-05	8.57E-05	8.57E-05
Total Hazard Index						0.55	0.58	0.56	0.58

Notes:
-- = Not available.
Based on methods presented in BJC, 1998.

Table 5-6
Use of Single-Media and Multi-Media Benchmarks for the Calculation of Hazard Quotients (HQ) and Hazard Indices (HI)
South Pond Sediment
Miami-Erie Canal, Mound Plant

COPC	Sediment Concentration	Sediment single media benchmark (pCi/g)		Sediment multimedia benchmark (pCi/g)		HQ based on single-media benchmarks		HQ based on multi-media benchmarks	
	pCi/g	small fish	large fish	small fish	large fish	small fish	large fish	small fish	large fish
Bismuth-210m	**2**	--	--	--	--	--	--	--	--
Polonium-210	2	--	--	--	--	--	--	--	--
Cesium-137+D	0.01	3.39E+04	3.65E+04	7.13E+03	5.84E+03	2.95E-07	2.74E-07	1.40E-06	1.71E-06
Potassium-40	38.6	3.16E+05	3.71E+05	4.19E+02	4.00E+02	1.22E-04	1.04E-04	9.21E-02	9.65E-02
Plutonium-238	2.00	9.59E+07	4.80E+08	1.17E+05	1.17E+05	2.09E-08	4.17E-09	1.71E-05	1.71E-05
Plutonium-239/240	0.01	1.00E+08	1.00E+08	1.24E+05	1.24E+05	1.00E-10	1.00E-10	8.06E-08	8.06E-08
Thorium-228+D	1.51	3.31E+04	3.69E+04	5.90E+02	5.91E+02	4.56E-05	4.09E-05	2.56E-03	2.55E-03
Thorium-230	1.84	1.12E+08	5.60E+08	4.13E+03	4.13E+03	1.64E-08	3.29E-09	4.46E-04	4.46E-04
Radium-226+D	1.60	2.82E+04	3.32E+04	7.99E+01	7.99E+01	5.67E-05	4.82E-05	2.00E-02	2.00E-02
Thorium-232+D	1.24	5.47E+04	6.29E+04	4.40E+03	4.44E+03	2.27E-05	1.97E-05	2.82E-04	2.79E-04
Tritium	2.40	1.00E+20	1.00E+20	1.00E+20	1.00E+20	2.40E-20	2.40E-20	2.40E-20	2.40E-20
Uranium-234	1.50	1.00E+08	5.02E+08	2.02E+02	2.02E+02	1.50E-08	2.99E-09	7.43E-03	7.43E-03
Uranium-235+D	0.08	2.96E+05	3.41E+05	2.18E+02	2.18E+02	2.70E-07	2.35E-07	3.67E-04	3.67E-04
Uranium-238+D	1.25	1.75E+06	9.99E+06	2.27E+02	2.27E+02	7.14E-07	1.25E-07	5.51E-03	5.51E-03
Total Hazard Index						2.49E-04	2.14E-04	1.29E-01	1.33E-01

Notes:
-- = Not available.
Based on methods presented in BJC, 1998.

Table 5-7 Risk to Muskrat: South Pond
Miami-Erie Canal, Mound Plant

Intake = [(Cs * Irs) + ((Cs * PUF) * Irplant) + (Csw * Irsw)] / BW
HQ = Intake / TRV

Constituent	Sediment Concentration	Surface Water Concentration	log Kow	Plant Uptake Factor	Plant Concentration	Intake				TRV	Hazard Quotient			
						Sediment	Suface Water	Plant	Total		Sediment	Surface Water	Plant	Total
Organics														
2-amino-4,6-dinitrotoluene	NC	0.002	--	--	--	--	0.00018	--	0.000	NTV	--	--	--	--
4,4-DDD	0.0094	0.0000038	5.9	0.0151 a,d	0.000141556	0.00001	0.0000003	0.00001	0.00002	0.739	0.000008	0.00000047	0.000015	0.000023
Benzo(a)anthracene	0.49	NC	5.679	0.0202 a	0.009902254	0.00029	--	0.00078	0.001	0.06677	0.004369	--	0.011748	0.016118
Benzo(a)pyrene	0.57	NC	6.129	0.0111 a	0.006328676	0.00034	--	0.00050	0.001	0.3998	0.000849	--	0.001254	0.002103
Benzo(b)fluoranthene	1.2	NC	6.202	0.0101 a	0.012089971	0.00071	--	0.00096	0.002	NTV	--	--	--	--
Benzo(g,h,I)perylene	0.24	NC	6.7	0.0052 a,d	0.001246267	0.00014	--	0.00010	0.000	NTV	--	--	--	--
Benzo(k)fluoranthene	1.5	NC	6.1	0.0115 a,d	0.017309768	0.00089	--	0.00137	0.002	NTV	--	--	--	--
Benzoic acid	0.24	NC	1.9	3.0889 a,d	0.74132943	0.00014	--	0.05873	0.059	NTV	--	--	--	--
Bis(2-ethylhexyl)phthalate	0.43	NC	5.205	0.0380 a	0.016329709	0.00026	--	0.00129	0.002	44.34	0.000006	--	0.000029	0.000035
Chrysene	0.59	NC	6.2	0.0101 a	0.005960079	0.00035	--	0.00047	0.001	NTV	--	--	--	--
Di-n-butylphthalate	0.21	NC	4.6	0.0850 a,d	0.017841004	0.00013	--	0.00141	0.002	219.89	0.0000006	--	0.000006	0.000007
Endrin ketone	0.00084	NC								NTV	--	--	--	--
Fluoranthene	1.1	NC	4.9	0.0570 a,d	0.062689194	0.00065	--	0.00497	0.006	NTV	--	--	--	--
Fluorene	0.072	NC	4	0.1888 a,d	0.013593538	0.00004	--	0.00108	0.001	NTV	--	--	--	--
gamma-Chlordane	0.002	NC	6.6	0.0059 a,d	0.000011864	0.00000	--	0.00000	0.00000	1.831	0.0000007	--	0.0000005	0.0000012
Heptachlor	0.0031	NC	5.015	0.0489 a,d	0.000151597	0.00000	--	0.00001	0.00001	0.00185	0.0009990	--	0.0065001	0.0074992
Hexane	0.007	NC	3.3	0.4793 a,d	0.003355043	0.00000	--	0.00027	0.000	NTV	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.34	NC	6.915	0.0039 a	0.0013262	0.00020	--	0.00011	0.000	NTV	--	--	--	--
Methoxychlor	0.063	NC	5.7	0.0197 a,d	0.001238057	0.00004	--	0.00010	0.000	2.956	0.000013	--	0.000033	0.000046
Phenanthrene	0.44	NC	4.3	0.1266 a,d	0.055725334	0.00026	--	0.00441	0.005	NTV	--	--	--	--
Pyrene	0.85	NC	4.9	0.0570 a,d	0.04844165	0.00051	--	0.00384	0.004	NTV	--	--	--	--
Inorganics														
Aluminum	17000	1.34	NA	0.0040 a	68	10.12181	0.12213	5.387	15.631	0.772	13.111147	0.15819880	6.977606	20.246953
Arsenic	7.7	NC	NA	0.0360 a	0.2772	0.00458	--	0.022	0.027	2.27	0.002020	--	0.009673	0.011693
Barium	65	NC	NA	0.150 a	9.75	0.03870	--	0.772	0.811	3.77	0.010266	--	0.204870	0.215135
Copper	31	NC	NA	0.400 a	12.4	0.01846	--	0.982	1.001	11.53	0.001601	--	0.085194	0.086794

Table 5-7 (cont.)

Constituent	Sediment Concentration	Surface Water Concentration	log Kow	Plant Uptake Factor	Plant Concentration	Intake Sediment	Intake Suface Water	Intake Plant	Intake Total	TRV	Hazard Quotient Sediment	Hazard Quotient Surface Water	Hazard Quotient Plant	Hazard Quotient Total
Iron	29100	NC	NA	0.0040 b	116.4	17.32615	--	9.221	26.547	29.56	0.586135	--	0.311934	0.898069
Lithium	34	0.009	NA	0.0250 b	0.85	0.02024	0.00082	0.067	0.088	3.76	0.005384	0.00021816	0.017908	0.023510
Manganese	549	0.22	NA	0.2500 b	137.25	0.32687	0.02005	10.872	11.219	65.03	0.005027	0.00030834	0.167191	0.172526
Molybdenum	2.1	0.0026	NA	0.0525 b	0.11025	0.00125	0.00024	0.009	0.010	0.104	0.012023	0.00227853	0.083977	0.098278
Nickel	28.8	NC	NA	0.0320 a	0.9216	0.01715	--	0.073	0.090	29.56	0.000580	--	0.002470	0.003050
Silver	NC	0.001	NA	0.4000 a	--	--	0.00009	--	0.000091	0.1499	--	0.00060801	--	0.000608
Tin	4	NC	NA	0.030 b	0.12	0.00238	--	0.010	0.012	9.355	0.000255	--	0.001016	0.001271
Vanadium	30.2	NC	NA	0.0049 c	0.14798	0.01798	--	0.012	0.030	0.155	0.116007	--	0.075629	0.191636
Zinc	274	NC	NA	0.121 c	33.154	0.16314	--	2.626	2.789	118.24	0.001380	--	0.022212	0.023592
Anions														
Bismuth	2	0.0651	NA	0.0350 a	0.07	0.00119	0.00593	0.006	0.013	NTV	--	--	--	--
Chloride	142	0.06	NA	--	--	0.08455	0.00547	--	0.090	NTV	--	--	--	--
Fluoride	7.4	0.0003	NA	--	--	0.00441	0.00003	--	0.004	30.15	0.000146	0.00000091	--	0.000147
Nitrate/Nitrite	1.1	NC	NA	--	--	0.00065	--	--	0.001	472	0.000001	--	--	0.000001
Nitrogen	NC	0.0005	NA	6.300 a	--	--	0.00005	--	0.000046	NTV	--	--	--	--
Sulfate	460	0.039	NA	--	--	0.27388	0.00355	--	0.277	NTV	--	--	--	--

Symbol	Parameter	Value	Source
Cs	Sediment concentration (mg/kg)	--	--
IRs	Sediment intake rate (kg dw/day)	6.99E-04	EPA 1999b
Irsw	Surface water intake rate (L/day)	1.07E-01	EPA 1999b
Irplant	Plant intake rate (kg dry/ day)	0.093	EPA 1999b
PUF	Plant uptake factor (unitless)	Chemical-specific	--
BW	Body weight (kg)	1.174	EPA 1993
TRV	Toxicity reference value (mg/kg/day)	Chemical-specific	Appendix B

a = EPA 1999b

b = Baes et al. 1984 (based on Bv).

c = Efroymson et al. 1997

d = TNRCC 1996.

NA = Not applicable.

NTV = No toxicity value available.

NC = Not a COPC in this medium.

Mink

A mink may be exposed to chemical COPCs in the South Pond through ingestion of fish, sediment, and surface water. The estimated daily dose and the potential risk to a mink are presented in Table 5-8. There is a limited potential for adverse effects to a mink from exposure to chemical COPCs in South Pond sediments. Aluminum and iron were found to be of potential concern through sediment ingestion, while molybdenum was found to be of potential concern from fish ingestion. Due to the conservative method for estimating exposure doses, this risk may be overestimated as discussed further in the Uncertainty Analysis (Section 5.4).

The total HI for aluminum (40.3) exceeded 10, while the total HI for iron (1.75) and molybdenum (3.18) did not exceed 10. An uncertainty factor of 10 is typically used to extrapolate from a no observable adverse effect level (NOAEL) to a lowest observable effect level (LOAEL) (EPA 1997; EPA 1999b). The more conservative NOAEL is the preferred screening exposure level to determine a level that is unlikely to adversely impact populations and to ensure that risk is not underestimated. If a LOAEL value is exceeded, there is more certainty that the contaminants may be adversely impacting ecological receptors.

No mammal TRVs were available for several organic contaminants measured in sediment, which may contribute to the ecological risk. The uncertainty associated with the lack of TRVs is discussed in the Uncertainty Analysis.

Mallard

A mallard may be exposed to chemical COPCs in the South Pond through ingestion of plants, sediment, and surface water. The estimated daily dose and the potential risk to a mallard are presented in Table 5-9. There is a potential for adverse effects to a mallard from exposure to PAHs in South Pond sediments. Benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,I)perylene, chrysene, and indeno(1,2,3-cd)pyrene were found to be of potential concern through sediment ingestion. Benzo(b)fluoranthene and benzo(k)fluoranthene were found to be of concern through sediment and plant ingestion. Due to the conservative method for estimating exposure doses, this risk may be overestimated as discussed further in the Uncertainty Analysis (Section 5.4).

Of these PAHs, the total HI for benzo(b)fluoranthene (32.2) and benzo(k)fluoranthene (41.1) exceeded 10. An uncertainty factor of 10 is typically used to extrapolate from a no observable adverse effect level (NOAEL) to a lowest observable effect level (LOAEL) (EPA 1997; EPA 1999). The more conservative NOAEL is the preferred screening exposure level to determine a level that is unlikely to adversely impact populations and to ensure that risk is not underestimated. If a LOAEL value is exceeded, there is more certainty that the contaminants may be adversely impacting ecological receptors.

No avian TRVs were available for several organic and inorganic contaminants measured in sediment, which may contribute to the ecological risk. The uncertainty associated with the lack of TRVs is discussed in the Uncertainty Analysis.

Table 5-8 Risk to Mink: South Pond
Miami-Erie, Canal, Mound Plant

Intake = [(Cs * Irs) + ((Cs * PUF) * Irplant) + (Csw * Irsw)] / BW
HQ = Intake / TRV

Constituent	Sediment Concentration	Surface Water Concentration	log Kow	Kow	Fish BCF	Fish Concentration	Intake				TRV	Hazard Quotient			
							Sediment	Suface Water	Fish	Total		Sediment	Surface Water	Fish	Total
Organics															
2-amino-4,6-dinitrotoluene	NC	0.002	--		--	--	--	0.00019	--	0.000	NTV	--	--	--	--
4,4-DDD	0.0094	0.0000038	5.9	794328	371337.0586 a	1.411080823	0.00002	0.0000004	0.29052	0.29053	0.765	0.000023	0.00000047	0.379760	0.379783
Benzo(a)anthracene	0.49	NC	5.679			0	0.00090	--	0.00000	0.001	0.06914	0.013062	--	0.000000	0.013062
Benzo(a)pyrene	0.57	NC	6.129			0	0.00105	--	0.00000	0.001	0.414	0.002538	--	0.000000	0.002538
Benzo(b)fluoranthene	1.2	NC	6.202			0	0.00221	--	0.00000	0.002	NTV	--	--	--	--
Benzo(g,h,I)perylene	0.24	NC	6.7			0	0.00044	--	0.00000	0.000	NTV	--	--	--	--
Benzo(k)fluoranthene	1.5	NC	6.1			0	0.00276	--	0.00000	0.003	NTV	--	--	--	--
Benzoic acid	0.24	NC	1.9			0	0.00044	--	0.00000	0.000	NTV	--	--	--	--
Bis(2-ethylhexyl)phthalate	0.43	NC	5.205			0	0.00079	--	0.00000	0.001	45.9	0.000017	--	0.000000	0.000017
Chrysene	0.59	NC	6.2			0	0.00109	--	0.00000	0.001	NTV	--	--	--	--
Di-n-butylphthalate	0.21	NC	4.6			0	0.00039	--	0.00000	0.000	227	0.000002	--	0.000000	0.000002
Endrin ketone	0.00084	NC					0.00000	--	0.00000	0.000	NTV	--	--	--	--
Fluoranthene	1.1	NC	4.9			0	0.00203	--	0.00000	0.002	NTV	--	--	--	--
Fluorene	0.072	NC	4			0	0.00013	--	0.00000	0.000	NTV	--	--	--	--
gamma-Chlordane	0.002	NC	6.6			0	0.00000	--	0.00000	0.00000	1.896	0.000002	--	0.000000	0.000002
Heptachlor	0.0031	NC	5.015			0	0.00001	--	0.00000	0.00001	0.00191	0.002988	--	0.000000	0.002988
Hexane	0.007	NC	3.3			0	0.00001	--	0.00000	0.000	NTV	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.34	NC	6.915			0	0.00063	--	0.00000	0.001	NTV	--	--	--	--
Methoxychlor	0.063	NC	5.7			0	0.00012	--	0.00000	0.000	3.06	0.000038	--	0.0000000	0.000038
Phenanthrene	0.44	NC	4.3			0	0.00081	--	0.00000	0.001	NTV	--	--	--	--
Pyrene	0.85	NC	4.9			0	0.00157	--	0.00000	0.002	NTV	--	--	--	--
Inorganics															
Aluminum	17000	1.34	NA		2.7000 a	3.618	31.33333	0.12704	0.745	32.205	0.799	39.215686	0.15899531	0.932268	40.306950
Arsenic	7.7	NC	NA			0	0.01419	--	0.000	0.014	2.35	0.006039	--	0.000000	0.006039
Barium	65	NC	NA			0	0.11980	--	0.000	0.120	3.9	0.030719	--	0.000000	0.030719
Beryllium	0.9	NC	NA			0	0.00166	--	0.000	0.002	0.505	0.003285	--	0.000000	0.003285

Table 5-8 (cont.)

Constituent	Sediment Concentration	Surface Water Concentration	log Kow	Kow	Fish BCF	Fish Concentration	Intake				TRV	Hazard Quotient			
							Sediment	Suface Water	Fish	Total		Sediment	Surface Water	Fish	Total
Copper	31	NC	NA			0	0.05714	--	0.000	0.057	11.94	0.004785	--	0.000000	0.004785
Iron	29100	NC	NA			0	53.63529	--	0.000	53.635	30.6	1.752787	--	0.000000	1.752787
Lithium	34	0.009	NA		633.0000 a	5.697	0.06267	0.00085	1.173	1.236	3.89	0.016110	0.00021934	0.301520	0.317849
Manganese	549	0.22	NA		633.0000 a	139.26	1.01188	0.02086	28.671	29.704	67.32	0.015031	0.00030982	0.425894	0.441235
Molybdenum	2.1	0.0026	NA		633.0000 a	1.6458	0.00387	0.00025	0.339	0.343	0.108	0.035839	0.00228232	3.137418	3.175539
Nickel	28.8	NC	NA			0	0.05308	--	0.000	0.053	30.6	0.001735	--	0.000000	0.001735
Silver	NC	0.001	NA		87.7100 a	0.08771	--	0.00009	--	0.000095	0.155	--	0.00061164	--	0.000612
Tin	4	NC	NA			0	0.00737	--	0.000	0.007	9.688	0.000761	--	0.000000	0.000761
Vanadium	30.2	NC	NA			0	0.05566	--	0.000	0.056	0.1607	0.346377	--	0.000000	0.346377
Zinc	274	NC	NA			0	0.50502	--	0.000	0.505	122.4	0.004126	--	0.000000	0.004126
Anions															
Bismuth	2	0.0651	NA			0	0.00369	0.00617	0.000	0.010	NTV	--	--	--	--
Chloride	142	0.06	NA			0	0.26173	0.00569	--	0.267	NTV	--	--	--	--
Fluoride	7.4	0.0003	NA			0	0.01364	0.00003	--	0.014	31.21	0.000437	0.00000091	--	0.000438
Nitrate/Nitrite	1.1	NC	NA			0	0.00203	--	--	0.002	472	0.000004	--	--	0.000004
Nitrogen	NC	0.0005	NA			0	--	0.00005	--	0.000047	NTV	--	--	--	--
Sulfate	460	0.039	NA			0	0.84784	0.00370	--	0.852	NTV	--	--	--	--

Symbol	Parameter	Value	Source
Cs	Sediment concentration (mg/kg)	--	--
IRs	Sediment intake rate (kg dw/day)	1.88E-03	EPA 1999b
Irsw	Surface water intake rate (L/day)	9.67E-02	EPA 1999b
Irfish	Fish intake rate (kg wet/ day)	0.21	EPA 1993
BCF	Bioconcentration factor (L/kg)	Chemical-specific	--
BW	Body weight (kg)	1.02	EPA 1993
TRV	Toxicity reference value (mg/kg/day)	Chemical-specific	Appendix B
BAF	Bioaccumulation factor, BCF x FCM	Chemical-specific	--
FCM	Food chain multiplier (unitless)	Log Kow specific	--
	Log Kow = 5.9, FCM =9.7 for trophic level 2.		

a = EPA 1999b

b = TNRCC 1996

NTV = No toxicity value available.

Table 5-9 Risk to Mallard: South Pond
Miami-Erie Canal, Mound Plant

Intake = [(Cs * Irs) + ((Cs * PUF) * Irplant) + (Csw * Irsw)] / BW
HQ = Intake / TRV

Constituent	Sediment	Surface Water	log	Plant		Plant	Intake				TRV	Hazard Quotient			
	Concentration	Concentration	Kow	Uptake Factor		Concentration	Sediment	Suface Water	Plant	Total		Sediment	Surface Water	Plant	Total
Organics															
2-amino-4,6-dinitrotoluene	NC	0.002	--	--		--	--	0.00012	--	0.000	NTV	--	--	--	--
4,4-DDD	0.0094	0.0000038	5.9	0.0151	a,d	0.000141556	0.00003	0.0000002	0.00001	0.00004	0.845	0.000035	0.00000026	0.000010	0.000045
Benzo(a)anthracene	0.49	NC	5.679	0.0202	a	0.009902254	0.00155	--	0.00057	0.002	0.00079	2.0	--	0.7	2.7
Benzo(a)pyrene	0.57	NC	6.129	0.0111	a	0.006328676	0.00181	--	0.00036	0.002	0.001	1.8	--	0.4	2.2
Benzo(b)fluoranthene	1.2	NC	6.202	0.0101	a	0.012089971	0.00381	--	0.00069	0.005	0.00014	27.2	--	5.0	32.2
Benzo(g,h,I)perylene	0.24	NC	6.7	0.0052	a,d	0.001246267	0.00076	--	0.00007	0.001	0.00014	5.4	--	0.5	6.0
Benzo(k)fluoranthene	1.5	NC	6.1	0.0115	a,d	0.017309768	0.00476	--	0.00099	0.006	0.00014	34.0	--	7.1	41.1
Benzoic acid	0.24	NC	1.9	3.0889	a,d	0.74132943	0.00076	--	0.04256	0.043	NTV	--	--	--	--
Bis(2-ethylhexyl)phthalate	0.43	NC	5.205	0.0380	a	0.016329709	0.00136	--	0.00094	0.002	1.11	0.0012	--	0.0	0.0
Chrysene	0.59	NC	6.2	0.0101	a	0.005960079	0.00187	--	0.00034	0.002	0.001	1.9	--	0.3	2.2
Di-n-butylphthalate	0.21	NC	4.6	0.0850	a,d	0.017841004	0.00067	--	0.00102	0.002	0.11	0.0	--	0.0	0.0
Endrin ketone	0.00084	NC				0	0.00000	--	0.00000	0.000	NTV	--	--	--	--
Fluoranthene	1.1	NC	4.9	0.0570	a,d	0.062689194	0.00349	--	0.00360	0.007	NTV	--	--	--	--
Fluorene	0.072	NC	4	0.1888	a,d	0.013593538	0.00023	--	0.00078	0.001	NTV	--	--	--	--
gamma-Chlordane	0.002	NC	6.6	0.0059	a,d	1.1864E-05	0.00001	--	0.00000	0.00001	2.14	0.000003	--	0.00000	0.000003
Heptachlor	0.0031	NC	5.015	0.0489	a,d	0.000151597	0.00001	--	0.00001	0.00002	0.065	0.000151	--	0.00013	0.00029
Hexane	0.007	NC	3.3	0.4793	a,d	0.003355043	0.00002	--	0.00019	0.000	NTV	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.34	NC	6.915	0.0039	a	0.0013262	0.00108	--	0.00008	0.001	0.001	1.1	--	0.1	1.2
Methoxychlor	0.063	NC	5.7	0.0197	a,d	0.001238057	0.00020	--	0.00007	0.000	0.556	0.00036	--	0.00013	0.00049
Phenanthrene	0.44	NC	4.3	0.1266	a,d	0.055725334	0.00140	--	0.00320	0.005	NTV	--	--	--	--
Pyrene	0.85	NC	4.9	0.0570	a,d	0.04844165	0.00270	--	0.00278	0.005	NTV	--	--	--	--
Inorganics															
Aluminum	17000	1.34	NA	0.0040	a	68	53.94231	0.07799	3.903	57.924	100	0.5	0.0008	0.0	0.6
Arsenic	7.7	NC	NA	0.0360	a	0.2772	0.02443	--	0.016	0.040	2.46	0.0099	--	0.0	0.0
Barium	65	NC	NA	0.150	a	9.75	0.20625	--	0.560	0.766	20.826	0.0099	--	0.0	0.0
Beryllium	0.9	NC	NA	0.010	a	0.009	0.00286	--	0.001	0.003	NTV	--	--	--	--
Copper	31	NC	NA	0.400	a	12.4	0.09837	--	0.712	0.810	46.97	0.002	--	0.0	0.0
Iron	29100	NC	NA	0.0040	b	116.4	92.33654	--	6.682	99.018	NTV	--	--	--	--
Lithium	34	0.009	NA	0.0250	b	0.85	0.10788	0.00052	0.049	0.157	NTV	--	--	--	--

Table 5-9 (cont.)

Constituent	Sediment	Surface Water	log	Plant		Plant	Intake				TRV	Hazard Quotient			
	Concentration	Concentration	Kow	Uptake Factor		Concentration	Sediment	Suface Water	Plant	Total		Sediment	Surface Water	Plant	Total
Manganese	549	0.22	NA	0.2500	b	137.25	1.74202	0.01280	7.879	9.634	977	0.001783	0.000013	0.008	0.00986
Molybdenum	2.1	0.0026	NA	0.0525	b	0.11025	0.00666	0.00015	0.006	0.013	3.5	0.001904	0.000043	0.002	0.00376
Nickel	28.8	NC	NA	0.0320	a	0.9216	0.09138	--	0.053	0.144	77.4	0.0012	--	0.001	0.00186
Silver	NC	0.001	NA	0.4000	a	--	--	0.00006	--	0.000058	178	--	0.0000003	--	0.00000033
Tin	4	NC	NA	0.030	b	0.12	0.01269	--	0.007	0.020	6.76	0.0019	--	0.0010	0.00290
Vanadium	30.2	NC	NA	0.0049	c	0.14798	0.09583	--	0.008	0.104	11.4	0.0084	--	0.0007	0.00915
Zinc	274	NC	NA	0.121	c	33.154	0.86942	--	1.903	2.773	130.9	0.0066	--	0.0145	0.02118
Anions															
Bismuth	2	0.0651	NA	0.0350	b	0.07	0.00635	0.00379	0.004	0.014	NTV	--	--	--	--
Chloride	142	0.06	NA	--		--	0.45058	0.00349	--	0.454	NTV	--	--	--	--
Fluoride	7.4	0.0003	NA	--		--	0.02348	0.00002	--	0.023	7.8	0.003010	0.000002	--	0.00301
Nitrate/Nitrite	1.1	NC	NA	--		--	0.00349	--	--	0.003	NTV	--	--	--	--
Nitrogen	NC	0.0005	NA	6.300	b	--	--	0.00003	--	0.000029	NTV	--	--	--	--
Sulfate	460	0.039	NA	--		--	1.45962	0.00227	--	1.462	NTV	--	--	--	--

Symbol	Parameter	Value	Source
Cs	Sediment concentration (mg/kg)	--	--
IRs	Sediment intake rate (kg dw/day)	6.99E-04	EPA 1999b
Irsw	Surface water intake rate (L/day)	1.07E-01	EPA 1999b
Irplant	Plant intake rate (kg dry/ day)	0.093	EPA 1999b
PUF	Plant uptake factor (unitless)	Chemical-specific	--
BW	Body weight (kg)	1.09	EPA 1999b
TRV	Toxicity reference value (mg/kg/day)	Chemical-specific	Appendix B

a = EPA 1999b
b = Baes et al. 1984 (based on Bv).
c = Efroymson et al. 1997
d = TNRCC 1996.
NA = Not applicable.
NTV = No toxicity value available.
NC = Not a COPC in this medium.

Table -5-10 Risk to Belted Kingfisher: South Pond
Miami-Erie Canal, Mound Plant

Intake = [(Cs * Irs) + ((Cs * PUF) * Irplant) + (Csw * Irsw)] / BW
HQ = Intake / TRV

Constituent	Sediment Concentration	Surface Water Concentration	log Kow	Kow	Fish BCF	Fish Concentration	Intake				TRV	Hazard Quotient			
							Sediment	Suface Water	Fish	Total		Sediment	Surface Water	Fish	Total
Organics															
2-amino-4,6-dinitrotoluene	NC	0.002	--		--	--	--	0.00022	--	0.000	NTV	--	--	--	--
4,4-DDD	0.0094	0.0000038	5.9	794328	371337 a	1.4111	0.00002	0.0000004	0.71034	0.71036	0.845	0.000024	0.00000050	0.840639	0.840664
Benzo(a)anthracene	0.49	NC	5.679			0	0.00107	--	0.00000	0.001	0.00079	1.350211	--	0.000000	1.350211
Benzo(a)pyrene	0.57	NC	6.129			0	0.00124	--	0.00000	0.001	0.001	1.240816	--	0.000000	1.240816
Benzo(b)fluoranthene	1.2	NC	6.202			0	0.00261	--	0.00000	0.003	0.00014	18.658892	--	0.000000	18.658892
Benzo(g,h,I)perylene	0.24	NC	6.7			0	0.00052	--	0.00000	0.001	0.00014	3.731778	--	0.000000	3.731778
Benzo(k)fluoranthene	1.5	NC	6.1			0	0.00327	--	0.00000	0.003	0.00014	23.323615	--	0.000000	23.323615
Benzoic acid	0.24	NC	1.9			0	0.00052	--	0.00000	0.001	NTV	--	--	--	--
Bis(2-ethylhexyl)phthalate	0.43	NC	5.205			0	0.00094	--	0.00000	0.001	1.11	0.000843	--	0.000000	0.000843
Chrysene	0.59	NC	6.2			0	0.00128	--	0.00000	0.001	0.001	1.284354	--	0.000000	1.284354
Di-n-butylphthalate	0.21	NC	4.6			0	0.00046	--	0.00000	0.000	0.11	0.004156	--	0.000000	0.004156
Endrin ketone	0.00084	NC					0.00000	--	0.00000	0.000	NTV	--	--	--	--
Fluoranthene	1.1	NC	4.9			0	0.00239	--	0.00000	0.002	NTV	--	--	--	--
Fluorene	0.072	NC	4			0	0.00016	--	0.00000	0.000	NTV	--	--	--	--
gamma-Chlordane	0.002	NC	6.6			0	0.00000	--	0.00000	0.00000	2.14	0.000002	--	0.000000	0.000002
Heptachlor	0.0031	NC	5.015				0.00001	--	0.00000	0.00001	0.065	0.000104	--	0.000000	0.000104
Hexane	0.007	NC	3.3			0	0.00002	--	0.00000	0.000	NTV	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.34	NC	6.915			0	0.00074	--	0.00000	0.001	0.001	0.740136	--	0.000000	0.740136
Methoxychlor	0.063	NC	5.7			0	0.00014	--	0.00000	0.000	0.556	0.000247	--	0.000000	0.000247
Phenanthrene	0.44	NC	4.3			0	0.00096	--	0.00000	0.001	NTV	--	--	--	--
Pyrene	0.85	NC	4.9			0	0.00185	--	0.00000	0.002	NTV	--	--	--	--
Inorganics															
Aluminum	17000	1.34	NA		2.7000 a	3.618	37.00680	0.14859	1.821	38.977	100	0.370068	0.00148585	0.018213	0.389767
Arsenic	7.7	NC	NA			0	0.01676	--	0.000	0.017	2.46	0.006814	--	0.000000	0.006814
Barium	65	NC	NA			0	0.14150	--	0.000	0.141	20.826	0.006794	--	0.000000	0.006794
Beryllium	0.9	NC	NA			0	0.00196	--	0.000	0.002	NTV	--	--	--	--
Copper	31	NC	NA			0	0.06748	--	0.000	0.067	46.97	0.001437	--	0.000000	0.001437
Iron	29100	NC	NA			0	63.34694	--	0.000	63.347	NTV	--	--	--	--
Lithium	34	0.009	NA		633.0000 a	5.697	0.07401	0.00100	2.868	2.943	NTV	--	--	--	--
Manganese	549	0.22	NA		633.0000 a	139.26	1.19510	0.02439	70.104	71.323	977	0.001223	0.00002497	0.071754	0.073002

Table 5-10 (cont.)

Constituent	Sediment Concentration	Surface Water Concentration	log Kow	Kow	Fish BCF	Fish Concentration	Intake				TRV	Hazard Quotient			
							Sediment	Suface Water	Fish	Total		Sediment	Surface Water	Fish	Total
Molybdenum	2.1	0.0026	NA		633.0000 a	1.6458	0.00457	0.00029	0.828	0.833	3.5	0.001306	0.00008237	0.236714	0.238102
Nickel	28.8	NC	NA			0	0.06269	--	0.000	0.063	77.4	0.000810	--	0.000000	0.000810
Silver	NC	0.001	NA		87.7100 a	0.08771	--	0.00011	--	0.000111	178	--	0.00000062	--	0.000001
Tin	4	NC	NA			0	0.00871	--	0.000	0.009	6.76	0.001288	--	0.000000	0.001288
Vanadium	30.2	NC	NA			0	0.06574	--	0.000	0.066	11.4	0.005767	--	0.000000	0.005767
Zinc	274	NC	NA			0	0.59646	--	0.000	0.596	130.9	0.004557	--	0.000000	0.004557
Anions															
Bismuth	2	0.0651	NA			0	0.00435	0.00722	0.000	0.012	NTV	--	--	--	--
Chloride	142	0.06	NA			0	0.30912	0.00665	--	0.316	NTV	--	--	--	--
Fluoride	7.4	0.0003	NA			0	0.01611	0.00003	--	0.016	7.8	0.002065	0.00000426	--	0.002070
Nitrate/Nitrite	1.1	NC	NA			0	0.00239	--	--	0.002	NTV	--	--	--	--
Nitrogen	NC	0.0005	NA			0	--	0.00006	--	0.000055	NTV	--	--	--	--
Sulfate	460	0.039	NA			0	1.00136	0.00432	--	1.006	NTV	--	--	--	--

Symbol	Parameter	Value	Source
Cs	Sediment concentration (mg/kg)	--	--
IRs	Sediment intake rate (kg dw/day)	6.99E-04	EPA 1999b
Irsw	Surface water intake rate (L/day)	1.07E-01	EPA 1999b
Irplant	Plant intake rate (kg dry/ day)	0.093	EPA 1999b
PUF	Plant uptake factor (unitless)	Chemical-specific	--
BW	Body weight (kg)	1.09	EPA 1999b
TRV	Toxicity reference value (mg/kg/day)	Chemical-specific	Appendix B

a = EPA 1999b
b = Baes et al. 1984 (based on Bv).
c = Efroymson et al. 1997
d = TNRCC 1996.
NA = Not applicable.
NTV = No toxicity value available.
NC = Not a COPC in this medium.

Belted Kingfisher

A belted kingfisher may be exposed to chemical COPCs in the South Pond through ingestion of fish, sediment, and surface water. The estimated daily dose and the potential risk to a kingfisher are presented in Table 5-10. There is a potential for adverse effects to a kingfisher from exposure to PAHs in South Pond sediments. Benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,I)perylene, benzo(k)fluoranthene, and chrysene were found to be of potential concern through sediment ingestion. Due to the conservative method for estimating exposure doses, this risk may be overestimated as discussed further in the Uncertainty Analysis (Section 5.4).

Of these PAHs, the total HI for benzo(b)fluoranthene (18.6) and benzo(k)fluoranthene (23.2) exceeded 10. An uncertainty factor of 10 is typically used to extrapolate from a no observable adverse effect level (NOAEL) to a lowest observable effect level (LOAEL) (EPA 1997; EPA 1999b). The more conservative NOAEL is the preferred screening exposure level to determine a level that is unlikely to adversely impact populations and to ensure that risk is not underestimated. If a LOAEL value is exceeded, there is more certainty that the contaminants may be adversely impacting ecological receptors. No avian TRVs were available for several organic and inorganic contaminants measured in sediment, which may contribute to the ecological risk. The uncertainty associated with the lack of TRVs is discussed in the Uncertainty Analysis.

Aquatic Organisms

The maximum detected concentration of aluminum in surface water exceeded the acute ambient water quality criteria (Table 5-11). The pesticide, 4,4-DDD, in sediment exceeded the probable effect level, while methoxyclor and lithium exceeded background levels (Table 5-12). No benchmarks were available for several organic and inorganic contaminants measured in surface water and sediment, which may contribute to the ecological risk. The uncertainty associated with the lack of benchmarks is discussed in the Uncertainty Analysis (Section 5-4).

5.3 Risk to Overflow Creek Ecological Receptors

5.3.1 Radionuclides

Aquatic organisms may be exposed to radionuclide concentrations in sediment and surface water through internal exposure to water and external exposures to water and sediment. Single-media and multimedia benchmarks were used to calculate hazard quotients and hazard indices (Table 5-13 and 5-14). The screening HQs and HI do not exceed unity, suggesting that the radionuclides measured in the Overflow Creek pose a negligible risk to aquatic biota.

Table 5-11
Comparison of South Pond Surface Water Concentrations to Surface Water Benchmarks
Miami-Erie Canal, Mound Plant

Chemical	Frequency of Detection	Range of Detections		Maximum Location	Background [a]	Ohio Water Quality Standard		NAWQ Criteria	
		Minimum	Maximum			OMZA	OMZM	chronic	acute
Organic Compounds (ug/L)									
2-amino-4,6-dinitroluene	3/3	1.2	2.00	mnd21-3402	ND	--	--	--	--
4,4-DDD	2/6	0.0028	0.0038	mnd21-3402	ND	0.1 *	--	0.011+	0.19+
Inorganics (ug/L)								--	--
Aluminum	12/12	23	1340	mnd21-3401	160	--	--	87	750
Iron	7/12	15.7	1880	mnd21-3401	9400	--	--	1000	
Lithium	8/12	3.9	8.9	mnd21-3401	5.9	--	--	14+	26+
Manganese	12/12	13.7	220	mnd21-3403	2900	--	--	120+	2300+
Molybdenum	9/12	1.2	2.6	mnd21-3403	8.6	--	--	370+	16000+
Silver	3/12	0.63	0.8	mnd21-3402	ND	0.06	5.3	--	4.1
Anions (mg/L)									
Bismuth	2/12	3.8	65.1	mnd21-3403	ND	--	--	--	--
Chloride	6/6	53.1	59.6	mnd21-3401	77	--	--	--	--
Fluoride	6/6	0.23	0.303	mnd21-3403	ND	--	--	--	--
Nitrogen	5/6	0.119	0.468	mnd21-3402	1.4	--	--	--	--
Sulfate	6/6	12.8	39.4	mnd21-3401	68	--	--	--	--

Notes:
Only chemicals detected above screening levels are presented.
ND = No data.
-- = Not applicable; not available.
Shading indicates maximum detected concentration exceeds highest benchmark.
a Site-specific background pond surface water; from OU-9 Surface Water and Sediment Investigation Report, September 1996.
OMZM = Outside mixing zone maximum.
OMZA = Outside mixing zone average.
* = Based on DDT.
+ = Tier II Values (Suter and Tsao 1996).

Table 5-12
Comparison of South Pond Sediment Concentrations to Sediment Screening Values
Miami-Erie Canal, Mound Plant

Chemical	Frequency of Detection	Range of Detections		Maximum Location	Background [a]	CCME[b]		Long et al.[c]	
		Minimum	Maximum			ISQG	PEL	ER-L	ER-M
Organic Compounds (ug/kg)									
4,4-DDD	5/7	0.57	9.40	MND21-3403	4.6	3.54	8.51	--	--
Benzo(a)anthracene	7/7	270	490.00	mnd21-3403	ND	31.70	385.00	261	1600
Benzo(a)pyrene	7/7	330	570.00	mnd21-3403	ND	31.90	782.00	430	1600
Benzo(b)fluoranthene	7/7	470	1200.00	mnd21-3403	ND	--	--	1700*	9600*
Benzo(g,h,I)perylene	6/7	130	240.00	mnd21-3403	ND	--	--	1700*	9600*
Benzo(k)fluoranthene	7/7	280	1500.00	mnd21-3403	ND	--	--	1700*	9600*
Benzoic acid	7/7	94	240.00	mnd21-3402	ND	--	--	--	--
Bis(2-ethylhexyl)phthalate	5/7	98	430	mnd21-3403	ND	--	--	--	--
Chrysene	7/7	360	590	mnd21-3403	ND	57.1	862	384	2800
Di-n-butylphthalate	4/7	150	210	mnd21-3402	ND	--	--	--	--
Endrin ketone	1/7		1	mnd21-3401	ND	--	--	--	--
Fluoranthene	7/7	680	1100	mnd21-3403	ND	111	2355	600	5100
Fluorene	1/7		72	mnd21-3401	ND	21.2	144	19	540
Heptachlor	2/7	1.8	3	mnd21-3402	ND	--	--	--	--
Hexane	1/7		7	mnd21-3402	ND	--	--	--	--
Indeno(1,2,3-cd)pyrene	7/7	130	340	mnd21-3403	ND	--	--	1700*	9600*
Methoxychlor	2/7	1.2	63	mnd21-3403	25	--	--	--	--
Phenanthrene	7/7	270	440	mnd21-3403	ND	41.9	515	240	1500
Pyrene	7/7	500	850	mnd21-3402	ND	53.0	875	665	2600
Inorganics (mg/kg)									
Aluminum	7/7	11000	17000	MND21-3402	25000	--	--	--	--
Arsenic	7/7	4.2	7.7	MND21-3402	16	5.9	17.0	8.2	70
Barium	7/7	43.3	65	MND21-3403	180	--	--	--	--
Beryllium	7/7	0.63	0.9	MND21-3402	1.1	--	--	--	--

Table 5-12 (cont.)

Chemical	Frequency of Detection	Range of Detections		Maximum Location	Background [a]	CCME[b]		Long et al.[c]	
		Minimum	Maximum			ISQG	PEL	ER-L	ER-M
Copper	7/7	22.8	31	MND21-3403	100	35.70	197.00	34.0	270
Iron	7/7	21900	29100	MND21-3402	39000	--	--	--	--
Lead	7/7	15.1	25	MND21-3403	36	35.00	91.30	46.7	218
Lithium	7/7	22.4	34	MND21-3402	28	--	--	--	--
Manganese	7/7	344	549	MND21-3403	770	--	--	--	--
Molybdenum	6/7	0.92	2.1	MND21-3401	8.8	--	--	--	--
Nickel	7/7	20.9	28.8	MND21-3402	25	--	--	20.9	51.6
Tin	3/7	3.4	4.0	MND21-3402	6.7	--	--	--	--
Vanadium	7/7	21.8	30.2	MND21-3402	54	--	--	--	--
Zinc	7/7	95.5	274	MND21-3401	92	123	315	150	410
Anions (mg/kg)									
Bismuth	3/7	1.3	2.0	MND21-3401	2.2	--	--	--	--
Chloride	4/7	82	142	MND21-3403	12000	--	--	--	--
Fluoride	5/7	2.93	7.4	MND21-3403	200	--	--	--	--
Nitrate/Nitrite	1/7	--	1.1	MND21-3403	350	--	--	--	--
Sulfate	7/7	134	460	MND21-3401	18000	--	--	--	--

Notes:
Shading indicates maximum detected concentration exceeds highest benchmark.
Only chemicals detected above screening levels are presented.
ND = No data.
-- = Not applicable; not available.
* = Based on high molecular weight PAH.
a Site-specific background pond sediment; from OU-9 Surface Water and Sediment Investigation Report, September 1996.
b CCME 1999
c Long et al. 1995.

Table 5-13
Use of Single-Media and Multi-Media Benchmarks for the Calculation of Hazard Quotients (HQ) and Hazard Indices (HI)
South Pond Surface Water
Miami-Erie Canal, Mound Plant

COPC	Surface Water Concentration	Water single media benchmark (pCi/l)		Water multimedia benchmark (pCi/l)		HQ based on single-media benchmarks		HQ based on multi-media benchmarks	
	pCi/l	small fish	large fish	small fish	large fish	small fish	large fish	small fish	large fish
Plutonium-238	1.65	1.17E+03	1.17E+03	1.17E+03	1.17E+03	1.41E-03	1.41E-03	1.41E-03	1.41E-03
Potassium-40	366.00	7.61E+02	7.27E+02	7.61E+02	7.27E+02	4.81E-01	5.03E-01	4.81E-01	5.03E-01
Thorium-230	0.42	4.13E+02	4.13E+02	4.13E+02	4.13E+02	1.02E-03	1.02E-03	1.02E-03	1.02E-03
Radium-226+D	0.31	1.60E+02	2.60E+02	1.60E+02	1.60E+02	1.94E-03	1.19E-03	1.94E-03	1.94E-03
Tritium	499.00	3.45E+09	3.45E+09	3.45E+09	3.45E+09	1.45E-07	1.45E-07	1.45E-07	1.45E-07
Uranium-234	0.83	4.04E+03	4.04E+03	4.04E+03	4.04E+03	2.05E-04	2.05E-04	2.05E-04	2.05E-04
Uranium-238+D	0.65	4.55E+03	4.55E+03	4.55E+03	4.55E+03	1.43E-04	1.43E-04	1.43E-04	1.43E-04
Total Hazard Index						0.49	0.51	0.49	0.51

Table 5-14
Use of Single-Media and Multi-Media Benchmarks for the Calculation of Hazard Quotients (HQ) and Hazard Indices (HI)
South Pond Sediment
Miami-Erie Canal, Mound Plant

COPC	Sediment Concentration	Sediment single media benchmark (pCi/g)		Sediment multimedia benchmark (pCi/g)		HQ based on single-media benchmarks		HQ based on multi-media benchmarks	
	pCi/g	small fish	large fish	small fish	large fish	small fish	large fish	small fish	large fish
Cesium-137+D	0.22	3.39E+04	3.65E+04	7.13E+03	5.84E+03	6.49E-06	6.03E-06	3.09E-05	3.77E-05
Potassium-40	14.5	3.16E+05	3.71E+05	4.19E+02	4.00E+02	4.59E-05	3.91E-05	3.46E-02	3.63E-02
Plutonium-238	51.00	9.59E+07	4.80E+08	1.17E+05	1.17E+05	5.32E-07	1.06E-07	4.36E-04	4.36E-04
Plutonium-239/240	0.46	1.00E+08	1.00E+08	1.24E+05	1.24E+05	4.60E-09	4.60E-09	3.71E-06	3.71E-06
Thorium-228+D	0.91	3.31E+04	3.69E+04	5.90E+02	5.91E+02	2.75E-05	2.47E-05	1.54E-03	1.54E-03
Thorium-230	1.31	1.12E+08	5.60E+08	4.13E+03	4.13E+03	1.17E-08	2.34E-09	3.17E-04	3.17E-04
Radium-226+D	1.21	2.82E+04	3.32E+04	7.99E+01	7.99E+01	4.29E-05	3.64E-05	1.51E-02	1.51E-02
Thorium-232+D	0.87	5.47E+04	6.29E+04	4.40E+03	4.44E+03	1.59E-05	1.38E-05	1.98E-04	1.96E-04
Tritium	19.60	1.00E+20	1.00E+20	1.00E+20	1.00E+20	1.96E-19	1.96E-19	1.96E-19	1.96E-19
Uranium-234	0.98	1.00E+08	5.02E+08	2.02E+02	2.02E+02	9.80E-09	1.95E-09	4.85E-03	4.85E-03
Uranium-235+D	0.03	2.96E+05	3.41E+05	2.18E+02	2.18E+02	1.07E-07	9.30E-08	1.45E-04	1.45E-04
Uranium-238+D	1.09	1.75E+06	9.99E+06	2.27E+02	2.27E+02	6.23E-07	1.09E-07	4.80E-03	4.80E-03
Total Hazard Index						1.40E-04	1.20E-04	6.21E-02	6.37E-02

Notes:
-- = Not available.
Based on methods presented in BJC, 1998.

5.3.2 Chemicals

Muskrat

A muskrat may be exposed to chemical COPCs in the Overflow Creek through ingestion of plants, sediment, and surface water. The estimated daily dose and the potential risk to a muskrat are presented in Table 5-15. There is a limited potential for adverse effects to a muskrat from exposure to chemical COPCs in Overflow Creek sediments. Aluminum was found to be of potential concern through sediment and plant ingestion, while antimony was found to be of potential concern through plant ingestion. Due to the conservative method for estimating exposure doses, this risk may be overestimated as further discussed in the Uncertainty Analysis (Section 5.4).

The total HI for aluminum (13.1) exceeds 10, while the total HI for antimony (1.5) did not exceed 10. An uncertainty factor of 10 is typically used to extrapolate from a no observable adverse effect level (NOAEL) to a lowest observable effect level (LOAEL) (EPA 1997; EPA 1999b). The more conservative NOAEL is the preferred screening exposure level to determine a level that is unlikely to adversely impact populations and to ensure that risk is not underestimated. If a LOAEL value is exceeded, there is more certainty that the contaminants may be adversely impacting ecological receptors.

No mammal TRVs were available for several organic contaminants measured in sediment, which may contribute to the ecological risk. The uncertainty associated with the lack of TRVs is discussed in the Uncertainty Analysis.

Mink

A mink may be exposed to chemical COPCs in the Overflow Creek through ingestion of fish, sediment, and surface water. The estimated daily dose and the potential risk to a mink are presented in Table 5-16. There is a limited potential for adverse effects to a mink from exposure to chemical COPCs in South Pond sediments. Aluminum and iron were found to be of potential concern through sediment and fish ingestion, while molybdenum and tin were found to be of potential concern through fish ingestion. Due to the conservative method for estimating exposure doses, this risk may be overestimated as discussed in the Uncertainty Analysis (Section 5.4).

The total HI for aluminum (26.8), iron (11.0), and molybdenum (75.4) exceeded 10, while the total HI for tin (1.8) did not exceed 10. An uncertainty factor of 10 is typically used to extrapolate from a no observable adverse effect level (NOAEL) to a lowest observable effect level (LOAEL) (EPA 1997; EPA 1999b). The more conservative NOAEL is the preferred screening exposure level to determine a level that is unlikely to adversely impact populations and to ensure that risk is not underestimated. If a LOAEL value is exceeded, there is more certainty that the contaminants may be adversely impacting ecological receptors.

No mammal TRVs were available for several organic contaminants measured in sediment, which may contribute to the ecological risk. The uncertainty associated with the lack of TRVs is discussed in the Uncertainty Analysis.

Table 5-15 Risk to Muskrat: Overflow Creek
Miami-Erie Canal, Mound Plant

Intake = [(Cs * Irs) + ((Cs * PUF) * Irplant) + (Csw * Irsw)] / BW
HQ = Intake / TRV

Constituent	Sediment Concentration	Surface Water Concentration	log Kow	Plant Uptake Factor		Plant Concentration	Intake				TRV	Hazard Quotient			
							Sediment	Suface Water	Plant	Total		Sediment	Surface Water	Plant	Total
Organics															
2-amino-4,6-dinitrotoluene	0.00022		--			0	0.00000013	0.00000	0.00000	0.00000013	NTV	--	--	--	--
Anthracene	0.077		4.3	0.1266	a,d	0.009751933	0.00005	0.00000	0.00077	0.001	NTV	--	--	--	--
Aroclor-1254	0.073		6.207	0.0100	a	0.000730595	0.00004	0.00000	0.00006	0.000101	0.1981	0.000	0.000	0.000	0.001
Benzo(a)anthracene	0.34		5.679	0.0202	a	0.006870952	0.00020	0.00000	0.00054	0.001	0.06677	0.003	0.000	0.008	0.011
Benzo(a)pyrene	0.4		6.129	0.0111	a	0.004441176	0.00024	0.00000	0.00035	0.001	0.3998	0.00060	0.000	0.001	0.001
Benzo(g,h,I)perylene	0.18		6.7	0.0052	a,d	0.000934701	0.00011	0.00000	0.00007	0.00018	NTV	--	--	--	--
Benzo(k)fluoranthene	1.3		6.1	0.0115	a,d	0.015001799	0.00077	0.00000	0.00119	0.002	NTV	--	--	--	--
Benzoic acid	0.31		1.9	3.0889	a,d	0.957550514	0.00018	0.00000	0.07585	0.076	NTV	--	--	--	--
beta-BHC	0.0054		4.3	0.1266	a,d	0.000683902	0.0000032	0.00000	0.00005	0.00006	2.956	0.0000011	0.0000000	0.00002	0.00002
Bis(2-ethylhexyl)phthalate	0.35		5.205	0.0380	a	0.013291624	0.00021	0.00000	0.00105	0.001	44.34	0.0000047	0.0000000	0.00002	0.00003
Carbazole	0.057		3.2	0.5475	a,d	0.031208641	0.00003	0.00000	0.00247	0.003	NTV	--	--	--	--
Chrysene	0.5		6.2	0.0101	a	0.005050914	0.00030	0.00000	0.00040	0.001	NTV	--	--	--	--
Dibenz(a,h)anthracene	0.056		5.739	0.0187	a	0.001044831	0.00003	0.00000	0.00008	0.00012	0.001478	0.0226	0.00000000	0.0560	0.0786
Dieldrin	0.004		5.4	0.0293	a,d	0.000117182	0.0000024	0.00000	0.00001	0.00001	0.01478	0.0002	0.00000000	0.0006	0.0008
Fluoranthene	0.86		4.9	0.0570	a,d	0.049011552	0.00051	0.00000	0.00388	0.004	NTV	--	--	--	--
gamma-BHC	0.002	0.00002	4.3	0.1266	a,d	0.000253297	0.0000012	0.000001823	0.00002	0.0000231	5.912	0.0000002	0.00000031	0.000003	0.000004
Heptachlor epoxide		0.0000008	4.9	0.0570	a,d	0	0	0.000000073	0.00000	0.0000001	NTV	--	--	--	--
HMX	0.48		0.26	27.3981	a	13.15107448	0.00029	0.00000	1.04178	1.042	NTV	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.21		6.915	0.0039	a	0.000819123	0.00013	0.00000	0.00006	0.000190	NTV	--	--	--	--
Methoxychlor	0.007		5.7	0.0197	a,d	0.000137562	0.00000	0.00000	0.00001	0.000015	2.956	0.000001	0.0000000	0.000004	0.000005
RDX	1.2		0.87	12.1658	a,d	14.59893739	0.00071	0.00000	1.15647	1.157	NTV	--	--	--	--
Phenanthrene	0.33		4.3	0.1266	a,d	0.041794	0.00020	0.00000	0.00331	0.004	NTV	--	--	--	--
Pyrene	0.77		4.9	0.0570	a,d	0.043882436	0.00046	0.00000	0.00348	0.004	NTV	--	--	--	--
Inorganics															
Aluminum	10900	2.05	NA	0.0040	a	43.6	6.48986	0.18684	3.45383	10.131	0.772	8.4	0.2	4.47	13.1

Table 5-15 (cont.)

Constituent	Sediment Concentration	Surface Water Concentration	log Kow	Plant Uptake Factor		Plant Concentration	Intake				TRV	Hazard Quotient			
							Sediment	Suface Water	Plant	Total		Sediment	Surface Water	Plant	Total
Antimony	4.6		NA	0.2000	a	0.92	0.00274	0.00000	0.07288	0.076	0.0488	0.056	0.00000	1.5	1.5
Arsenic	6.5		NA	0.0360	a	0.234	0.00387	0.00000	0.01854	0.022	2.27	0.002	0.00000	0.008	0.010
Barium	112		NA	0.150	a	16.8	0.06668	0.00000	1.33083	1.398	3.77	0.018	0.00000	0.353	0.371
Beryllium	0.63		NA	0.010	a	0.0063	0.00038	0.00000	0.00050	0.001	0.488	0.001	0.00000000	0.0010	0.0018
Copper	73		NA	0.400	a	29.2	0.04346	0.00000	2.31312	2.357	11.53	0.004	0.000	0.20	0.20
Cyanide	0.84	0.01	NA			0	0.00050	0.00091	0.00000	0.001	17.74	0.00003	0.0001	0.0000000	0.000080
Iron	18700	2.32	NA	0.0040	b	74.8	11.13399	0.21145	5.92538	17.271	29.56	0.4	0.0072	0.2	0.6
Lead	57.5		NA	0.0450	a	2.5875	0.03424	0.00000	0.20497	0.239	3.198	0.0107	0.0000	0.0641	0.0748
Lithium	14.1		NA	0.0250	b	0.3525	0.00840	0.00000	0.02792	0.036	3.76	0.0022	0.0000	0.0074	0.0097
Manganese	439	0.046	NA	0.2500	b	109.75	0.26138	0.00419	8.69399	8.960	65.03	0.0040	0.0001	0.1337	0.1378
Molybdenum	9.8	0.0623	NA	0.0525	b	0.5145	0.00583	0.00568	0.04076	0.052	0.104	0.0561	0.0546	0.3919	0.5026
Nickel	17.3		NA	0.0320	a	0.5536	0.01030	0.00000	0.04385	0.054	29.56	0.0003	0.000000	0.0015	0.0018
Thallium	0.4		NA	0.0040	a	0.0016	0.00024	0.00000	0.00013	0.00036	0.00968	0.0246	0.000000	0.0131	0.0377
Tin	4.2	0.132	NA	0.030	b	0.126	0.00250	0.01203	0.00998	0.025	9.355	0.0003	0.0013	0.0011	0.0026
Vanadium	23.5		NA	0.005	c	0.11515	0.01399	0.00000	0.00912	0.023	0.155	0.0903	0.000000	0.0589	0.1491
Zinc	102		NA	0.121	c	12.342	0.06073	0.00000	0.97769	1.038	118.24	0.0005	0.000000	0.0083	0.0088
Anions															
Bismuth	42.4		NA	0.0350	b	1.484	0.02524	0.00000	0.11756	0.143	NTV	--	--	--	--
Chloride	119	0.172	NA			0	0.07085	0.01568	0.00000	0.087	NTV	--	--	--	--
Fluoride	5.7	0.0005	NA			0	0.00339	0.00005	0.00000	0.003	30.15	0.0001	0.000002	0.00000	0.0001
Nitrate/Nitrite	3.2		NA			0	0.00191	0.00000	0.00000	0.002	472	0.000004	0.000000	0.000000	0.000004
Nitrogen		0.0014	NA	6.300	b	0	0.00000	0.00013	0.00000	0.00013	NTV	--	--	--	--
Sulfate	282	0.142	NA			0	0.16790	0.01294	0.00000	0.181	NTV	--	--	--	--

Symbol	Parameter	Value	Source
Cs	Sediment concentration (mg/kg)	--	--
Irs	Sediment intake rate (kg dw/day)	6.99E-04	EPA 1999b
Irsw	Surface water intake rate (L/day)	1.07E-01	EPA 1999b
Irplant	Plant intake rate (kg dry/ day)	0.093	EPA 1999b
PUF	Plant uptake factor (unitless)	Chemical-specific	--
BW	Body weight (kg)	1.09	EPA 1999b
TRV	Toxicity reference value (mg/kg/day)	Chemical-specific	Appendix B

a = EPA 1999b
b = Baes et al. 1984 (based on Bv).
c = Efroymson et al. 1997
d = TNRCC 1996.
NA = Not applicable.
NTV = No toxicity value available.
NC = Not a COPC in this medium.

Table 5-16 Risk to Mink: Overflow Creek
Miami-Erie Canal, Mound Plant

Intake = [(Cs * Irs) + ((Cs * PUF) * Irplant) + (Csw * Irsw)] / BW
HQ = Intake / TRV

Constituent	Sediment Concentration	Surface Water Concentration	log Kow	Kow	Fish BCF/BAF	Fish Concentration	Intake				TRV	Hazard Quotient			
							Sediment	Suface Water	Fish	Total		Sediment	Surface Water	Fish	Total
Organics															
2-amino-4,6-dinitrotoluene	0.00022		--			0	0.00000	0.00000	0.00000	0.000	NTV	--	--	--	--
Anthracene	0.077		--			0	0.00014	0.00000	0.00000	0.000	NTV	--	--	--	--
Aroclor-1254	0.073		--			0	0.00013	0.00000	0.00000	0.000	0.000205	0.656	0.000	0.000	0.656
Benzo(a)anthracene	0.34		--			0	0.00063	0.00000	0.00000	0.001	0.06914	0.009	0.000	0.000	0.009
Benzo(a)pyrene	0.4		--			0	0.00074	0.00000	0.00000	0.001	0.414	0.002	0.000	0.000	0.002
Benzo(g,h,I)perylene	0.18		--			0	0.00033	0.00000	0.00000	0.000	NTV	--	--	--	--
Benzo(k)fluoranthene	1.3		--			0	0.00240	0.00000	0.00000	0.002	NTV	--	--	--	--
Benzoic acid	0.31		--			0	0.00057	0.00000	0.00000	0.001	NTV	--	--	--	--
beta-BHC	0.0054		--			0	0.00001	0.00000	0.00000	0.000	3.06	0.000003	0.000000	0.000000	0.000003
Bis(2-ethylhexyl)phthalate	0.35		--			0	0.00065	0.00000	0.00000	0.001	45.9	0.00001	0.00000	0.00000	0.00001
Carbazole	0.057		--			0	0.00011	0.00000	0.00000	0.000	NTV	--	--	--	--
Chrysene	0.5		--			0	0.00092	0.00000	0.00000	0.001	NTV	--	--	--	--
Dibenz(a,h)anthracene	0.056		--			0	0.00010	0.00000	0.00000	0.000	0.00153	0.0675	0.0000	0.0000	0.0675
Dieldrin	0.004		--			0	0.00001	0.00000	0.00000	0.000	0.0153	0.0005	0.0000	0.0000	0.0005
Fluoranthene	0.86		--			0	0.00159	0.00000	0.00000	0.002	NTV	--	--	--	--
gamma-BHC	0.002	0.00002	4.3	19953	2009.5034 a,b	0.040190069	0.00000	0.000001896	0.00827	0.008	3.06	0.0000012	0.0000006	0.0027041	0.0027059
Heptachlor epoxide		0.0000008	4.9	79433	13187.2784 a,b	0.010549823	0.00000	0.000000076	0.00217	0.002	NTV	--	--	--	--
HMX	0.48		--			0	0.00088	0.00000	0.00000	0.001	NTV	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.21		--			0	0.00039	0.00000	0.00000	0.000	NTV	--	--	--	--
Methoxychlor	0.007		--			0	0.00001	0.00000	0.00000	0.000	3.06	0.000004	0.000000	0.000000	0.000004
RDX	1.2		--			0	0.00221	0.00000	0.00000	0.002	NTV	--	--	--	--
Phenanthrene	0.33		--			0	0.00061	0.00000	0.00000	0.001	NTV	--	--	--	--
Pyrene	0.77		--			0	0.00142	0.00000	0.00000	0.001	NTV	--	--	--	--
Inorganics															
Aluminum	10900	2.05	--		2.7 a	5.535	20.09020	0.19435	1.13956	21.424	0.799	25.1	0.2	1.43	26.8
Antimony	4.6		--			0	0.00848	0.00000	0.00000	0.008	0.0505	0.1679	0.0000	0.0000	0.1679
Arsenic	6.5		--			0	0.01198	0.00000	0.00000	0.012	2.35	0.005	0.000	0.000	0.005
Barium	112		--			0	0.20643	0.00000	0.00000	0.206	3.9	0.053	0.000	0.000	0.053
Beryllium	0.63		--			0	0.00116	0.00000	0.00000	0.001	0.505	0.00230	0.00000	0.00000	0.00230
Copper	73		--			0	0.13455	0.00000	0.00000	0.135	11.94	0.011	0.000	0.00	0.01
Cyanide	0.84	0.01	--		633 a	6.33	0.00155	0.00095	1.30324	1.306	18.36	0.0001	0.0001	0.0710	0.0711
Iron	18700	2.32	--		633 a	1468.56	34.46667	0.21995	302.35059	337.037	30.6	1.1	0.0	9.9	11.0

Table 5-16 (cont.)

Constituent	Sediment Concentration	Surface Water Concentration	log Kow	Kow	Fish BCF/BAF	Fish Concentration	Intake				TRV	Hazard Quotient			
							Sediment	Suface Water	Fish	Total		Sediment	Surface Water	Fish	Total
Lead	57.5		--			0	0.10598	0.00000	0.00000	0.106	3.312	0.03200	0.00000	0.00000	0.03200
Lithium	14.1		--			0	0.02599	0.00000	0.00000	0.026	3.89	0.00668	0.00000	0.00000	0.00668
Manganese	439	0.046	--		633 a	29.118	0.80914	0.00436	5.99488	6.808	67.32	0.0120	0.0001	0.0891	0.1011
Molybdenum	9.8	0.0623	--		633 a	39.4359	0.01806	0.00591	8.11916	8.143	0.108	0.1672	0.0547	75.1774	75.3993
Nickel	17.3		--			0	0.03189	0.00000	0.00000	0.032	30.6	0.0010	0.0000	0.0000	0.0010
Thallium	0.4		--			0	0.00074	0.00000	0.00000	0.001	0.01	0.0737	0.0000	0.0000	0.0737
Tin	4.2	0.132	--		633 a	83.556	0.00774	0.01251	17.20271	17.223	9.688	0.0008	0.0013	1.7757	1.7778
Vanadium	23.5		--			0	0.04331	0.00000	0.00000	0.043	0.1607	0.2695	0.0000	0.0000	0.2695
Zinc	102		--			0	0.18800	0.00000	0.00000	0.188	122.4	0.0015	0.0000	0.0000	0.0015
Anions															
Bismuth	42.4		--			0	0.07815	0.00000	0.00000	0.078	NTV	--	--	--	--
Chloride	119	0.172	--			0	0.21933	0.01631	0.00000	0.236	NTV	--	--	--	--
Fluoride	5.7	0.0005	--			0	0.01051	0.00005	0.00000	0.011	31.21	0.0003	0.0000	0.0000	0.0003
Nitrate/Nitrite	3.2		--			0	0.00590	0.00000	0.00000	0.006	486	0.000012	0.000000	0.000000	0.000012
Nitrogen		0.0014	--			0	0.00000	0.00013	0.00000	0.000	NTV	--	--	--	--
Sulfate	282	0.142	--			0	0.51976	0.01346	0.00000	0.533	NTV	--	--	--	--

Symbol	Parameter	Value	Source
Cs	Sediment concentration (mg/kg)	--	--
Irs	Sediment intake rate (kg dw/day)	6.99E-04	EPA 1999b
Irsw	Surface water intake rate (L/day)	1.07E-01	EPA 1999b
Irplant	Plant intake rate (kg dry/ day)	0.093	EPA 1999b
PUF	Plant uptake factor (unitless)	Chemical-specific	--
BW	Body weight (kg)	1.09	EPA 1999b
TRV	Toxicity reference value (mg/kg/day)	Chemical-specific	Appendix B

a = EPA 1999b
b = Baes et al. 1984 (based on Bv).
c = Efroymson et al. 1997
d = TNRCC 1996.
NA = Not applicable.
NTV = No toxicity value available.
NC = Not a COPC in this medium.

Mallard

A mallard may be exposed to chemical COPCs in the Overflow Creek through ingestion of plants, sediment, and surface water. The estimated daily dose and the potential risk to a mallard are presented in Table 5-17. There is a potential for adverse effects to a mallard from exposure to PAHs in Overflow Creek sediments. Benzo(a)anthracene, benzo(a)pyrene, benzo(g,h,I)perylene, and chrysene were found to be of potential concern through sediment ingestion. Benzo(k)fluoranthene was found to be of concern through sediment and plant ingestion. Due to the conservative method for estimating exposure doses, this risk may be overestimated as discussed further in the Uncertainty Analysis (Section 5.4).

Of these PAHs, the total HI for benzo(k)fluoranthene (35.6) exceeded 10. An uncertainty factor of 10 is typically used to extrapolate from a no observable adverse effect level (NOAEL) to a lowest observable effect level (LOAEL) (EPA 1997; EPA 1999b). The more conservative NOAEL is the preferred screening exposure level to determine a level that is unlikely to adversely impact populations and to ensure that risk is not underestimated. If a LOAEL value is exceeded, there is more certainty that the contaminants may be adversely impacting ecological receptors.

No avian TRVs were available for several organic and inorganic contaminants measured in sediment, which may contribute to the ecological risk. The uncertainty associated with the lack of TRVs is discussed in the Uncertainty Analysis.

Belted Kingfisher

A belted kingfisher may be exposed to chemical COPCs in the Overflow Creek through ingestion of fish, sediment, and surface water. The estimated daily dose and the potential risk to a kingfisher are presented in Table 5-18. There is a potential for adverse effects to a kingfisher from exposure to PAHs in Overflow Creek sediments. Benzo(g,h,I)perylene, benzo(k)fluoranthene, and chrysene were found to be of potential concern through sediment ingestion. Due to the conservative method for estimating exposure doses, this risk may be overestimated as discussed further in the Uncertainty Analysis (Section 5.4).

Of these PAHs, the total HI for benzo(k)fluoranthene (20.2) exceeded 10, while the total HI for benzo(g,h,I)perylene (2.8) and chrysene (1.1) did not exceed 10. An uncertainty factor of 10 is typically used to extrapolate from a no observable adverse effect level (NOAEL) to a lowest observable effect level (LOAEL) (EPA 1997; EPA 1999b). The more conservative NOAEL is the preferred screening exposure level to determine a level that is unlikely to adversely impact populations and to ensure that risk is not underestimated. If a LOAEL value is exceeded, there is more certainty that the contaminants may be adversely impacting ecological receptors.

No avian TRVs were available for several organic and inorganic contaminants measured in sediment, which may contribute to the ecological risk. The uncertainty associated with the lack of TRVs is discussed in the Uncertainty Analysis.

Table 5-17 Risk to Mallard: Overflow Creek
Miami-Erie Canal, Mound Plant

Intake = [(Cs * Irs) + ((Cs * PUF) * Irplant) + (Csw * Irsw)] / BW
HQ = Intake / TRV

Constituent	Sediment Concentration	Surface Water Concentration	log Kow	Plant Uptake Factor	Plant Concentration	Intake Sediment	Intake Suface Water	Intake Plant	Intake Total	TRV	Hazard Quotient Sediment	Hazard Quotient Surface Water	Hazard Quotient Plant	Hazard Quotient Total
Organics														
2-amino-4,6-dinitrotoluene	0.00022		--		0	0.00000	0.00000	0.00000	0.000	NTV	--	--	--	--
Anthracene	0.077		4.3	0.1266 a,d	0.009751933	0.00024	0.00000	0.00056	0.001	NTV	--	--	--	--
Aroclor-1254	0.073		6.207	0.0100 a	0.000730595	0.00023	0.00000	0.00004	0.000	0.072	0.003	0.000	0.001	0.004
Benzo(a)anthracene	0.34		5.679	0.0202 a	0.006870952	0.00108	0.00000	0.00039	0.001	0.00079	1.366	0.000	0.499	1.865
Benzo(a)pyrene	0.4		6.129	0.0111 a	0.004441176	0.00127	0.00000	0.00025	0.002	0.001	1.269	0.000	0.255	1.524
Benzo(g,h,I)perylene	0.18		6.7	0.0052 a,d	0.000934701	0.00057	0.00000	0.00005	0.001	0.00014	4.080	0.000	0.383	4.463
Benzo(k)fluoranthene	1.3		6.1	0.0115 a,d	0.015001799	0.00413	0.00000	0.00086	0.005	0.00014	29.464	0.000	6.151	35.615
Benzoic acid	0.31		1.9	3.0889 a,d	0.957550514	0.00098	0.00000	0.05497	0.056	NTV	--	--	--	--
beta-BHC	0.0054		4.3	0.1266 a,d	0.000683902	0.00002	0.00000	0.00004	0.000	0.563	0.00003	0.00000	0.00007	0.00010
Bis(2-ethylhexyl)phthalate	0.35		5.205	0.0380 a	0.013291624	0.00111	0.00000	0.00076	0.002	1.11	0.00100	0.00000	0.00069	0.00169
Carbazole	0.057		3.2	0.5475 a,d	0.031208641	0.00018	0.00000	0.00179	0.002	NTV	--	--	--	--
Chrysene	0.5		6.2	0.0101 a	0.005050914	0.00159	0.00000	0.00029	0.002	0.001	1.6	0.0	0.3	1.9
Dibenz(a,h)anthracene	0.056		5.739	0.0187 a	0.001044831	0.00018	0.00000	0.00006	0.000	0.00039	0.5	0.0	0.2	0.6
Dieldrin	0.004		5.4	0.0293 a,d	0.000117182	0.00001	0.00000	0.00001	0.000	0.077	0.0	0.0	0.0	0.0
Fluoranthene	0.86		4.9	0.0570 a,d	0.049011552	0.00273	0.00000	0.00281	0.006	NTV	--	--	--	--
gamma-BHC	0.002	0.00002	4.3	0.1266 a,d	0.000253297	0.00001	0.000001164	0.00001	0.000	0.563	0.00001	0.00000	0.00003	0.00004
Heptachlor epoxide		0.0000008	4.9	0.0570 a,d	0	0.00000	0.000000047	0.00000	0.000	NTV	--	--	--	--
HMX	0.48		0.26	27.3981 a,d	13.15107448	0.00152	0.00000	0.75492	0.756	NTV	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.21		6.915	0.0039 a	0.000819123	0.00067	0.00000	0.00005	0.001	0.001	0.666	0.000	0.047	0.713
Methoxychlor	0.007		5.7	0.0197 a,d	0.000137562	0.00002	0.00000	0.00001	0.000	0.556	0.00004	0.00000	0.00001	0.00005
RDX	1.2		0.87	12.1658 a,d	14.59893739	0.00381	0.00000	0.83804	0.842	NTV	--	--	--	--
Phenanthrene	0.33		4.3	0.1266 a,d	0.041794	0.00105	0.00000	0.00240	0.003	NTV	--	--	--	--
Pyrene	0.77		4.9	0.0570 a,d	0.043882436	0.00244	0.00000	0.00252	0.005	NTV	--	--	--	--
Inorganics														
Aluminum	10900	2.05	NA	0.0040 a	43.6	34.58654	0.11931	2.50281	37.209	100	0.3	0.0	0.03	0.4
Antimony	4.6			0.2000 a	0.92	0.01460	0.00000	0.05281	0.067	NTV	--	--	--	--
Arsenic	6.5		NA	0.0360 a	0.234	0.02063	0.00000	0.01343	0.034	2.46	0.008	0.000	0.005	0.014
Barium	112		NA	0.150 a	16.8	0.35538	0.00000	0.96438	1.320	20.826	0.017	0.000	0.046	0.063
Beryllium	0.63		NA	0.010 a	0.0063	0.00200	0.00000	0.00036	0.002	NTV	--	--	--	--
Copper	73		NA	0.400 a	29.2	0.23163	0.00000	1.67619	1.908	46.97	0.005	0.000	0.04	0.04
Cyanide	0.84	0.01			0	0.00267	0.00058	0.00000	0.003	NTV	--	--	--	--

Table 5-17 (cont.)

Constituent	Sediment Concentration	Surface Water Concentration	log Kow	Plant Uptake Factor	Plant Concentration	Intake Sediment	Intake Suface Water	Intake Plant	Intake Total	TRV	Hazard Quotient Sediment	Hazard Quotient Surface Water	Hazard Quotient Plant	Hazard Quotient Total
Iron	18700	2.32	NA	0.0040 b	74.8	59.33654	0.13503	4.29381	63.765	NTV	--	--	--	--
Lead	57.5			0.0450 a	2.5875	0.18245	0.00000	0.14853	0.331	1.13	0.2	0.0	0.1	0.3
Lithium	14.1		NA	0.0250 b	0.3525	0.04474	0.00000	0.02023	0.065	NTV	--	--	--	--
Manganese	439	0.046	NA	0.2500 b	109.75	1.39298	0.00268	6.30007	7.696	977	0.0014	0.0000	0.0064	0.0079
Molybdenum	9.8	0.0623	NA	0.0525	0.5145	0.03110	0.00363	0.02953	0.064	3.5	0.0089	0.0010	0.0084	0.0184
Nickel	17.3		NA	0.0320 a	0.5536	0.05489	0.00000	0.03178	0.087	77.4	0.0007	0.0000	0.0004	0.0011
Thallium	0.4			0.0040 a	0.0016	0.00127	0.00000	0.00009	0.001	0.192	0.0066	0.0000	0.0005	0.0071
Tin	4.2	0.132	NA	0.030 b	0.126	0.01333	0.00768	0.00723	0.028	6.76	0.0020	0.0011	0.0011	0.0042
Vanadium	23.5		NA	0.0049 c	0.11515	0.07457	0.00000	0.00661	0.081	11.4	0.0065	0.0000	0.0006	0.0071
Zinc	102		NA	0.121 c	12.342	0.32365	0.00000	0.70848	1.032	130.9	0.0025	0.0000	0.0054	0.0079
Anions														
Bismuth	42.4		NA	0.0350 b	1.484	0.13454	0.00000	0.08519	0.220	NTV	--	--	--	--
Chloride	119	0.172	NA		0	0.37760	0.01001	0.00000	0.388	NTV	--	--	--	--
Fluoride	5.7	0.0005	NA		0	0.01809	0.00003	0.00000	0.018	7.8	0.0023	0.0000	0.0000	0.0023
Nitrate/Nitrite	3.2		NA		0	0.01015	0.00000	0.00000	0.010	NTV	--	--	--	--
Nitrogen		0.0014	NA	6.300 b	0	0.00000	0.00008	0.00000	0.000	NTV	--	--	--	--
Sulfate	282	0.142	NA		0	0.89481	0.00826	0.00000	0.903	NTV	--	--	--	--

Symbol	Parameter	Value	Source
Cs	Sediment concentration (mg/kg)	--	--
Irs	Sediment intake rate (kg dw/day)	6.99E-04	EPA 1999b
Irsw	Surface water intake rate (L/day)	1.07E-01	EPA 1999b
Irplant	Plant intake rate (kg dry/ day)	0.093	EPA 1999b
PUF	Plant uptake factor (unitless)	Chemical-specific	--
BW	Body weight (kg)	1.09	EPA 1999b
TRV	Toxicity reference value (mg/kg/day)	Chemical-specific	Appendix B

a = EPA 1999b
b = Baes et al. 1984 (based on Bv).
c = Efroymson et al. 1997
d = TNRCC 1996.
NA = Not applicable.
NTV = No toxicity value available.
NC = Not a COPC in this medium.

Table 5-18 Risk to Belted Kingfisher: Overflow Creek
Miami-Erie Canal, Mound Plant

Intake = [(Cs * Irs) + ((Cs * PUF) * Irplant) + (Csw * Irsw)] / BW
HQ = Intake / TRV

Constituent	Sediment Conc.	Surface Water Conc.	log Kow	Kow	Fish BCF/BAF	Fish Concentration	Intake				TRV	Hazard Quotient			
							Sediment	Suface Water	Fish	Total		Sediment	Surface Water	Fish	Total
Organics															
2-amino-4,6-dinitrotoluene	0.00022		--			0	0.00000	0.00000	0.00000	0.000	NTV	--	--	--	--
Anthracene	0.077		--			0	0.00017	0.00000	0.00000	0.000	NTV	--	--	--	--
Aroclor-1254	0.073		--			0	0.00016	0.00000	0.00000	0.000	0.072	0.002	0.000	0.000	0.002
Benzo(a)anthracene	0.34		--			0	0.00074	0.00000	0.00000	0.001	0.00079	0.937	0.000	0.000	0.937
Benzo(a)pyrene	0.4		--			0	0.00087	0.00000	0.00000	0.001	0.001	0.871	0.000	0.000	0.871
Benzo(g,h,I)perylene	0.18		--			0	0.00039	0.00000	0.00000	0.000	0.00014	2.799	0.000	0.000	2.799
Benzo(k)fluoranthene	1.3		--			0	0.00283	0.00000	0.00000	0.003	0.00014	20.214	0.000	0.000	20.214
Benzoic acid	0.31		--			0	0.00067	0.00000	0.00000	0.001	NTV	--	--	--	--
beta-BHC	0.0054		--			0	0.00001	0.00000	0.00000	0.000	0.563	0.00002	0.00000	0.00000	0.00002
Bis(2-ethylhexyl)phthalate	0.35		--			0	0.00076	0.00000	0.00000	0.001	1.11	0.00069	0.00000	0.00000	0.00069
Carbazole	0.057		--			0	0.00012	0.00000	0.00000	0.000	NTV	--	--	--	--
Chrysene	0.5		--			0	0.00109	0.00000	0.00000	0.001	0.001	1.1	0.0	0.0	1.1
Dibenz(a,h)anthracene	0.056		--			0	0.00012	0.00000	0.00000	0.000	0.00039	0.3	0.0	0.0	0.3
Dieldrin	0.004		--			0	0.00001	0.00000	0.00000	0.000	0.077	0.0	0.0	0.0	0.0
Fluoranthene	0.86		--			0	0.00187	0.00000	0.00000	0.002	NTV	--	--	--	--
gamma-BHC	0.002	0.00002	4.3	19953	2009.5034 a,b	0.040190069	0.00000	0.000002218	0.02023	0.020	0.563	0.00001	0.00000	0.03594	0.03595
Heptachlor epoxide		0.0000008	4.9	79433	13187.2784 a,b	0.010549823	0.00000	0.000000089	0.00531	0.005	NTV	--	--	--	--
HMX	0.48		--			0	0.00104	0.00000	0.00000	0.001	NTV	--	--	--	--
Indeno(1,2,3-cd)pyrene	0.21		--			0	0.00046	0.00000	0.00000	0.000	0.001	0.457	0.000	0.000	0.457
Methoxychlor	0.007		--			0	0.00002	0.00000	0.00000	0.000	0.556	0.00003	0.00000	0.00000	0.00003
RDX	1.2		--			0	0.00261	0.00000	0.00000	0.003	NTV	--	--	--	--
Phenanthrene	0.33		--			0	0.00072	0.00000	0.00000	0.001	NTV	--	--	--	--
Pyrene	0.77		--			0	0.00168	0.00000	0.00000	0.002	NTV	--	--	--	--
Inorganics															
Aluminum	10900	2.05	--		2.7 a	5.535	23.72789	0.22731	2.78633	26.742	100	0.2	0.0	0.03	0.3
Antimony	4.6		--			0	0.01001	0.00000	0.00000	0.010	NTV	--	--	--	--
Arsenic	6.5		--			0	0.01415	0.00000	0.00000	0.014	2.46	0.006	0.000	0.000	0.006
Barium	112		--			0	0.24381	0.00000	0.00000	0.244	20.826	0.012	0.000	0.000	0.012
Beryllium	0.63		--			0	0.00137	0.00000	0.00000	0.001	NTV	--	--	--	--
Copper	73		--			0	0.15891	0.00000	0.00000	0.159	46.97	0.003	0.000	0.00	0.00
Cyanide	0.84	0.01	--		633 a	6.33	0.00183	0.00111	3.18653	3.189	NTV	--	--	--	--

Table 5-18 (cont.)

Constituent	Sediment Conc.	Surface Water Conc.	log Kow	Kow	Fish BCF/BAF	Fish Concentration	Intake Sediment	Intake Suface Water	Intake Fish	Intake Total	TRV	Hazard Quotient Sediment	Hazard Quotient Surface Water	Hazard Quotient Fish	Hazard Quotient Total
Iron	18700	2.32	--		633 a	1468.56	40.70748	0.25725	739.27510	780.240	NTV	--	--	--	--
Lead	57.5		--			0	0.12517	0.00000	0.00000	0.125	1.13	0.1	0.0	0.0	0.1
Lithium	14.1		--			0	0.03069	0.00000	0.00000	0.031	NTV	--	--	--	--
Manganese	439	0.046	--		633 a	29.118	0.95565	0.00510	14.65804	15.619	977	0.0010	0.0000	0.0150	0.0160
Molybdenum	9.8	0.0623	--		633 a	39.4359	0.02133	0.00691	19.85209	19.880	3.5	0.0061	0.0020	5.6720	5.6801
Nickel	17.3		--			0	0.03766	0.00000	0.00000	0.038	77.4	0.0005	0.0000	0.0000	0.0005
Thallium	0.4		--			0	0.00087	0.00000	0.00000	0.001	0.192	0.0045	0.0000	0.0000	0.0045
Tin	4.2	0.132	--		633 a	83.556	0.00914	0.01464	42.06220	42.086	6.76	0.0014	0.0022	6.2222	6.2257
Vanadium	23.5		--			0	0.05116	0.00000	0.00000	0.051	11.4	0.0045	0.0000	0.0000	0.0045
Zinc	102		--			0	0.22204	0.00000	0.00000	0.222	130.9	0.0017	0.0000	0.0000	0.0017
Anions															
Bismuth	42.4		--			0	0.09230	0.00000	0.00000	0.092	NTV	--	--	--	--
Chloride	119	0.172	--			0	0.25905	0.01907	0.00000	0.278	NTV	--	--	--	--
Fluoride	5.7	0.0005	--			0	0.01241	0.00006	0.00000	0.012	7.8	0.0016	0.0000	0.0000	0.0016
Nitrate/Nitrite	3.2		--			0	0.00697	0.00000	0.00000	0.007	NTV	--	--	--	--
Nitrogen		0.0014	--			0	0.00000	0.00016	0.00000	0.000	NTV	--	--	--	--
Sulfate	282	0.142	--			0	0.61388	0.01575	0.00000	0.630	NTV	--	--	--	--

Symbol	Parameter	Value	Source
Cs	Sediment concentration (mg/kg)	--	--
Irs	Sediment intake rate (kg dw/day)	6.99E-04	EPA 1999b
Irsw	Surface water intake rate (L/day)	1.07E-01	EPA 1999b
Irplant	Plant intake rate (kg dry/ day)	0.093	EPA 1999b
PUF	Plant uptake factor (unitless)	Chemical-specific	--
BW	Body weight (kg)	1.09	EPA 1999b
TRV	Toxicity reference value (mg/kg/day)	Chemical-specific	Appendix B

a = EPA 1999b
b = Baes et al. 1984 (based on Bv).
c = Efroymson et al. 1997
d = TNRCC 1996.
NA = Not applicable.
NTV = No toxicity value available.
NC = Not a COPC in this medium.

Aquatic Organisms

The maximum detected concentration of aluminum in surface water exceeded the acute ambient water quality criteria (Table 5-19). The maximum detected concentration of chloride, fluoride, and sulfate exceeded background levels. No water quality benchmarks were available for these anions. The pesticide gamma-BHC in sediment exceeded the probable effect level, while aluminum, beryllium, lithium, molybdenum, tin, and bismuth exceeded background levels (Table 5-20). No benchmarks were available for several organic and inorganic contaminants measured in surface water and sediment, which may contribute to the ecological risk. The uncertainty associated with the lack of benchmarks is discussed in the Uncertainty Analysis.

5.4 Summary of Uncertainty

The ecological risk assessment process is subject to a variety of uncertainties. Almost every step involves assumptions based on professional judgment. Due to the conservative nature of a SLERA, most of the uncertainty results are an overestimation of risk. However, the risk may also be underestimated or unknown. Uncertainties specific to this risk assessment can be attributed to:

- Environmental chemistry and sampling analysis.
- Fate and transport parameters.
- Exposure assumptions.
- Toxicological data.

Uncertainties specific to this risk assessment include the following:

Environmental Chemistry and Sampling Analysis

- Bis(2-ethylhexyl)phthalate (BEHP)and di-n-butyl phthalate (DNBP) were found to pose a potential for adverse effects on the robin and short-tailed shrew. Phthalate esters are plasticizers and common laboratory contaminants. These constituents may not be site-related; thus, risks associated with exposure to BEHP and DNBP may be overestimated.
- Metals, PAHs, and pesticides were found to pose a potential for adverse effects on mammals and birds, and on aquatic organisms in the South Pond and Overflow Creek. Since, metals, PAHs, and pesticides are ubiquitous in the environment due to natural and man-made causes, background concentrations should be considered when evaluating contamination. Background pond and stream samples collected during OU9 Remedial Investigations suggest that aluminum is present at concentrations similar to background. Background levels of PAHs were not measured in any medium at the time of the OU9 Remedial Investigation. The land surrounding the site is developed and both the Conrail Railroad and the Dayton-Cincinnati Road are adjacent to the Canal. Thus, metals, PAHs, and pesticides may be present due to other off-site sources, such as automobile exhaust. Thus, risks from site-related contaminants may be overestimated.

Table 5-19
Comparison of Overflow Creek Surface Water Concentrations to Surface Water Benchmarks
Miami-Erie Canal, Mound Plant

	Frequency of	Range of Detections		Maximum	Background [a]	Ohio Water Quality Standard		NAWQ Criteria	
Chemical	Detection	Minimum	Maximum	Location		OMZA	OMZM	chronic	Acute
Organic Compounds (ug/L)									
gamma-BHC	2/9	0.0067	0.015	MND21-2605	ND	--	--	0.08	2
Heptachlor epoxide	2/9	--	0.0008	MND21-2605	ND	--	--	--	--
HMX	1/9	--	0.80	MND21-2605	ND	--	--	--	--
Inorganics (ug/L)									
Aluminum	5/6	78.5	2050	MND21-2605	360	--	--	87	750
Cyanide	1/6	--	10.2	MND21-2605	ND	--	--	5.2	22
Iron	3/6	576	2320	MND21-2605	1700	--	--	1000	
Lithium	4/6	4	7.7	MND21-2605	ND	--	--	14+	260+
Manganese	6/6	1.7	45.8	MND21-2605	460	--	--	120+	2300+
Molybdenum	6/6	31.4	62.3	MND21-2605	15	--	--	370+	16000+
Tin	1/6	--	132	MND21-2605	ND	--	--	73+	2700+
Anions (mg/L)									
Chloride	3/3	143	172	MND21-2605	150	--	--	--	--
Fluoride	3/3	0.186	0.545	MND21-2605	0.1	--	--	--	--
Nitrogen	2/3	0.7	1.4	MND21-2605	280	--	--	--	--
Sulfate	3/3	36.6	142	MND21-2605	4.2	--	--	--	--

Table 5-20
Comparison of Overflow Creek Sediment Concentrations to Sediment Benchmarks
Miami-Erie Canal, Mound Plant

	Frequency of	Range of Detections		Maximum	Background [a]	CCME[b]		Long et al.[c]	
Chemical	Detection	Minimum	Maximum	Location		ISQG	PEL	ER-L	ER-M
Organic Compounds (ug/kg)									
2-Amino-4,6-dinitrotoluene	1/8		0.22	MND22-2606	ND	--	--	--	--
Anthracene	2/8	60	77.00	MND21-2605	ND	46.90	245	85.3	1100
Aroclor-1254	4/8	38	73.00	MND21-2605	ND	34.1	277	22.7	180
Benzo(a)anthracene	8/8	44	340.00	MND21-2605	ND	31.7	385	261	1600
Benzo(a)pyrene	8/8	44	400.00	MND21-2605	ND	31.9	782	430	1600
Benzo(b)fluoranthene	8/8	95	810.00	MND21-2605	ND	--	--	1700*	9600*
Benzo(g,h,I)perylene	4/8	50	180.00	MND21-2605	ND	--	--	1700*	9600*
Benzo(k)fluoranthene	7/8	99	1300.00	MND21-2605	ND	--	--	1700*	9600*
Benzoic acid	1/8		310.00	MND21-2605	ND	--	--	--	--
beta-BHC	3/8	0.69	5.40	MND22-2606	ND	--	--	--	--
Bis(2-ethylhexyl)phthalate	7/8	91	350	MND21-2605	ND	--	--	--	--
Carbazole	1/8		57	MND21-2605	ND	--	--	--	--
Chrysene	7/8	60	500	MND21-2605	ND	57.1	862	384	2800
Dibenz(a,h)anthracene	1/8		56	MND21-2605	ND	6.22	135	63.4	260
Dieldrin	6/8	0.3	4	MND22-2606	22	2.85	6.67	--	--
Fluoranthene	8/8	95	860	MND21-2605	ND	111	2355	600	5100
gamma-BHC	5/8	0.23	2	MND21-2605	ND	0.940	1.38	--	--
HMX	3/9	0.1	0.48	MND22-2606	ND	--	--	--	--
Indeno(1,2,3-cd)pyrene	5/8	48	210	MND21-2605	ND	--	--		
Methoxychlor	4/8	1.2	7	MND22-2606	ND	--	--	--	--
RDX	4/9	0.73	1	MND22-2606	ND	--	--	--	--
Phenanthrene	7/8	48	330	MND21-2605	ND	41.9	515	240	1500
Pyrene	8/8	79	770	MND21-2605	ND	53.0	875	665	2600

Table 5-20 (cont.)

Chemical	Frequency of Detection	Range of Detections Minimum	Range of Detections Maximum	Maximum Location	Background [a]	CCME[b] ISQG	CCME[b] PEL	Long et al.[c] ER-L	Long et al.[c] ER-M
Inorganics (mg/kg)									
Aluminum	8/8	2880	10900	mnd22-2606	10000	--	--	--	--
Antimony	3/8	0.53	4.6	mnd21-2605	NA	--	--	--	--
Arsenic	8/8	2.1	6.5	mnd22-2606	29	5.9	17	8.2	70
Barium	8/8	18	112	mnd22-2606	270	--	--	--	--
Beryllium	8/8	0.16	0.6	mnd21-2605	0.48	--	--	--	--
Cadmium	2/6	0.23	0.7	mnd21-2605	0.75	0.6	3.5	1.2	9.6
Copper	8/8	14.7	73	mnd22-2606	34	35.7	197	34	270
Cyanide	1/8	--	1	mnd21-2605	ND	--	--	--	--
Iron	8/8	7080	18700	mnd22-2606	30000	--	--	--	--
Lead	8/8	8	58	mnd22-2606	36	35.0	91.3	46.7	218
Lithium	8/8	5	14	mnd22-2606	12	--	--	--	--
Manganese	8/8	211	439	mnd22-2606	2800	--	--	--	--
Molybdenum	7/8	1.3	9.8	mnd22-2606	1.4	--	--	--	--
Nickel	8/8	12.1	17.3	mnd22-2606	19	--	--	20.9	51.6
Thallium	1/8	--	0.40	mnd21-2605	ND	--	--	--	--
Tin	2/8	2.4	4.2	mnd21-2605	1.3	--	--	--	--
Vanadium	8/8	8.6	23.5	mnd21-2605	28	--	--	--	--
Anions (mg/kg)									
Bismuth	3/8	1	42.4	mnd21-2605	0.49	--	--	--	--
Chloride	8/8	31.7	119	mnd21-2605	41000	--	--	--	--
Fluoride	8/8	1.7	5.7	mnd21-2605	130	--	--	--	--
Nitrate/Nitrite	5/8	1.09	3.2	mnd21-2605	820	--	--	--	--
Sulfate	4/8	150	282	mnd22-2606	84000	--	--	--	--

Fate and Transport Parameters

- Total (i.e., non-filtered or undissolved) surface water concentrations were used to evaluate risk for this site, though dissolved (i.e., filtered) metal concentrations more closely approximate the bioavailable fraction of metal in the water column than does the total recoverable metal (EPA 1995). Thus, risks associated with surface water exposure may be overestimated.
- Aluminum and iron are major constituents in the earth's crust and are typically found at high concentrations. The soluble fraction that is easily mobile and exchangeable plays a major role in the availability, and thus the toxicity, of these elements. Generally, the soluble fraction of these elements is very low in comparison to the total concentration. Thus, evaluating total concentrations of these elements may overestimate risk.
- The bioavailability of COPCs in the environmental media and diet of the receptors (e.g., soil, earthworms, and plants) was estimated at 100 percent. This is likely to overestimate risk since constituents in the environment are quite frequently bound as complexes that reduce their bioavailability.

Exposure Assumptions

- Maximum values were used as exposure point concentrations for all media. This is likely to result in an overestimation of risk, especially for terrestrial ecological receptors that may inhabit a greater area than the area represented by just one or a few samples.
- Exposure parameters for all receptors were selected based on literature information. The amount of food, soils, sediment, and water consumed on a daily basis; the variety of food consumed; and the percentage of the whole diet that each food item represents was estimated based on information from scientific literature. In addition, the amount of time spent exposed to site-related media is assumed to be the highest possible value. Because conservative assumptions were used throughout the exposure assessment process, these assumptions are likely to overestimate dietary intake.
- Several food and water ingestion rates for bird and mammal receptors were estimated based on allometric models from the scientific literature. Allometric models that estimate dietary and water ingestion rates are based on the relationship that exists between relative body weights and ingestion rates of birds and mammals. The allometric models were developed by incorporating information on many different species that have varying weights and food preferences. These models generally result in an overestimation of the actual intake rates for ecological receptors.
- Risk to the robin and shrew was primarily associated with ingestion of earthworms. There are a number of difficulties associated with applying literature-based earthworm BAFs. Environmental conditions such as soil characteristics obscure the underlying relationship between concentrations in soil and in earthworms. Earthworms selectively feed on plant debris and soil organic matter, and consequently, soil concentrations may not represent true exposure concentrations. Also, different earthworm species bioaccumulate chemicals at different rates (Beyer 1990). In addition, it is not known how available metals in earthworm tissues are to predators. The presence of high metal concentrations in earthworm tissues is not

adequate proof that they will be absorbed by the predator (Lee 1985). Thus, risks to the robin and shrew may be over- or under-estimated, depending on the metal evaluated and its bioavailability.

- BAFs for earthworms were predicted from the octanol water partitian coefficient (log K_{ow}) of each organic compound. Metabolism of organic chemicals in earthworms is not considered in the model used to estimate BAFs. High BAFs were estimated for bis(2-ethylhexyl)phthalate and di-n-butylphthalate. While these phthalates may accumulate, rapid metabolism in higher organisms seems to prevent biomagnification in the food chain (ATSDR 1991). Thus, the predicted BAF may be substantially greater than what would be calculated on the basis of a field-measured BAF. In addition, the model used to calculate BAFs for organic constituents is based on accumulation of PAHs by aquatic invertebrates. Thus, the BAFs, and subsequently the earthworm tissue concentrations, may be overestimated.
- An exposure pathway was eliminated from the quantitative evaluation in the SLERA if the pathway is incomplete (e.g., receptors cannot be exposed to the chemical); the pathway is complete but insignificant; or the pathway would be very difficult to quantify (e.g., ingestion of sediments by fish because of lack of toxicological and intake data). Several complete exposure pathways could not be quantified in this SLERA primarily because exposure assumptions and toxicity data were not available to estimate exposure and risk. There is very little information on the dermal absorption and inhalation exposure pathways. Although these exposure pathways are complete, the relative contribution to risk from these pathways when compared to that of ingestion is likely less, though the actual risk is unknown.

Toxicological Data

- Mammalian TRVs were not available for twenty organics and four anions in soil and sediment. Bird TRVs were not available for fifteen organics, four inorganics, and five anions in soil and sediment. Surface water benchmarks were not available for one organic, three inorganics, and four anions. Thus, the potential for adverse effects on terrestrial wildlife, fish, and benthic organisms may be underestimated.
- TRVs were obtained from literature sources that were not specific to the ecological receptors at the site; therefore, in the absence of site-specific data, the extrapolation of the effect data to the receptors was necessary. Since most toxicity data were unavailable for wild bird and mammalian receptors, effects doses were obtained from laboratory studies (e.g., rat, mouse, quail, chicken, and turkey). The lowest reported chronic NOAEL for potential effects on reproduction, development, and reduced survival were used to derive TRVs when available. However, limitations in the available data necessitated the use of other endpoints such as organ-specific effects for several chemicals. This results in conservative TRVs whose relationship to potential population effects is uncertain (Sample et al. 1996). The NOAEL-based TRVs are designed not to underestimate risk, so that the risks at the site may actually be overestimated.
- The majority of available effect data was determined using laboratory animals studied under laboratory conditions. These data as well as toxicological interpretations based on blood biochemistry or body weight changes may not represent adverse health effects or cannot be precisely extrapolated to free-ranging wildlife population.

- Since toxic effects on benthic organisms are species-specific and directly related to ambient conditions (e.g., pH, organic carbon content, grain size), comparison of literature-based toxic concentrations in sediment is extremely simplistic and may not accurately illustrate potential hazards. The reliability of the ER-L values as predictors of the threshold of effects is low for anthracene and fluorene, and the reliability of the ER-M for dibenzo(a,h)anthracene is relatively low (Jones et al. 1996). For the remaining PAHs, the reliability of the ER-L and ER-M values is relatively high. Thus, risks to benthic organisms may be overestimated for some PAHs.

5.5 Refinement of Preliminary COPCs

To ensure that sites which may pose an ecological risk are property identified, EPA (1996) suggests that values used in a screening level assessment should be consistently biased in the direction of overestimating risk. "Without this bias, a screening evaluation could not provide a defensible conclusion for an absence of ecological risk." The screening-level ecological risk assessment found that there is a potential for adverse effects on terrestrial organisms from residual chemical contamination (primarily PAHs, phthalate esters, and select heavy metals) in Canal soils. No potential for adverse effects from radiological contamination was found. Based on the results of this screening level ERA, further investigation is needed to determine if site-related concentrations pose an adverse ecological threat or if the concentrations detected on-site are consistent with expected concentrations not related to site activity.

Although the SLERA probably overestimates the risk from non-radiological contaminants, further evaluation of the available site data, the terrestrial habitat on the site, the toxicity of these contaminants and the results of the Human Health Risk Assessment would have to be done to reduce that conservatism. Because of the conservative assumptions used during the SLERA, some of the retained contaminants (i.e., contaminants with an HQ>1) may also pose a negligible risk. The constituents that pose a potential risk are summarized in Table 5-21 by area and receptor organism. The following subsections describe site conditions by area (i.e., canal, South Pond, Overflow Creek) that will reduce the conservatism of the risk estimates presented in the SLERA.

5.5.1 Canal

The area use factor is defined as the ratio of the home range (or feeding/foraging range) of the receptor to the area of contamination. The Canal covers approximately 7.9 hectares (ha). The average territory size of a robin is 0.25 ha, resulting in an area use factor of 1. For a meadow vole and short-tailed shrew, the area use factor defaults to 1 because their home range [0.027 ha – vole; 0.39 ha- shrew (EPA 1993)] is less than the area of the Canal. Thus, the risk estimates will not change.

Table 5-21
Refinement of COPCs: Receptors and COPCs with HQ >1
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Receptor	Contaminant	Soil/Sediment	Plant	Worm	Fish	Soil + Prey	COEC?	Rationale
South Pond								
Muskrat	Aluminum	X	X				No	BKG
Mink	Aluminum	X			X		No	BKG
	Iron	X					No	BKG
	Molybdenum				X		No	BKG
Mallard	Benzo(a)anthracene	X					No	BKG; AUF
	Indeno(1,2,3-cd)pyrene	X					No	BKG; AUF
	Benzo(a)pyrene	X					No	BKG; AUF
	Benzo(g,h,I)perylene	X					No	BKG; AUF
	Chrysene	X					No	BKG; AUF
	Benzo(b)fluoranthene	X	X				No	BKG; AUF
	Benzo(k)flouranthene	X	X				No	BKG; AUF
Kingfisher	Benzo(a)anthracene	X					No	BKG; AUF
	Benzo(a)pyrene	X					No	BKG; AUF
	Benzo(b)fluoranthene	X					No	BKG; AUF
	Benzo(g,h,I)perylene	X					No	BKG; AUF
	Benzo(k)flouranthene	X					No	BKG; AUF
	Chrysene	X					No	BKG; AUF
Overflow Creek								
Muskrat	Aluminum	X	X				No	BKG
	Antimony		X				No	BKG
Mink	Aluminum	X			X		No	BKG
	Iron	X					No	BKG
	Molybdenum				X		No	AUF;BCF
	Tin				X		No	AUF;BCF
Mallard	Benzo(a)anthracene	X					No	BKG;AUF;BCF
	Benzo(a)pyrene	X					No	BKG;AUF;BCF
	Benzo(g,h,I)perylene	X					No	BKG;AUF;BCF
	Chrysene	X					No	BKG;AUF;BCF
	Benzo(k)flouranthene	X	X				No	BKG;AUF;BCF
Kingfisher	Molybdenum				X		No	AUF;BCF
	Tin				X		No	AUF;BCF
	Benzo(g,h,I)perylene	X					No	BKG;AUF;BCF
	Benzo(k)flouranthene	X					No	BKG;AUF;BCF
	Chrysene	X					No	BKG;AUF;BCF

Table 5-21 (cont.)

Receptor	Contaminant	Soil/Sediment	Plant	Worm	Fish	Soil + Prey	COEC?	Rationale
Canal								
Vole	Antimony	X	X				No	BSL
	Barium	X					No	BKG
	Cadmium		X				No	BKG;EPC
	Chromium					X	No	BSL:EPC
	Copper		X				No	BSL
	Iron	X	X				No	BKG
	Lead	X	X				No	BKG:BSL
	Silver	X	X				No	BKG;EPC
	Thallium	X	X				No	BSL
	Vanadium	X					No	BKG
	Benzo(a)anthracene		X				No	EPC
Shrew	Antimony	X	X				No	BSL;EPC
	Barium		X				No	BKG
	Cadmium		X				No	BKG;EPC
	Iron	X	X				No	BKG
	Lead	X	X				No	EPC
	Selenium						No	EPC
	Silver		X				No	BKG
	Thallium	X	X				No	BSL
	Vanadium		X				No	BKG
	Benzo(a)anthracene					X	No	BGK;BSL
	Bis(2-ethylhexyl)phthalate		X				No	BCF; BSL
	Di-n-butyl phthalate		X				No	BCF; BSL
Robin	Barium			X			No	BKG;EPC
	Cadmium			X			No	BKG;EPC
	Chromium	X					No	EPC
	Lead	X		X			No	BKG;BSL
	Thallium	X		X			No	EPC
	Benzo(a)anthracene	X		X			No	BKG;BSL
	Benzo(a)pyrene	X		X			No	BKG;BSL
	Chrysene	X		X			No	BKG;BSL
	Naphthalene			X			No	BKG;BSL
	Bis(2-ethylhexyl)phthalate			X			No	BCF;BSL
	Di-n-butyl phthalate			X			No	BCF; BSL

COEC = Contaminant of ecological concern.
BKG = Below background levels.
AUF = Area use factor will decrease HQ below 1.
BCF = Low bioavailabilty will result in HQ below 1.
BSL = Below screening level.
EPC = 95% UCL exposure point concentration will decrease HQ below 1.

Maximum values were used as exposure point concentrations for all media. In order to account for uncertainties in the ability of the measured data to reflect actual site conditions, the EPA (1992) has recommended the calculation of the 95% upper confidence limit (UCL) of the arithmetic mean using log-transformed data. The 95% UCL concentration reasonably represents the concentration that mobile ecological receptors will be exposed to. The 95% UCL concentrations for the COPCs in Canal soil with a HQ>1 (based on the maximum concentration) are presented in Tables 5-22 through 5-24. Hazard quotients were re-calculated using the average concentration. For the meadow vole, the re-calculated HQ exceeded one for antimony, barium, copper, iron, lead, thallium, and vanadium. For the shrew, the re-calculated HQ exceeded one for bis(2-ethylhexyl)phthalate, barium, iron, thallium, and vanadium. For the robin, the re-calculated HQ exceeded one for bis(2-ethylhexyl)phthalate, di-n-butylphthalate, benzo(a)anthraene, benzo(a)pyrene, chrysene, naphthalene, and lead.

However, the average concentrations of barium, iron, and vanadium do not exceed site-specific background concentrations. In addition, within the Canal, only one sample location out of 135 samples exceeded background levels of barium and cadmium while only two samples exceeded background levels of iron and silver. Thus, these metals can be considered to be at background levels throughout the Canal.

The U.S. EPA has developed additional ecological soil screening values (EcoSSL) (EPA 2000; EPA 1996), which are designed to be protective of terrestrial wildlife. Only one sample location out of 135 samples exceeded the EcoSSL of 21 mg/kg for antimony, though the average concentration of antimony (0.59 mg/kg) did not exceed the EcoSSL or the Region 4 soil screening value (3.5 mg/kg). No samples exceeded the EPA Region 4 soil screening value of 200 mg/kg for di-n-butylphthalate. The average concentration of thallium (0.849 mg/kg) does not exceed the Region 4 soil screening level of 1.0 mg/kg. The average concentration of copper (34.36 mg/kg) does not exceed the Region 4 soil screening level of 40 mg/kg and the EcoSSL of 61 mg/kg. Thus, these contaminants are considered to pose negligible risk to terrestrial receptors.

An anomalous concentration of lead (8,190 mg/kg) was found at one sample location (97VS43N24), which was collected near the railroad tracks. This elevated lead concentration may be attributable to an off-site source. If this sample location is removed from the average calculation, the average lead concentration at the site is 54.52 mg/kg. This concentration is slightly above background (48 mg/kg) and slightly above the Region 4 soil screening level (50 mg/kg). Thus, lead is considered to pose a negligible risk to terrestrial receptors.

High BAFs were estimated for bis(2-ethylhexyl)phthalate and di-n-butylphthalate. Metabolism of organic chemicals in earthworms is not considered in the model used to estimate BAFs. While these phthalates may accumulate, rapid metabolism in higher organisms seems to prevent biomagnification in the food chain (ATSDR 1991). The predicted BAF may be substantially greater than what would be calculated on the basis of a field-measured BAF. In addition, an anomalous concentration of bis(2-ethylhexyl)phthalate (44 mg/kg) was measured at location 97VN35L13. Removing this sample location from the average calculation results in an average

Table 5-22
Risk to Meadow Vole: 95% UCL Exposure Point Concentration
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Intake = [(Cs * IRs) + ((Cs * PUF) * IRp)] / BW
HQ = Intake / TRV

Constituent	95% UCL Soil Concentration	log Kow	Plant Uptake Factor		Plant Concentration	Intake			TRV	Hazard Quotient		
						Soil	Plant	Total		Soil	Plant	Total
Organics												
Benzo(a)anthracene	1.184	5.679	0.0202	a	0.02392708	0.061179331	0.0522484	0.1134277	0.163	0.375	0.3	0.7
Inorganics												
Antimony	0.59	NA	0.2000	a	0.1	0.030486322	0.2576708	0.2881571	0.1188	0.257	2.2	2.4
Barium	88.76	NA	0.150	a	13.3	4.586382979	29.073124	33.659507	9.18	0.500	3.2	3.7
Cadmium	0.329	NA	0.364	a	0.12	0.017	0.2615053	0.2785053	0.977	0.017	0.3	0.3
Chromium	21.14	NA	0.008	e	0.2	1.092340426	0.3462178	1.4385582	6.3	0.173	0.1	0.2
Copper	34.36	NA	0.400	a	13.7	1.775440729	30.012094	31.787535	28.2	0.063	1.06	1.13
Iron	20482	NA	0.0040	b	81.9	1058.340426	178.90213	1237.2426	72	14.699	2.5	17.2
Lead	64.99	NA	0.045	a	2.92	3.358145897	6.3861954	9.7443413	7.816	0.430	0.8	1.2
Silver	0.217	NA	0.400	a	0.0868	0.011212766	0.1895409	0.2007536	0.366	0.031	0.5	0.5
Thallium	0.849	NA	0.004	a	0.003396	0.043869301	0.0074157	0.051285	0.0236	1.859	0.3	2.2
Vanadium	22.12	NA	0.0049	c	0.1	1.142978723	0.2366815	1.3796602	0.378	3.024	0.63	3.6

Symbol	Parameter	Value	Source
Cs	Soil concentration (mg/kg)	--	--
IRs	Soil intake rate (kg dw/day)	0.0017	EPA 1993
IRp	Plant intake rate (kg dw/ day)	0.0718	EPA 1993
PUF	Plant uptake factor (unitless)	Chemical-specific	--
BW	Body weight (kg)	0.0329	EPA 1993
TRV	Toxicity reference value (mg/kg/day)	Chemical-specific	Appendix B
log Kow	Octanol-water partition coefficient	Chemical-specific	--

a = EPA 1999b
b = Baes et al. 1984 (based on Bv).
c = Efroymson et al. 1997
d = Montgomery 1991.
e = TNRCC 1996.

NA = Not applicable.
NTV = No toxicity value available.

Table 5-23
Risk to Short-tailed Shrew: 95% UCL Exposure Point Concentration
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Intake = [(Cs * IRs) + ((Cs * BAF) * IRew)] / BW
HQ = Intake / TRV

Constituent	95% UCL Soil Concentration	log Kow	Earthworm BAF		Earthworm Concentration	Intake			TRV	Hazard Quotient		
						Soil	Earthworm	Total		Soil	Earthworm	Total
Organics												
Bis(2-ethylhexyl)phthalate	0.314	5.205	1309	a	410.9837477	0.003823412	217.57963	217.58345	127.8	0.000	1.7	1.7
Di-n-butylphthalate	0.441	4.6	418	a	184.4329825	0.005369824	97.640991	97.646361	632.5	0.0000	0.15	0.15
Benzo(a)anthracene	1.184	5.679	0.03	a	0.03552	0.014416941	0.0188047	0.0332216	0.192	0.1	0.10	0.17
Inorganics												
Antimony	0.59	NA	0.22	a	0.1298	0.007184118	0.0687176	0.0759018	0.141	0.1	0.5	0.5
Barium	88.76	NA	0.22	a	19.5272	1.080783529	10.337929	11.418713	10.86	0.1	0.95	1.05
Cadmium	0.329	NA	0.96	a	0.31584	0.004006059	0.1672094	0.1712155	1.15	0.003	0.145	0.15
Iron	20482		0.0608	b	1245.3056	249.3984706	659.27944	908.67791	85.2	2.9	7.7	10.7
Lead	64.99	NA	0.03	a	1.9497	0.791348824	1.0321941	1.8235429	9.2	0.1	0.1	0.2
Selenium	0.915	NA	0.22	a	0.2013	0.011141471	0.1065706	0.1177121	0.23	0.05	0.46	0.51
Silver	0.217	NA	0.22	a	0.04774	0.002642294	0.0252741	0.0279164	0.431	0.01	0.06	0.06
Thallium	0.849	NA	0.22	a	0.18678	0.010337824	0.0988835	0.1092214	0.0279	0.4	3.54	3.91
Vanadium	22.13	NA	0.22	a	4.8686	0.269465294	2.5774941	2.8469594	0.4473	0.6	5.76	6.36

Symbol	Parameter	Value	Source
Cs	Soil concentration (mg/kg)	--	--
IRs	Soil intake rate (kg dw/day)	2.07E-04	EPA 1999b
IRew	Earthworm intake rate (kg wet/ day)	0.009	EPA 1999b
BAF	Bioaccumulation factor (unitless)	Chemical-specific	--
BW	Body weight (kg)	0.017	EPA 1993
TRV	Toxicity reference value (mg/kg/day)	Chemical-specific	Appendix B

NA = Not applicable.
NTV = No toxicity value.
a = EPA 1999b
b = Beyer and Stafford 1993.

Table 5-24
Risk to American Robin: 95% UCL Exposure Point Concentration
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Intake = [(Cs * IRs) + ((Cs * BAF) * IRew)] / BW
HQ = Intake / TRV

Constituent	95% UCL Soil Concentration	log Kow	Earthworm BAF		Earthworm Concentration	Intake			TRV	Hazard Quotient		
						Soil	Earthworm	Total		Soil	Earthworm	Total
Organics												
Bis(2-ethylhexyl)phthalate	0.314	5.205	1309	a	410.9837477	0.00447	180.833	180.837	1.11	0.0	162.9	162.9
Di-n-butylphthalate	0.441	4.6	418	a	184.4329825	0.00628	81.151	81.157	0.11	0.1	737.7	737.8
Benzo(a)anthracene	1.184	5.679	0.03	a	0.03552	0.01687	0.016	0.033	0.00079	21.4	19.8	41.1
Benzo(a)pyrene	1.089	6.129	0.07	a	0.07623	0.01552	0.034	0.049	0.001	15.5	33.5	49.1
Chrysene	1.469	6.2	0.04	a	0.05876	0.02093	0.026	0.047	0.001	20.9	25.9	46.8
Naphthalene	0.28	3.2	29.8	a	8.355222725	0.00399	3.676	3.680	3.47	0.0011	1.06	1.06
Inorganics												
Barium	88.76	NA	0.22	a	19.5272	1.2648	8.5920	9.8568	20.826	0.06	0.41	0.47
Cadmium	0.329	NA	0.96	a	0.31584	0.0047	0.1390	0.1437	1.45	0.00	0.10	0.10
Chromium	21.14	NA	0.01	a	0.2114	0.3012	0.0930	0.3943	1	0.30	0.09	0.39
Copper	34.36	NA	0.04	a	1.3744	0.4896	0.6047	1.0944	46.97	0.01	0.01	0.02
Lead	64.99	NA	0.03	a	1.9497	0.9261	0.8579	1.7840	1.13	0.8	0.8	1.6
Thallium	0.849	NA	0.22	a	0.18678	0.012	0.082	0.094	0.35	0.03	0.23	0.27

Symbol	Parameter	Value	Source
Cs	Soil concentration (mg/kg)	--	--
IRs	Soil intake rate (kg dw/day)	1.14E-03	EPA 1999b
IRew	Earthworm intake rate (kg wet/ day)	0.0352	EPA 1999b
BAF	Bioaccumulation factor (unitless)	Chemical-specific	--
BW	Body weight (kg)	0.08	EPA 1999b
TRV	Toxicity reference value (mg/kg/day)	Chemical-specific	Table x-x

NA = Not applicable.

NTV = No toxicity value available.

a = EPA 1999b

b = Beyer and Stafford 1993.

concentration of 0.264 mg/kg, which is below the EPA Region 5 EDQL of 0.92594 mg/kg. Thus, these phthalate esters are considered to pose a negligible risk to terrestrial receptors.

Background levels of PAHs were not analyzed for any medium at the time of the OU9 Remedial Investigation. The area surrounding the Canal is developed, with both the Conrail Railroad and the Dayton-Cincinnati Road adjacent to the site. PAHs in Canal soil may not be site-related. There may be other contributors of PAHs, such as automobile and train exhaust. In nonpolluted areas, background concentrations up to 1 mg/kg benzo(a)pyrene have been measured (Eisler 1987a). In addition, the average concentrations of benzo(a)pyrene (1.089 mg/kg), benzo(a)anthracene (1.184 mg/kg), and chrysene 1.469 mg/kg) do not exceed the EPA Region 5 EDQLs for these PAHs (1.52 mg,kg, 5.21 mg/kg, and 4.73 mg/kg, respectively). Acute toxicity data were used to derive the avian TRVs for these PAHs, which generally results in conservative toxicity values. Thus, these PAHs are considered to pose a negligible risk to terrestrial receptors.

It should also be noted that following the remediation activities and verification sampling, the excavated areas were graded to form the Canal and ancillary areas to reassemble their original topography. Roughly one to two feet of soil was used in most areas to achieve the appropriate contour and slope. In addition, the habitat adjacent to the Canal is maintained lawn. Following remediation, numerous shade trees were planted to enhance the park-like setting, and grasses typically used in this region for lawn cover were sown. Routine mowing of the former Canal area has taken place subsequent to remediation. While the site will support some wildlife species, the Canal area does not provide high quality habitat that will support a wide variety of species.

5.5.2 South Pond

Background pond and stream sediments samples were collected as part of the OU9 surface water and sediment investigation (DOE 1996b). The maximum concentrations of aluminum, iron, and molybdenum in South Pond sediments and molybdenum in surface water are lower than background levels (Tables 5-11 and 5-12). Thus, these constituents do not need to be evaluated further. In addition, the area surrounding the South Pond is developed, with both the Conrail Railroad and the Dayton-Cincinnati Road adjacent to the Canal site. PAHs in South Pond sediments may not be site-related. There may be other contributors of PAHs, such as automobile and train exhaust.

The area use factor is defined as the ratio of the home range (or feeding/foraging range) of the receptor to the area of contamination. The South Pond covers approximately 0.097 hectares (ha), while the home range of a mallard averages 435 ha (EPA 1993). Thus, the area use factor for a mallard would be 0.00022, and the risk estimates would be four orders of magnitude lower. The average territory size of a belted kingfisher is 1.16-km shoreline. The shoreline of the South Pond is approximately 0.031 km. Thus, the area use factor is 0.027, and the risk estimates would be two orders of magnitude lower. Overall, risks from exposure to contaminants in surface water and sediment in the South Pond appear to be negligible.

5.5.3 Overflow Creek

Background pond and stream sediments samples were collected as part of the OU9 surface water and sediment investigation (DOE 1996). As shown only on Table 5-21, aluminum, antimony, and iron had HI>1 for wildlife receptors. The maximum concentrations of aluminum and iron in Overflow Creek sediments were near background levels (Table 5-20). A background level for antimony was not available for the Overflow Creek nor was there sediment benchmarks from the cited sources. The concentration of antimony in creek sediments ranged from 0.53 mg/kg to 4.6 mg/kg. EPA Region 4 recommends a sediment screening value of 7.24 mg/kg for antimony (EPA 2001), which is greater than the maximum detected concentration of antimony in sediment. Thus, these constituents do not need to be evaluated further. Background levels of PAHs were not analyzed for any medium at the time of the OU9 Remedial Investigation. The area surrounding the Overflow Creek is developed, with both the Conrail Railroad and the Dayton-Cincinnati Road adjacent to the Canal site. PAHs in Overflow Creek sediments may not be site-related. There may be other contributors of PAHs, such as automobile and train exhaust.

The area use factor is defined as the ratio of the home range (or feeding/foraging range) of the receptor to the area of contamination. The Overflow Creek covers approximately 0.214 hectares (ha), while the home range of a mallard averages 435 ha (EPA 1993). Thus, the area use factor for a mallard would be 0.00049, and the risk estimates would be four orders of magnitude lower. The average territory size of a belted kingfisher is 1.16-km shoreline. The shoreline of the Overflow Creek is approximately 0.34 km (Ohio EPA 1996). Thus, the area use factor is 0.29, and the risk estimates would be one order of magnitude lower. Based on an average home range of 2.24 km (EPA 1993), the area use factor for a mink 0.15. For a muskrat, the area use factor defaults to 1 because its home range of 0.13 ha (EPA 1993) is less than the area of the Overflow Creek. The risk estimates for the muskrat will not change.

PAHs and phthalate esters do not biomagnify in the food chain, nor are they appreciably bioaccumulated. While metals pose a potential for adverse effects on terrestrial receptors, they may not be present in a form that is bioavailable. A BCF of 633 was applied for molybdenum and tin in surface water of the Overflow Creek. While bioconcentration of these metals may be rapid, degradation will preclude food biomagnification. The absorption of ingested inorganic tin is usually less than 5 percent (Eisler 1989).

5.6 RISK DESCRIPTION

A screening-level ecological risk assessment was conducted at this site to evaluate which contaminants pose a potential to adverse impact ecological receptors inhabiting the Miami-Erie Canal, the South Pond, Overflow Creek and adjacent areas. Birds, such as the mallard, northern robin, and belted kingfisher, and mammals, such as the meadow vole, short-tailed shrew, muskrat, and mink, which represent several trophic levels, were selected as target receptors. Direct ingestion of COPCs in soil, sediment, and surface water, and indirect ingestion through the food chain via ingestion of plants, insects, and fish were considered in this assessment. External exposure through direct radiation from soil and inhalation of radionulide-contaminated

dust were also considered for radiological COPCs. Direct impacts on fish and benthic organisms were evaluated for both chemicals and radionuclides.

The conservative screening level ERA found that there is a potential for adverse effects on terrestrial organisms from residual chemical contamination (i.e., PAHs, phthalate esters, and metals). However, refinement of the preliminary COPCs found that negligible ecological risk is posed by these contaminants. The refinement included a background evaluation, re-calculation of HQs using an average exposure point concentration (i.e., 95% UCL), evaluation of bioavailability of COPCs, adjustment of the area use factor, and a re-evaluation of ecological screening levels. These are shown in tables 5-22, 5-23, and 5-24 for the Meadow Vole, Short Tailed Shrew and American Robin respectively. The ecological risk is within acceptable levels and no further action is necessary.

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APPENDIX A

SCREENING OF CHEMICALS OF POTENTIAL CONCERN BY MEDIUM

Table A-1

Comparison of Canal Soil Verification Concentrations to Soil Screening Values

Chemical	Frequency of Detection	Range of Detections		Maximum Location	Minimum Quantitation Limit	Background [a]	Screening Value [b]	Hazard Quotient	COPC?
		Minimum	Maximum						
Radionuclide (pCi/g)									
Plutonium-238	730/735	0.00716	150	97VS11N12	1	0.13	NSL	--	Yes
Plutonium-239	438/735	0.0033	4.17	97VS43N16	1	0.18	NSL	--	Yes
Thorium-228	135/135	0.607	2.81	97VS15N4	1	1.5	NSL	--	Yes
Thorium-230	133/135	0.874	7.99	97VS8N21	1	1.9	NSL	--	Yes
Thorium-232	133/135	0.507	1.41	97VS24N5	1	1.4	NSL	--	Yes
Tritium	118/135	0.0504	29.0	97VEWRL5	50	1.6	NSL	--	Yes
Uranium-234	135/135	0.624	1.28	97VS17N6	0.6	1.1	NSL	--	Yes
Uranium-235	102/135	0.0134	0.270	97VN9L20	0.6	0.11	NSL	--	Yes
Uranium-238	134/135	0.636	1.62	97VN35L13	0.6	1.2	NSL	--	Yes
Semivolatile Organic Compounds (ug/kg)									
Benzoic acid	35/160	20	220	97V35L13	330	--	NSL	--	Yes
Bis(2-ethylhexyl)phthalate	78/160	20	4400	97VN35L13	330	--	925.94	4.752	Yes
Butylbenzylphthalate	12/160	20	380	97VS25N33	330	--	238.89	1.591	Yes
Carbazole	77/160	22	1100	97VN5L2	330	--	NSL	--	Yes
Dibenzofuran	33/160	20	760	97VN5L2	330	--	NSL	--	Yes
Di-n-butylphthalate	40/160	22	4300	97VS20N23	330	--	149.79	28.707	Yes
Diethylphthalate	2/160	44	59	97VS20N23	330	--	24800	0.002	No
4-Methylphenol	2/160	24	64	97VN6N21	330	--	163000	0.0004	No
Pentachlorophenol	2/160	30	70	97VS2N22	800	--	119.27	0.587	No
Phenol	21/160	21	1600	97VN3L15	330	--	120000	0.013	No
Acenaphthene	52/160	20	970	97VN5L2	330	--	682000	0.001	No
Acenaphthylene	64/160	19	650	97VN4L22	330	--	682000	0.001	No
Anthracene	87/160	21	2300	97VN5N20	330	--	1480000	0.002	No
Benzo(a)anthracene	150/160	21	7300	97VN5N20	330	--	5210	1.401	Yes
Benzo(a)pyrene	141/160	21	7900	97VN5N20	330	--	1520	5.197	Yes
Benzo(b)fluoranthene	149/160	23	7100	97VN5N20	330	--	59800	0.119	No
Benzo(k)fluoranthene	147/160	22	7000	97VN5N20	330	--	148000	0.047	No
Benzo(gh,I)perylene	141/160	22	4700	97VN5N20	330	--	119000	0.039	No

Table A-1 (cont.)

Chemical	Frequency of Detection	Range of Detections		Maximum Location	Minimum Quantitation Limit	Background [a]	Screening Value [b]	Hazard Quotient	COPC?
		Minimum	Maximum						
Chrysene	152/160	25	8100	97VN5N20	330	--	4730	1.712	Yes
Dibenz(a,h)anthracene	137/160	20	1500	97VN21L17	330	--	18400	0.082	No
Fluoranthene	155/160	20	17000	97VN5N20	330	--	122000	0.139	No
Fluorene	56/160	20	1300	97VN5L2	330	--	122000	0.011	No
Indeno(1,2,3-cd)pyrene	140/160	20	4600	97VN35L13	330	--	109000	0.042	No
2-Methylnaphthalene	32/160	23	310	97VN5L2	330	--	3240	0.096	No
Naphthalene	39/160	19	440	97VN53N1	330	--	99.39	4.427	Yes
Phenanthrene	145/160	21	13000	97VN520	330	--	45700	0.284	No
Pyrene	154/160	28	17000	97VN520	330	--	78500	0.217	No
Inorganics (mg/kg)									
Aluminum	135/135	3700	15700	97VS55L23	4	19000	NSL	--	No; BKG
Antimony	33/135	0.45	81.1	97VN5L2	2	NA	0.14	570	Yes
Arsenic	135/135	3.7	27	97VN35L13	2	8.6	6	4.74	Yes
Barium	135/135	34.9	234	97VRHN1	40	180	1.04	225	Yes
Beryllium	134/135	0.17	1.1	97VN47L14	0.2	1.3	1.06	1.04	No; BKG
Cadmium	71/135	0.08	4.2	97VS31N17	1	2.1	0.0022	1892	Yes
Calcium	135/135	6890	144000	97VS26N25	1000	310000	NSL	--	No; BKG
Chromium	135/135	6.9	116	97VS50N19	2	20	0.40	290	Yes
Cobalt	135/135	3.5	15.5	97VN18L12	10	19	0.14	110	No; BKG
Copper	135/135	12.3	141	97VS31N17	5	26	0.31	450	Yes
Iron	135/135	7040	46800	97VN35L13	20	35000	NSL	--	Yes
Lead	135/135	5.5	8190	97VS43N24	0.6	48	0.05	152429	Yes
Magnesium	135/135	5320	83200	97VS26N25	1000	40000	NSL	--	No; nutrient
Manganese	135/135	213	1130	97VS41N2	3	1400	NSL	--	No; BKG

Table A-1 (cont.)

Chemical	Frequency of Detection	Range of Detections		Maximum Location	Minimum Quantitation Limit	Background [a]	Screening Value [b]	Hazard Quotient	COPC?
		Minimum	Maximum						
Mercury	108/135	0.05	1.3	97VS31N17	0.04	NA	0.10	13.0	Yes
Nickel	135/135	7.5	31.8	97VN35L13	8	32	13.60	2.3	No; BKG
Potassium	135/135	529	2690	97VN27L15	1000	1900	NSL	--	No; nutrient
Selenium	70/135	0.51	2.2	97VN13L8	1	NA	0.03	79.57	Yes
Silver	22/135	0.2	11.2	97VS19N5	2	1.7	4.04	2.77	Yes
Sodium	135/135	59.5	600	97VS48N	1000	240	NSL	--	No; BKG
Thallium	37/135	0.94	3.2	97VS55L3	2	0.46	0.06	56.2	Yes
Vanadium	135/135	9.7	34.4	97VS1AN13	2	25	1.59	21.6	Yes
Zinc	135/135	29.1	481	97VS43N24	4	140	6.62	72.7	Yes
Cyanide	7/135	0.31	6.8	97VS51L6	2	ND	1.33	5.11	Yes
Anions (mg/kg)									
Bismuth	16/135	1.2	6.1	97VS19NS	0.82	NA	NSL	--	Yes
Chloride	126/135	2.9	354	97VS9N14	2.7	107	NSL	--	Yes
Fluoride	90/135	0.001	4.9	97VN18L12	0.001	6.7	NSL	--	No; BKG
Nitrate/Nitrite	123/135	0.25	34.9	97VN4L22	0.22	26	NSL	--	Yes
Sulfate	92/135	29.6	1160	97VS33N10	22.5	150	NSL	--	Yes

Notes:
Only chemicals detected above method detection limit are presented.
NBL = No background level.
NSL = No screening level.
-- = Not applicable; not available.

a Site-specific background levels for Mound Plant.
b U.S EPA Region V,. Ecological Data Quality Levels, RCRA Corrective Action (EPA 1999a).

Table A-2

Comparison of South Pond Surface Water Concentrations to Surface Water Screening Values

Chemical	Frequency of Detection	Range of Detections		Maximum Location	Minimum Quantitation Limit	Screening Value[b]	Source	Screening Hazard Quotient	COPC?
		Minimum	Maximum						
Radionuclide (pCi/L)									
Americium-241	1/6	--	0.24	MND21-3401	0.145	NSL	--	--	Yes
Bismuth-210M	4/6	-2.13	0.73	MND21-3402	8.12	NSL	--	--	Yes
Potassium-40	6/6	42.4	420.00	MND21-3401	132	NSL	--	--	Yes
Radium-226	5/6	0.155	0.24	MND21-3402	0.034	NSL	--	--	Yes
Strontium-90	1/6	--	0.69	MND21-3403	0.572	NSL	--	--	Yes
Thorium-228	2/6	0.13	0.14	MND21-3403	0.0309	NSL	--	--	Yes
Thorium-230	2/6	0.165	0.21	MND21-3403	0.0591	NSL	--	--	Yes
Tritium	6/6	574	846.0	MND21-3403	247	NSL	--	--	Yes
Uranium-234	2/6	0.376	0.64	MND21-3403	0.322	NSL	--	--	Yes
Uranium-238	1/6	--	0.39	MND21-3401	0.304	NSL	--	--	Yes
Organic Compounds (ug/L)									
2-amino-4,6-dinitroluene	3/3	1.2	2.00	MND21-3402	3	NSL		--	Yes
4,4-DDD	2/6	0.0028	0.0038	MND21-3402	0.1	0.0011	b	3.454545455	Yes
Acetone	1/6	--	13.00	MND21-3402	10	78000.00	a	0.000166667	No
Acetonitrile	1/6	--	240.00	MND21-3401	100	30000.00	b	0.008	No
alpha-BHC	1/6	--	0.00	MND21-3402	0.05	0.10	a	0.01	No
beta-BHC	1/6	--	0.00	MND21-3402	0.05	0.10	a	0.027	No
Bis(2-ethylhexyl)phthalate	4/6	1	4.00	MND21-3401	5	8.40	a	0.476190476	No
Dieldrin	2/6	0.0018	0.00	MND21-3401	0.1	5.00	a	0.00056	No
Endosulfan sulfate	1/6	--	0.00	MND21-3402	0.1	2.22	b	0.001306306	No
gamma-BHC	3/6	0.0028	0.00	MND21-3401	0.05	0.01	a	0.36	No
Methylene chloride	4/6	2	4.00	MND21-3402	5	430.00	a	0.009302326	No
Phenol	1/6	--	3.00	MND21-3402	5	200.00	a	0.015	No

Table A-2 (cont.)

Chemical	Frequency of Detection	Range of Detections		Maximum Location	Minimum Quantitation Limit	Screening Value[b]	Source	Screening Hazard Quotient	COPC?
		Minimum	Maximum						
Inorganics (ug/L)									
Aluminum	12/12	23	1340	MND21-3401	19.2	87.00	c	15.40229885	Yes
Antimony	6/12	1.5	24	MND21-3402	1.9	190.00	a	0.124210526	No
Arsenic	5/12	2.2	3.7	MND21-3401	1.6	150	a	0.024666667	No
Barium	12/12	47	63	MND21-3403	0.2	5000.00	b	0.0125	No
Calcium	12/12	45200	55000	MND21-3403	28.5	NSL	--	--	No; nutrient
Chromium	7/12	0.78	2.6	MND1-3402	0.9	11.00	a	0.236363636	No
Cobalt	5/12	0.52	0.82	MND21-3401	0.6	5.00	b	0.164	No
Copper	11/12	0.7	3.8	MND21-3402	0.7	21.00	a,h	0.180952381	No
Iron	7/12	15.7	1880	MND21-3401	15.7	1000.00	c	1.88	Yes
Lead	1/12	--	2.0	MND21-3401	1.9	4.90	a,h	0.408163265	No
Lithium	8/12	3.9	8.9	MND21-3401	3.8	NSL	--	--	Yes
Magnesium	12/12	13100	18200	MND21-3402	4	NSL	--	--	No; nutrient
Manganese	12/12	13.7	220	MND21-3403	15	NSL	--	--	Yes
Molybdenum	9/12	1.2	2.6	MND21-3403	1.7	NSL	--	--	Yes
Nickel	9/12	1.8	7.4	MND21-3401	1.4	89.00	a,h	0.083146067	No
Potassium	12/12	5640	9770	MND21-3403	16.7	NSL	--	--	No; nutrient
Silver	3/12	0.63	0.8	MND21-3402	0.5	0.06	a	13.33333333	Yes
Sodium	12/12	21300	297000	MND21-3401	202	NSL	--	--	No; nutrient
Tin	1/12	--	57.2	MND21-3402	5.9	73.00	b	0.783561644	No
Vanadium	9/12	0.4	3.4	MND21-3401	0.4	19.00	b	0.178947368	No
Zinc	10/12	1.4	34.6	MND21-3403	1.4	181.00	a,h	0.191160221	No

Table A-2 (cont.)

Chemical	Frequency of Detection	Range of Detections		Maximum Location	Minimum Quantitation Limit	Screening Value[b]	Source	Screening Hazard Quotient	COPC?
		Minimum	Maximum						
Anions (ug/L)									
Bismuth	2/12	3.8	65.11	MND21-3403	2.6	NSL	--	--	Yes
Chloride	6/6	53.1	59.6	MND21-3401	3	NSL	--	--	Yes
Fluoride	6/6	0.23	0.303	MND21-3403	0.1	NSL	--	--	Yes
Nitrate/Nitrite	1/6	--	0.057	MND21-3403	0.05	5000.00	c	0.00001132	No
Nitrogen	5/6	0.119	0.468	MND21-3402	0.1	NSL	--	--	Yes
Phosphorous	2/6	0.865	4.43	MND21-3403	0.1	10.00	c	0.443	No
Sulfate	6/6	12.8	39.40	MND21-3401	2	NSL	--	--	Yes

Notes:
Only chemicals detected above method detection limit are presented.
NBL = No background level.
NSL = No screening level.
-- = Not applicable; not available.

a =OEPA 1999. Ohio Water Quality Standards. Chapte 3745-1 of the Administrative Code.
b = EPA 1999a. Ecological Data Quality Level.
c = EPA 1986. Quality Criteria for Water.
h = hardness-dependent criteria, based on a hardness of 190 mg/L; See Table x-x.

Table A-3

Comparison of South Pond Sediment Concentrations to Sediment Screening Values

Chemical	Frequency of Detection	Range of Detections		Maximum Location	Minimum Quantitation Limit	Screening Value[a]	Screening Hazard Quotient	COPC?
		Minimum	Maximum					
Radionuclide (pCi/g)								
Bismuth-210M	3/7	-0.0274	0.06	MND21-3401	0.172	NSL	--	Yes
Cesium-137	1/7	--	0.23	MND21-3401	0.195	NSL	--	No; bkg
Plutonium-238	7/7	0.524	2	MND21-3403	0.00129	NSL	--	Yes
Plutonium-239/240	4/7	0.0041	0.01	MND21-3403	0.00139	NSL	--	No; bkg
Potassium-40	7/7	23.5	38.60	MND21-3402		NSL	--	Yes
Radium-226	7/7	0.78	1.60	MND21-3402	0.654	NSL	--	No; bkg
Thorium-228	7/7	0.901	1.51	MND21-3403	0.00801	NSL	--	Yes
Thorium-230	7/7	0.77	1.84	MND21-3401	0.00674	NSL	--	No; bkg
Thorium-232	7/7	0.865	1.24	MND21-3401	0.0042	NSL	--	No; bkg
Tritium	4/4	1	2.4	MND21-3403	0.3	NSL	--	Yes
Uranium-234	7/7	0.812	1.50	MND21-3402	0.0368	NSL	--	Yes
Uranium-235	4/7	0.042	0.080	MND21-3401	0.0361	NSL	--	No; bkg
Uranium-238	7/7	0.926	1.25	MND21-3403	0.0317	NSL	--	Yes
Organic Compounds (ug/kg)								
4,4-DDD	5/7	0.57	9.40	MND21-3403	8.5	5.53	1.699819168	Yes
4,4-DDE	2/7	0.26	0.78	MND21-3403	8.8	1.42	0.549295775	No
4,4-DDT	4/7	0.46	0.99	MND21-3403	9.4	1.19	0.831932773	No
Acetone	6/7	16	220.00	MND21-3403	29	453.37	0.485254869	No
Aldrin	3/7	1.1	1.30	MND21-3402	4.4	2.00	0.65	No
Benzo(a)anthracene	7/7	270	490.00	MND21-3403	--	31.70	15.45741325	Yes
Benzo(a)pyrene	7/7	330	570.00	MND21-3403	--	31.90	17.86833856	Yes
Benzo(b)fluoranthene	7/7	470	1200.00	MND21-3403	--	10400.00	0.115384615	No
Benzo(g,h,I)perylene	6/7	130	240.00	MND21-3403	--	170.00	1.411764706	Yes
Benzo(k)fluoranthene	7/7	280	1500.00	MND21-3403	--	240.00	6.25	Yes

Table A-3 (cont.)

Chemical	Frequency of Detection	Range of Detections		Maximum Location	Minimum Quantitation Limit	Screening Value[a]	Screening Hazard Quotient	COPC?
		Minimum	Maximum					
Benzoic acid	7/7	94	240.00	MND21-3402	--	NSL	--	Yes
Bis(2-ethylhexyl)phthalate	5/7	98	430	MND21-3403	940	182	2.36	Yes
Chrysene	7/7	360	590	MND21-3403	--	57.1	10.33	Yes
delta-BHC	1/7	--	0.25	MND21-3401	4.5	7.15E+04	3.5E-06	No
Dieldrin	3/7	0.74	1.60	MND21-3402	9.6	2	0.8	No
Di-n-butylphthalate	4/7	150	210	MND21-3402	850	110.5	1.900	Yes
Di-n-octylphthalate	2/7	120	170	MND21-3403	850	4.06E+04	0.004	No
Endosulfan I	1/7	--	0.12	MND21-3403	4.5	0.175	0.686	No
Endosulfan sulfate	1/7	--	0.52	MND21-3403	9	34.6	0.015	No
Endrin	2/7	0.29	0.64	MND21-3401	8.8	2.67	0.240	No
Endrin aldehyde	3/7	0.5	2.50	MND21-3401	8.8	3.20E+03	0.001	No
Endrin ketone	1/7	--	0.84	MND21-3401	8.8	NSL	--	Yes
Fluoranthene	7/7	680	1100	MND21-3403	--	111	9.883	Yes
Fluorene	1/7	--	72	MND21-3401	850	21	3.396	Yes
gamma-Chlordane	5/7	0.39	1.60	MND21-3403	4.4	5	0.356	No
Heptachlor	2/7	1.8	3.10	MND21-3402	4.4	1	5.167	Yes
Heptachlor epoxide	1/7	--	0.50	MND21-3402	4.4	1	0.833	No
Hexane	1/7	--	7.00	MND21-3402	26	NSL	--	Yes
Indeno(1,2,3-cd)pyrene	7/7	130	340.00	MND21-3403	--	200	1.7	Yes
Methoxychlor	2/7	1.2	63	MND21-3403	44	4	17.5	Yes
Methylene chloride	7/7	10	240	MND21-3401	5	1260	0.190	No
Phenanthrene	7/7	270	440	MND21-3403	--	42	10.5	Yes
Pyrene	7/7	500	850	MND21-3402	--	53	16.0	Yes

Table A-3 (cont.)

Chemical	Frequency of Detection	Range of Detections		Maximum Location	Minimum Quantitation Limit	Screening Value[a]	Screening Hazard Quotient	COPC?
		Minimum	Maximum					
Inorganics (mg/kg)								
Aluminum	7/7	11000	17000	MND21-3402	19.2	NSL	--	Yes
Arsenic	7/7	4.2	7.7	MND21-3402	1.6	6	1.3	Yes
Barium	7/7	43.3	65	MND21-3403	0.2	NSL	--	Yes
Beryllium	7/7	0.63	0.9	MND21-3402	0.2	NSL	--	Yes
Cadmium	3/7	0.2	0.6	MND21-3401	0.3	0.5960	0.9	No
Calcium	7/7	15800	40300	MND21-3403	28.5	NSL	--	No; nutrient
Chromium	7/7	17.5	25	MND21-3402	0.9	26.00	0.97	No
Cobalt	7/7	9.9	13.8	MND21-3402	0.6	50.00	0.3	No
Copper	7/7	22.8	31	MND21-3403	0.7	16.00	1.9	Yes
Iron	7/7	21900	29100	MND21-3402	15.7	NSL	--	Yes
Lead	7/7	15.1	25	MND21-3403	1.9	31.00	0.8	No
Lithium	7/7	22.4	34	MND21-3402	3.8	NSL	--	Yes
Magnesium	7/7	8320	12000	MND21-3403	4	NSL	--	No; nutrient
Manganese	7/7	344	549	MND21-3403	0.3	NSL	--	Yes
Molybdenum	6/7	0.92	2.1	MND21-3401	1.7	NSL	--	Yes
Nickel	7/7	20.9	28.8	MND21-3402	1.4	16.00	1.8	Yes
Potassium	7/7	2140	4870	MND21-3402	16.7	NSL	--	No; nutrient
Sodium	7/7	327	619	MND21-3403	202	NSL	--	No; nutrient
Tin	3/7	3.4	4.0	MND21-3402	5.9	NSL	--	Yes
Vanadium	7/7	21.8	30.2	MND21-3402	0.4	NSL	--	Yes
Zinc	7/7	95.5	274	MND21-3401	1.4	120.00	2.3	Yes

Table A-3 (cont.)

Chemical	Frequency of Detection	Range of Detections		Maximum Location	Minimum Quantitation Limit	Screening Value[a]	Screening Hazard Quotient	COPC?
		Minimum	Maximum					
Anions (mg/kg)								
Bismuth	3/7	1.3	2.0	MND21-3401	2.6	NSL	--	Yes
Chloride	4/7	82	142	MND21-3403	3	NSL	--	Yes
Fluoride	5/7	2.93	7.4	MND21-3403	2.5	NSL	--	Yes
Nitrate/Nitrite	1/7	--	1.1	MND21-3403	0.05	NSL	--	Yes
Sulfate	7/7	134	460	MND21-3401	2	NSL	--	Yes

Notes:
Only chemicals detected above method detection limit are presented.
NBL = No background level.
NSL = No screening level.
-- = Not applicable; not available.

a U.S EPA Region V 1999a. Ecological Data Quality Levels, RCRA Corrective Action

Table A-4

Comparison of Overflow Creek Surface Water Concentrations to Surface Water Screening Values

Chemical	Frequency of Detection	Range of Detections		Maximum Location	Minimum Quantitation Limit	Screening Value	Source	Screening Hazard Quotient	COPC?
		Minimum	Maximum						
Radionuclide (pCi/L)									
Plutonium-238	2/3	0.793	1.65	MND21-2605	0.365	--			
Potassium-40	2/3	214	366.00	MND21-2605	192	NSL	--	--	Yes
Radium-226	3/3	0.213	0.31	MND21-2605	0.0419	NSL	--	--	Yes
Thorium-230	2/3	0.26	0.42	MND21-2605	0.11	NSL	--	--	Yes
Tritium	3/3	407	499.0	MND21-2605	299	NSL	--	--	Yes
Uranium-234	3/3	0.37	0.83	MND21-2605	0.07	NSL	--	--	Yes
Uranium-238	3/3	0.5	0.65	MND21-2605	0.07	NSL	--	--	Yes
Organic Compounds (ug/L)									
1,3-Dinitrobenzene	1/9	--	0.18	MND21-2605	15	2.36	b	0.076271186	No
2.6-Dinitrotoluene	1/9	--	3.0000	MND21-2605	0.5	42.0000	a	0.071428571	No
gamma-Chlordane	1/9	--	0.0013	MND21-2605	0.05	10.00	a	0.00013	No
gamma-BHC	2/9	0.0067	0.02	MND21-2605	0.05	0.01	a	1.5	Yes
Heptachlor epoxide	2/9	--	0.00	MND21-2605	0.05	0.00	b	1.666666667	Yes
HMX	1/9	--	0.80	MND21-2605	20	NSL	--	--	No
Inorganics (ug/L)									
Aluminum	5/6	78.5	2050	MND21-2605	19.2	87.00	c	23.56321839	Yes
Antimony	2/6	5.1	8.3	MND21-2605	1.9	190.00	a	0.043684211	No
Arsenic	1/6	--	1.2	MND21-2605	1	150	a	0.008	No
Barium	6/6	63.1	74.4	MND21-2605	0.2	5000.00	b	0.01488	No
Calcium	6/6	56600	71200	MND21-2605	28.5	NSL	--	--	No; nutrient
Chromium	3/6	0.96	3.30	MND21-2605	0.9	11.00	a	0.3	No
Cobalt	3/6	0.7	0.89	MND21-2605	0.6	5.00	b	0.178	No
Copper	5/6	3.3	9.3	MND21-2605	0.7	27.00	a,h	0.344444444	No

Table A-4 (cont.)

Chemical	Frequency of Detection	Range of Detections		Maximum Location	Minimum Quantitation Limit	Screening Value	Source	Screening Hazard Quotient	COPC?
		Minimum	Maximum						
Cyanide	1/6	--	10.2	MND21-2605	--	5.20	a,h	1.961538462	Yes
Iron	3/6	576	2320	MND21-2605	15.7	1000.00	c	2.32	Yes
Lead	2/2	2.3	3.8	MND21-2605	1.9	7.40	a,h	0.513513514	No
Lithium	4/6	4	7.7	MND21-2605	3.8	NSL	--	--	Yes
Magnesium	6/6	21300	28000	MND21-2605	4	NSL	--	--	No; nutrient
Manganese	6/6	1.7	46	MND21-2605	0.3	NSL	--	--	Yes
Molybdenum	6/6	31.4	62.3	MND21-2605	1.7	NSL	--	--	Yes
Nickel	4/6	3.40	4.6	MND21-2605	1.4	117.00	a,h	0.039316239	No
Potassium	6/6	3160	8150	MND21-2605	16.7	NSL	--	--	No; nutrient
Sodium	6/6	82300	144000	MND21-2605	202	NSL	--	--	No; nutrient
Tin	1/6	--	132.0	MND21-2605	75.8	73.00	b	1.808219178	Yes
Vanadium	5/6	0.81	3.9	MND21-2605	0.4	19.00	b	0.205263158	No
Zinc	5/6	1.8	20	MND21-2605	1.4	237.00	a,h	0.082278481	No
Anions (ug/L)									
Chloride	3/3	143	172	MND21-2605	3	NSL	--	--	Yes
Fluoride	3/3	0.186	0.545	MND21-2605	0.1	NSL	--	--	Yes
Nitrate/Nitrite	3/3	3.21	4.38	MND21-2605	0.05	5000.00	c	0.000876	No
Nitrogen	2/3	0.7	1.40	MND21-2605	0.1	NSL	--	--	Yes
Phosphorous	3/3	0.27	0.56	MND21-2605	0.05	10.00	c	0.056	No
Sulfate	3/3	36.6	142.00	MND21-2605	2	NSL	--	--	Yes

Notes:
Only chemicals detected above method detection limit are presented.
NBL = No background level.
NSL = No screening level.
-- = Not applicable; not available.

a =OEPA 1999. Ohio Water Quality Standards. Chapte 3745-1 of the Administrative Code.
b = EPA 1999a. Ecological Data Quality Level.
c = EPA 1986. Quality Criteria for Water.
h = hardness-dependent criteria, based on a hardness of 263 mg/L; See Table x-x.

Table A-5

Comparison of Overflow Creek Sediment Concentrations to Sediment Screening Values

Chemical	Frequency of Detection	Range of Detections		Maximum Location	Minimum Quantitation Limit	Screening Value[a]	Screening Hazard Quotient	COPC?
		Minimum	Maximum					
Radionuclide (pCi/g)								
Cesium-137	3/7	0.19	0.22	MND22-2606	1	NSL	--	No; bkg
Plutonium-238	7/7	1.78	51	MND22-2606	0.00956	NSL	--	Yes
Plutonium-239/240	4/7	0.0495	0.46	MND22-2605	0.0328	NSL	--	Yes
Potassium-40	7/7	5.47	14.50	MND21-2605	10	NSL	--	No; bkg
Radium-226	7/7	0.472	1.21	MND22-2606	0.3	NSL	--	No; bkg
Strontium-90	1/7	--	1.15	MND21-2605	1.6	NSL	--	Yes
Thorium-228	7/7	0.334	0.91	MND21-2605	0.02	NSL	--	No; bkg
Thorium-230	7/7	0.689	1.31	MND21-2605	0.01	NSL	--	No; bkg
Thorium-232	7/7	0.277	0.87	MND22-2606	0.01	NSL	--	No; bkg
Tritium	3/7	0.668	19.6	MND22-2606	1.6	NSL	--	Yes
Uranium-234	7/7	0.66	0.98	MND22-2606	0.02	NSL	--	No; bkg
Uranium-235	4/7	0.0317	0.070	MND21-2605	0.0145	NSL	--	No; bkg
Uranium-238	7/7	0.475	1.09	MND22-2606	0.0145	NSL	--	No; bkg
Organic Compounds (ug/kg)								
2-Amino-4,6-dinitrotoluene	1/8	--	0.22	MND22-2606	2	NSL	--	
2-Butanone	1/8	--	15.00	MND21-2605	--	136.96	0.109521028	No
4,4-DDD	2/8	0.19	0.32	MND21-2605	3.3	5.53	0.057866184	No
4,4-DDE	2/8	0.093	0.30	MND22-2605	3.3	1.42	0.211267606	No
4,4-DDT	2/8	0.26	0.31	MND21-2605	3.3	1.19	0.260504202	No
Acetone	5/8	5	110.00	MND21-2605	--	453.37	0.242627435	No
Aldrin	2/8	1.4	2.00	MND22-2606	2	2.00	1.00	No
alpha-Chlordane	5/8	0.13	1.20	MND22-2606	1.7	4.50	0.27	No
alpha-BHC	2/8	0.27	0.48	MND22-2606	1.7	6.00	0.08	No
Anthracene	2/8	60	77.00	MND21-2605	--	46.90	1.64	Yes
Aroclor-1254	4/8	38	73.00	MND21-2605	--	34.10	2.14	Yes

Table A-5 (cont.)

Chemical	Frequency of Detection	Range of Detections Minimum	Range of Detections Maximum	Maximum Location	Minimum Quantitation Limit	Screening Value[a]	Screening Hazard Quotient	COPC?
Benzo(a)anthracene	8/8	44	340.00	MND21-2605	330	31.70	10.72555205	Yes
Benzo(a)pyrene	8/8	44	400.00	MND21-2605	330	31.90	12.53918495	Yes
Benzo(b)fluoranthene	8/8	95	810.00	MND21-2605	330	10400.00	0.077884615	No
Benzo(g,h,I)perylene	4/8	50	180.00	MND21-2605	330	170.00	1.058823529	Yes
Benzo(k)fluoranthene	7/8	99	1300.00	MND21-2605	330	240.00	5.416666667	Yes
Benzoic acid	1/8	--	310.00	MND21-2605	--	NSL	--	Yes
beta-BHC	3/8	0.69	5.40	MND22-2606	--	5.00	1.08	Yes
Bis(2-ethylhexyl)phthalate	7/8	91	350	MND21-2605	330	182	1.92	Yes
Carbazole	1/8	--	57	MND21-2605	--	NSL	--	Yes
Chrysene	7/8	60	500	MND21-2605	330	57.1	8.76	Yes
Dibenz(a,h)anthracene	1/8	--	56	MND21-2605	330	6.22	9.00	Yes
Dieldrin	6/8	0.3	4	MND22-2606	--	2	1.85	Yes
Di-n-butylphthalate	1/8	--	39	MND22-2606	--	110.5	0.353	No
Endrin	1/8	--	0	MND22-2606	3.3	2.67	0.120	No
Endrin aldehyde	4/8	0.16	1	MND22-2606	3.3	3.20E+03	0.000344	No
Fluoranthene	8/8	95	860	MND21-2605	330	111	7.727	Yes
gamma-Chlordane	4/8	0.16	1	MND22-2606	1.7	5	0.289	No
gamma-BHC	5/8	0.23	2	MND21-2605	1.7	1	2.021	Yes
HMX	3/9	0.1	0	MND22-2606	--	NSL	--	Yes
Indeno(1,2,3-cd)pyrene	5/8	48	210	MND21-2605	330	200	1.050	Yes
Methoxychlor	4/8	1.2	7	MND22-2606	--	4	2.033	Yes
Methylene chloride	7/8	2	21	MND22-2606	5	1260	0.017	No
RDX	4/9	0.73	1	MND22-2606	2.5	NSL	--	Yes
Phenanthrene	7/8	48	330	MND21-2605	330	42	7.9	Yes
Pyrene	8/8	79	770	MND21-2605	330	53	14.5	Yes

Table A-5 (cont.)

Chemical	Frequency of Detection	Range of Detections Minimum	Range of Detections Maximum	Maximum Location	Minimum Quantitation Limit	Screening Value[a]	Screening Hazard Quotient	COPC?
Inorganics (mg/kg)								
Aluminum	8/8	2880	10900	MND22-2606	19.2	NSL	--	Yes
Antimony	3/8	0.53	4.60	MND21-2605	1.9	NSL	--	Yes
Arsenic	8/8	2.1	6.50	MND22-2606	1	6	1.1	Yes
Barium	8/8	18	112	MND22-2606	0.2	NSL	--	Yes
Beryllium	8/8	0.16	0.630	MND21-2605	0.2	NSL	--	Yes
Cadmium	2/6	0.23	0.660	MND21-2605	0.3	0.5960	1.1	Yes
Calcium	8/8	39000	64100	MND21-2605	28.5	NSL	--	No; nutrient
Chromium	8/8	7.6	22.90	MND22-2606	0.9	26.00	0.88	No
Cobalt	8/8	2.8	8.70	MND22-2606	0.6	50.00	0.2	No
Copper	8/8	14.7	73.10	MND22-2606	0.7	16.00	4.6	Yes
Cyanide	1/8	--	0.84	MND21-2605	--	0.10	8.4	Yes
Iron	8/8	7080	18700	MND22-2606	15.7	NSL	--	Yes
Lead	8/8	8	57.5	MND22-2606	1	31.00	1.9	Yes
Lithium	8/8	5	14.4	MND22-2606	3.8	NSL	--	Yes
Magnesium	8/8	8800	23200	MND21-2605	4	NSL	--	Yes
Manganese	8/8	211	439	MND22-2606	0.3	NSL	--	Yes
Mercury	1/8	--	0.18	MND21-2605	--	174.00	0.0010	No
Molybdenum	7/8	1.3	9.8	MND22-2606	1.7	NSL	--	Yes
Nickel	8/8	12.1	17.3	MND22-2606	1.4	16.00	1.1	Yes
Potassium	8/8	543	2860	MND21-2605	16.7	NSL	--	No; nutrient
Silver	3/8	0.67	1.4	MND22-2606	0.5	500.00	0.0028	No
Sodium	8/8	194	909	MND22-2606	202	NSL	--	No; nutrient
Thallium	1/8	--	0.40	MND21-2605	--	NSL	--	No; bkg
Tin	2/8	2.4	4.2	MND21-2605	5.9	NSL	--	No; bkg
Vanadium	8/8	8.6	23.5	MND21-2605	0.4	NSL	--	No; bkg
Zinc	8/8	23.9	102	MND21-2605	1.4	120.00	0.9	No

Table A-5 (cont.)

Chemical	Frequency of Detection	Range of Detections		Maximum Location	Minimum Quantitation Limit	Screening Value[a]	Screening Hazard Quotient	COPC?
		Minimum	Maximum					
Anions (mg/kg)								
Bismuth	3/8	1	42.4	MND21-2605	2.6	NSL	--	Yes
Chloride	8/8	31.7	119	MND21-2605	3	NSL	--	Yes
Fluoride	8/8	1.7	5.7	MND21-2605	0.1	NSL	--	No; bkg
Nitrate/Nitrite	5/8	1.09	3.2	MND21-2605	0.05	NSL	--	No; bkg
Sulfate	4/8	150	282.0	MND22-2606	2	NSL	--	Yes

Notes:
Only chemicals detected above method detection limit are presented.
NBL = No background level.
NSL = No screening level.
-- = Not applicable; not available.

a U.S EPA Region V, 1999a. Ecological Data Quality Levels, RCRA Corrective Action

Table A-6

Calculation of Hardness and Hardness-Dependent Criteria

	Hardness calculations			
	POND		OVERFLOW	
	Calcium	Magnesium	Calcium	Magnesium
	50400	14700	56600	25600
	50600	4500	62800	28000
	52800	17100	63600	21300
	50700	17500	71200	23100
	50800	13100	67800	24100
	45200	14500	67700	24800
	53000	18200		
	53700	17800		
	49700	14700		
	51900	14100		
	52600	18700		
	55000	17700		
Average (ug/L)	51366.67	15216.66667	64950	24483.33333
Average (mg/L)	51.36667	15.21666667	64.95	24.48333333
equivalents	2.563197	1.25081	3.241005	2.01253
Hardness (mg/L)	190.891		262.9394	

POND (Total recoverable)	Chemical	imzm	omzm	omza
hdness =	Beryllium	2234.517371	732.4695	4.884152315
190.8910337	Cadmium	12.7705267	5.84346	7.328852886
	Chromium	2751.935775	1559.953	129.2819607
	Copper	54.56316063	28.40072	20.76400605
	Lead	505.0810516	209.0143	4.90178103
	Nickel	1029.623557	572.8767	89.33085382
	Silver	0.074828889	0.02272	--
	Zinc	325.6945078	181.0514	181.0513965

Overflow (Total recoverable	Chemical	imzm	omzm	omza
hdness =	Beryllium	3740.655026	1226.178	8.176230422
262.9394268	Cadmium	18.32651872	8.385737	9.42397035
	Chromium	3577.146882	2027.729	168.0491845
	Copper	73.77877583	38.40265	27.29899238
	Lead	759.2720583	314.2044	7.368689362
	Nickel	1349.994019	751.129	117.1264173
	Silver	0.129798601	0.03941	--
	Zinc	427.2131384	237.4849	237.4849236

APPENDIX B

TOXICITY REFERENCE VALUES

Table B-1
Bird Toxicity Reference Values
Miami-Erie Canal
Miamisburg, Ohio

Analyte	Test Species	Dose	Duration and Endpoint	Uncertainty Factor	TRV	Reference
Organics (ug/kg-BW-day)						
2-Amino-4,5-Dinitrotoluene	NDA	--	--	--	--	--
Anthracene	NDA	--	--	--	--	--
Aroclor-1254	Ring dove	720	Chronic LOAEL (embryonic mortality)	0.1	72	EPA 1999b
Benzoic acid	NDA	--	--	--	--	--
Bis(2-ethylhexyl)phthalate	Ring dove	1110	Chronic NOAEL	1	1110	Sample et al. 1996
Butylbenzylphthalate	NDA	--	--	--	--	--
beta-BHC	Japanese quail	563	Chronic NOAEL	1	563	Sample et al. 1996
Carbazole	NDA	--	--	--	--	--
4,4-DDD	Japanese quail	84,500	Acute LOAEL (mortality)	0.01	845	EPA 1999 (4,4-DDE)
Dibenzofuran	NDA	--	--	--	--	--
Dieldrin	Barn owl	77	Chronic NOAEL	1	77	Sample et al. 1996
Di-n-butylphthalate	Ringed dove	1100	Chronic LOAEL (reproduction)	0.1	110	Sample et al. 1996
Benzo(a)pyrene	Chicken embryo	100	Acute NOAEL	0.01	1.0	EPA 1999b
Benzo(a)anthracene	Chicken embryo	79	Acute LD50	0.01	0.79	EPA 1999b
Benzo(b)fluoranthene	--	--	--	--	0.14	EPA 1999b
Benzo(g,h,i)perylene	--	--	--	--	0.14	EPA 1999b
Benzo(k)fluoranthene	Chicken embryo	14	Acute LD50	0.01	0.14	EPA 1999b
Dibenz(a,h)anthracene	Chicken embryo	39	Acute LD50	0.01	0.39	EPA 1999b
Chrysene	Chicken embryo	100	Acute LOAEL	0.01	1.0	EPA 1999b
Endrin ketone	NDA	--	--	--	--	--
Fluoranthene	NDA	--	--	--	--	--
Fluorene	NDA	--	--	--	--	--
gamma-Chlordane	Red-winged blackbird	2140	Chronic NOAEL	1	2140	Sample et al. 1996

Table B-1
Bird Toxicity Reference Values
Miami-Erie Canal
Miamisburg, Ohio

Analyte	Test Species	Dose	Duration and Endpoint	Uncertainty Factor	TRV	Reference
Heptachlor	Quail	6500	Acute LOAEL (mortality)	0.01	65	EPA 1999b
Heptachlor epoxide	NDA	--	--	--	--	--
HMX	NDA	--	--	--	--	--
Hexane	NDA	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	Chicken embryo	100	Acute LOAEL	0.01	1	EPA 1999b
Methoxychlor	White leghorn chicken	556	Chronic no effect level	1	556	Foster 1973
Phenanthrene	NDA	--	--	--	--	--
Pyrene	NDA	--	--	--	--	--
RDX	NDA	--	--	--	--	--
Naphthalene	Bobwhite quail	347,000	Acute NOAEL	0.01	3470	Wildlife International 1985
Inorganics (mg/kg-BW-day)						
Aluminum	ringed turtle dove	110	Chronic NOAEL	1	110	EPA 1999b
Antimony	NDA	--	--	--	--	--
Arsenic	Brown-headed cowbird	2.46	Chronic NOAEL	1	2.46	EPA 1999b
Barium	One day old chick	208.26	S;ubchronic NOAEL	0.1	20.826	EPA 1999b
Beryllium	NDA	--	--	--	--	--
Cadmium	Mallard drake	1.45	Chronic NOAEL	1.0	1.45	EPA 1999b
Chromium (trivalent)	Black duck	1.0	Chronic NOAEL	1	1.0	EPA 1999b
Copper	1-day old chicks	46.97	Chronic NOAEL (growth)	1.0	46.97	EPA 1999b
Cyanide	NDA	--	--	--	--	--
Iron	NDA	--	--	--	--	--
Lead	Japanese quail	1.13	Chronic NOAEL	1	1.13	Sample et al. 1996
Lithium	NDA	--	--	--	--	--
Manganese	Japanese quail	977	Chronic NOAEL	1	977	Sample et al. 1996
Molybdenum	Chicken	35.3	Chronic LOAEL	0.1	3.53	Sample et al. 1996

Table B-1
Bird Toxicity Reference Values
Miami-Erie Canal
Miamisburg, Ohio

Analyte	Test Species	Dose	Duration and Endpoint	Uncertainty Factor	TRV	Reference
Mercury	Coturniz quail	325	Acute LOAEL (mortality)	0.01	3.25	EPA 1999b
Nickel	Mallard	77.4	Chronic NOAEL	1	77.4	Sample et al. 1996
Selenium	Mallard	0.5	Chronic LOAEL (mortality)	1.0	0.5	EPA 1999b
Silver	Mallard	1780	Subchronic NOAEL	0.1	178	EPA 1999b
Thallium	Starling	35	Acute LD50	0.01	0.35	EPA 1999b
Tin	Japanese quail	6.76	Chronic NOAEL	1	6.76	Sample et al. 1996
Vanadium	Mallard	11.4	Chronic NOAEL	1.0	11.4	Sample et al. 1996
Zinc	Leghorn hen and New Hampshire rooster	130.9	Chronic NOAEL	1.0	130.9	EPA 1999
Anions (mg/kg-BW day)						
Bismuth	NDA	--	--	--	--	--
Chloride	NDA	--	--	--	--	--
Fluoride	Screech owl	7.8	Chronic NOAEL	1	7.8	Sample et al. 1996
Nitrate/Nitrite	NDA	--	--	--	--	--
Nitrogen	NDA					
Sulfate	NDA	--	--	--	--	--

Notes:

NDA - No data available.
NOAEL - No observable adverse effect level.
LOAEL - Lowest observable adverse effect level.
NOAEL values were estimated from LOAEL values by multiplying by a factor of 0.1 (EPA 1999b).
Chronic values were estimated from subchronic values by multiplying by a factor of 0.1 (EPA 1999b).
No effect levels and effect levels are considered to be the same as a NOAEL and a LOAEL, respectively.
Acute NOAEL values were converted to chronic NOAEL values by multiplying acute values by a factor of 0.01 (EPA 1999b).
LD50 values were converted to chronic NOAEL values by multiplying the LD50 by 0.01 (EPA 1999b).

Table B-2
Mammal Toxicity Reference Values
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Analyte	Test Species	Dose	Duration and Endpoint	Uncertainty Factor	TRV	Reference
Organics (ug/kg-BW-day)						
2-amino4,6-dintitrotoluene	NDA	--	--	--	--	--
Anthracene	NDA	--	--	--	--	--
Aroclor-1254	mink	20.6	Subchronic LOAEL (mortality)	0.01	0.206	EPA 1999b
4,4-DDD	rat	10,000	Subchronic NOAEL	0.1	1000	EPA 1999b (4,4-DDE)
Benzo(a)pyrene	mouse	10,000	Chronic LOAEL (reproductive effects)	0.1	1000	Sample et al. 1996
Naphthalene	rat	1,630,000	Acute LD_{50} (death)	0.01	16,300	Sax and Lewis 1989
Dibenzofuran	NDA	--	--	--	--	--
Benzo(a)anthracene	mouse	16,666	Single dose LOAEL (gastrointestinal effects)	0.01	167	EPA 1999b
Benzo(g,h,i)perylene	NDA	--	--	--	--	--
Benzo(b)fluoranthene	NDA	--	--	--	--	--
Benzo(k)fluoranthene	NDA	--	--	--	--	--
Dibenz(a,h)anthracene	rat	200	Subchronic LOAEL (reduced growth rate)	0.01	2	EPA 1999b
Fluoranthene	NDA	--	--	--	--	--
Fluorene	NDA	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	NDA	--	--	--	--	--
Phenathrene	NDA	--	--	--	--	--
Pyrene	NDA	--	--	--	--	--
Chrysene	NDA	--	--	--	--	--
Benzoic acid	NDA	--	--	--	--	--
Bis(2-ethylhyexyl)phthalate	rat	60,000	Chronic NOAEL	1	60,000	EPA 1999b
beta-BHC	rat	4000	Chronic NOAEL	1	4000	Sample et al. 1996
gamma-BHC	rat	8000	Chronic NOAEL	1	8000	Sample et al. 1996

Table B-2
Mammal Toxicity Reference Values
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Analyte	Test Species	Dose	Duration and Endpoint	Uncertainty Factor	TRV	Reference
Dieldrin	rat	200	Chronic LOAEL (reproduction)	0.1	20	Sample et al. 1996
Endrin ketone	NDA	--	--	--	--	--
Heptachlor	rat	250	Subchronic LOAEL	0.01	2.5	EPA 1999b
Heptachlor epoxide	NDA	--	--	--	--	--
Hexane	NDA	--	--	--	--	--
HMX	NDA	--	--	--	--	--
Methoxychlor	rat	4000	Chronic NOAEL	1	4000	Sample et al. 1996
RDX	NDA	--	--	--	--	--
gamma-Chlordane	mouse	4580	Chronic NOAEL	1	4580	Sample et al. 1996
Butylbenzylphthalate	NDA	--	--	--	--	--
Di-n-butylphthalate	mouse	550,000	Chronic NOAEL	1	550,000	Sample et al. 1996
Carbazole	NDA	--	--	--	--	--
Inorganics (mg/kg-BW-day)						
Aluminum	mouse	19.3	Chronic LOAEL (reproduction)	0.1	1.93	EPA 1999b
Antimony	rat	0.66	Chronic LOAEL (mortality)	0.1	0.066	EPA 1999b
Arsenic	dog	1.25	Chronic NOAEL	1	1.25	EPA 1999b
Barium	rat	5.1	Chronic NOAEL	1	5.1	Sample et al. 1996
Beryllium	rat	0.66	Chronic NOAEL	1	0.66	EPA 1999b
Cadmium	mouse	10	Chronic LOAEL (reproduction)	0.1	1	Sample et al. 1996
Chromium (hexavalent)	rat	3.5	Chronic NOAEL	1	3.5	EPA 1999b
Copper	mink	12	Chronic NOAEL	1.0	12	EPA 1999b
Cyanide	rat	24	Chronic NOAEL	1	24	EPA 1999b
Iron	rat	4,000	LD_{50} (death)	0.01	40	Shanas and Boyd 1969
Lead	mouse	8	Chronic NOAEL	1	8	Sample et al. 1996
Lithium	rat	9.4	Chronic NOAEL	1	9.4	Sample et al. 1996

Table B-2
Mammal Toxicity Reference Values
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Analyte	Test Species	Dose	Duration and Endpoint	Uncertainty Factor	TRV	Reference
Manganese	rat	88	Chronic NOAEL	1	88	Sample et al. 1996
Molybdenum	mouse	2.6	Chronic LOAEL (reproduction)	0.1	0.26	Sample et al. 1996
Mercury	mink	1.01	Chronic NOAEL (reproduction)	1.0	1.01	EPA 1999b
Nickel	rat	40	Chronic NOAEL	1	40	Sample et al 1996
Selenium	mouse	0.2	Chronic NOAEL	1	0.2	Sample et al. 1996
Silver	mouse	3.75	Chronic LOAEL (hypoactivity)	0.1	0.375	EPA 1999b
Thallium	rat	1.31	Subchronic LOAEL (testicular function)	0.01	0.0131	EPA 1999b
Tin	mouse	23.4	Chronic NOAEL	1	23.4	Sample et al. 1996
Vanadium	rat	2.1	Chronic LOAEL (reproduction)	0.1	0.21	Sample et al. 1996
Zinc	rat	160	Chronic NOAEL	1	160	Sample et al. 1996
Anions (mg/kg-day BW)						
Bismuth	NDA	--	--	--	--	--
Chloride	NDA	--	--	--	--	--
Fluoride	mink	31.37	Chronic NOAEL	1	31.37	Sample et al. 1996
Nitrate/Nitrite	guinea pig	507	Chronic NOAEL	1	507	Sample et al. 1996
Nitrogen	NDA	--	--	--	--	--
Sulfate	NDA	--	--	--	--	--

Notes:

NDA - No data available.
NOAEL - No observable adverse effect level.
LOAEL - Lowest observable adverse effect level.
NOAEL values were estimated from LOAEL values by multiplying by a factor of 0.1 (EPA 1999b).
Chronic values were estimated from subchronic values by multiplying by a factor of 0.1 (EPA 1999b).
No effect levels and effect levels are considered to be the same as a NOAEL and a LOAEL, respectively.
Acute NOAEL values were converted to chronic NOAEL values by multiplying acute values by a factor of 0.01 (EPA 1999b).
LD50 values were converted to chronic NOAEL values by multiplying the LD50 by 0.01 (EPA 1999b).

Table B-3
Mammal Toxicity Reference Values by Receptor Group
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Analyte	Test Species	TRV	Meadow Vole	Short-tailed shrew	Muskrat	Mink
Organics (ug/kg-BW-day)						
2-amino4,6-dintitrotoluene	NDA	--	--	--	--	--
Anthracene	NDA	--	--	--	--	--
Aroclor-1254	mink	0.206	0.484	0.571	0.198	0.205
4,4-DDD	rat	1000	1800	2130	739	765
Benzo(a)pyrene	mouse	1000	977	1150	399.8	414
Naphthalene	rat	16,300	29340	34719	12046	12470
Dibenzofuran	NDA	--	--	--	--	--
Benzo(a)anthracene	mouse	167	163	192	66.77	69.14
Benzo(g,h,i)perylene	NDA	--	--	--	--	--
Benzo(b)fluoranthene	NDA	--	--	--	--	--
Benzo(k)fluoranthene	NDA	--	--	--	--	--
Dibenz(a,h)anthracene	rat	2	3.6	4.26	1.478	1.53
Fluoranthene	NDA	--	--	--	--	--
Fluorene	NDA	--	--	--	--	--
Indeno(1,2,3-cd)pyrene	NDA	--	--	--	--	--
Phenathrene	NDA	--	--	--	--	--
Pyrene	NDA	--	--	--	--	--
Chrysene	NDA	--	--	--	--	--
Benzoic acid	NDA	--	--	--	--	--
Bis(2-ethylhyexyl)phthalate	rat	60,000	108000	127800	44340	45900
beta-BHC	rat	4000	7200	8520	2956	3060
gamma-BHC	rat	8000	14400	17040	5912	6120
Dieldrin	rat	20	36	42.6	14.78	15.3
Endrin ketone	NDA	--	--	--	--	--
Heptachlor	rat	2.5	4.5	5.325	1.8475	1.9125
Heptachlor epoxide	NDA	--	--	--	--	--

Table B-3
Mammal Toxicity Reference Values by Receptor Group
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Analyte	Test Species	TRV	Meadow Vole	Short-tailed shrew	Muskrat	Mink
Hexane	NDA	--	--	--	--	--
HMX	NDA	--	--	--	--	--
Methoxychlor	rat	4000	7200	8520	2956	3060
RDX	NDA	--	--	--	--	--
gamma-Chlordane	mouse	4580	4475	5267	1831	1896
Butylbenzylphthalate	NDA	--	--	--	--	--
Di-n-butylphthalate	mouse	550,000	537350	632500	219890	227700
Carbazole	NDA	--	--	--	--	--
Inorganics (mg/kg-BW-day)						
Aluminum	mouse	1.93	1.89	2.22	0.772	0.799
Antimony	rat	0.066	0.1188	0.141	0.0488	0.0505
Arsenic	dog	1.25	5.54	6.54	2.27	2.35
Barium	rat	5.1	9.18	10.86	3.77	3.90
Beryllium	rat	0.66	1.19	1.41	0.488	0.505
Cadmium	mouse	1	0.977	1.15	0.3998	0.414
Chromium (hexavalent)	rat	3.5	6.3	7.455	2.59	2.68
Copper	mink	12	28.2	33.24	11.53	11.94
Cyanide	rat	24	43.2	51.12	17.74	18.36
Iron	rat	40	72	85.2	29.56	30.6
Lead	mouse	8	7.816	9.2	3.198	3.312
Lithium	rat	9.4	9.18	10.81	3.76	3.89
Manganese	rat	88	158.4	187.4	65.03	67.32
Molybdenum	mouse	0.26	0.254	0.299	0.104	0.108
Mercury	mink	1.01	2.37	2.798	0.971	1.005
Nickel	rat	40	72	85.2	29.56	30.6
Selenium	mouse	0.2	0.1954	0.23	0.07996	0.0828
Silver	mouse	0.375	0.366	0.431	0.1499	0.155

Table B-3
Mammal Toxicity Reference Values by Receptor Group
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Analyte	Test Species	TRV	Meadow Vole	Short-tailed shrew	Muskrat	Mink
Thallium	rat	0.0.31	0.0236	0.0279	0.00968	0.0100
Tin	mouse	23.4	22.86	26.91	9.355	9.688
Vanadium	rat	0.21	0.378	0.4473	0.155	0.1607
Zinc	rat	160	288	340.8	118.24	122.4
Anions (mg/kg-day BW)						
Bismuth	NDA	--	--	--	--	--
Chloride	NDA	--	--	--	--	--
Fluoride	mink	31.37	73.72	86.89	30.15	31.21
Nitrate/Nitrite	guinea pig	507	1146	1354	472	486
Nitrogen	NDA	--	--	--	--	--
Sulfate	NDA	--	--	--	--	--

Notes:
See following table for Scaling Factors.
NDA - No data available.

Table B-4
Allometric Scaling Factors
Miami-Erie Canal
Miamisburg, Montgomery County, Ohio

Experimental Animals		Wildlife		
Species	Body Weight [a] (BWt in kg)	Species	Body Weight (BWw in kg)	Scaling factor $(BWt/BWw)^{1/4}$
rat	0.35	meadow vole	0.0329	1.80
		short-tailed shrew	0.017	2.13
		muskrat	1.174	0.739
		mink	1.02	0.765
mouse	0.03	meadow vole	0.0329	0.977
		short-tailed shrew	0.017	1.15
		muskrat	1.174	0.3998
		mink	1.02	0.414
mink	1.0	meadow vole	0.0329	2.35
		short-tailed shrew	0.017	2.77
		muskrat	1.174	0.961
		mink	1.02	0.995
dog	12.7	meadow vole	0.0329	4.43
		short-tailed shrew	0.017	5.23
		muskrat	1.174	1.814
		mink	1.02	1.88
guinea pig	0.86	meadow vole	0.0329	2.26
		short-tailed shrew	0.017	2.67
		muskrat	1.174	0.93
		mink	1.02	0.958

[a] Sample et al. 1996.

APPENDIX C

RADIOLOGICAL EXPOSURE DOSES

Table C-1
External Exposure: Direct Radiation from Soil
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Daboveground = Fabove * Fru Σ Csoil,I * DFgrd,I * CFb x ECF
Dbelowground = 1.05 Fbelow Σ Csoil,I * ξi * CFa
Source: Sample et al., 1997

COPC	Csoil, I pCi/g	DFgrd,I	ξi, γ	External Exposure	
				Daboveground	Dbelowground
Plutonium-238	150	8.07E-22	0.002	1.24E-04	1.54E-02
Plutonium-239/240	4.17	1.52E-21		6.48E-06	0.00E+00
Thorium-228	2.81	4.17E-20	0.003	1.20E-04	4.32E-04
Radium-224	2.81	2.62E-19	0.01	7.53E-04	1.44E-03
Radon-220	2.81	1.1E-20	0	3.16E-05	0.00E+00
Polonium-216	2.81	4.87E-22	0	1.40E-06	0.00E+00
Lead-212	2.81	3.62E-18	0.148	1.04E-02	2.13E-02
Bismuth-212	2.81	5.36E-18	0.186	1.54E-02	2.68E-02
Polonium-212	1.80	3.62E-18	0	6.66E-03	0.00E+00
Thallium-208	1.01	9.68E-17	3.375	1.00E-01	1.75E-01
Lead-208	2.81	0	0	0.00E+00	0.00E+00
Thorium-230	7.99	6.39E-21	0.002	5.22E-05	8.18E-04
Radium-226	7.99	1.65E-19	0.007	1.35E-03	2.86E-03
Radon-220	7.99	1.1E-20	0	8.99E-05	0.00E+00
Polonium-218	7.99	2.63E-22	0	2.15E-06	0.00E+00
Lead-214	7.99	6.7E-18	0.25	5.47E-02	1.02E-01
Astatine-218	1.60E-03	3.13E-20	0.007	5.11E-08	5.73E-07
Bismuth-214	7.99	4.36E-17	1.508	3.56E-01	6.17E-01
Polonium-214	7.99	2.4E-21	0	1.96E-05	0.00E+00
Thallium-210	1.60E-03	0	0	0.00E+00	0.00E+00
Thorium-232	1.41	2.78E-21	0.001	4.01E-06	7.22E-05
Radium-228	1.41	0	0	0.00E+00	0.00E+00
Actinium-228	1.41	2.76E-17	0.971	3.98E-02	7.01E-02
Tritium	79.60	0	0	0.00E+00	0.00E+00
Uranium-234	1.28	2.14E-21	0.002	2.80E-06	1.31E-04
Uranium-235	0.27	3.75E-18	1.56E-01	1.04E-03	2.16E-03
Thorium-231	0.27	1.94E-19	0.026	5.36E-05	3.59E-04
Uranium-238	1.62	5.52E-22	0.001	9.14E-07	8.29E-05
Thorium-234	1.62	1.29E-19	0.009	2.14E-04	7.46E-04
Protactinium-234m	1.62	4.2E-19	0.012	0.000695641	0.000995328
Total External Exposure				4.11E-01	1.09E+00
				1.50E+02	3.98E+02

Parameter	Source	Definition	Value	Units
Dabovegrd	Sample et al., 19	External dose rate to receptor from aboveground exposure to contaminated soil	--	mrad/day
Dbelow grrd	Sample et al., 19	External dose rate to receptor from belowground exposure to contaminated soil	--	mrad/day
Fabove	Conservative estimate; Sample et al., 1997	Dose rate reduction factor acounting for the time the receptor spends aboveground	1	unitless
Fbelow	Conservative estimate; Sample et al., 1997	Dose rate reduction factor acounting for the time the receptor spends below ground	1	unitless
Fruf	Sample et al., 19	Dose rate reduction factor accounting for gound roughness	0.7	unitless
Csoil, I	Sample et al., 19	Activity of radionuclide in surface soil	--	pCi/.g
DFgrd,I	Sample et al., 19	Dose coefficient for radionuclide I in soil contaminated to given depth	--	Sv/s per Bq/m3
CFb	Sample et al., 19	Conversion factor to change Sv/s per Bq/m3 to mrad g/pCi d	5.11E+14	--
Cfa	Sample et al., 19	Conversion factor to change MeV/nt to g mrad/pCi d	5.12E-02	--
1.05	Sample et al., 19	Coversion factor to account for immersion in soil versus water	--	unitless
ξi	Sample et al., 19	Energy for γ emissions by nuclide I	--	Me V/nt
ECF	Sample et al., 19	Elevation correction factor to adjust dose coefficients to value representative of effective height of animal aboveground	2	unitless, small mammal

Table C-2
Internal Exposure: Inhalation
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Source: Sample et al., 1997
Dinh (α, β) = QF * Fbelow Σ Csoil,I * A * 1/AD * ξI * Cfa * 1
Dinh (γ) = QF * Fbelow Σ Csoil,I * A * 1/AD * ξI * Cfa * AF

COPC	Csoil, I pCi/g	ξI, α	ξI, β	ξI, γ	AF - A	AF-B	AF-C	AF-D	AF-E	plants + insects			small mammals			small-medium mammals			medium mammals			large mammals		
										alpha	beta	gamma	alpha	beta	gamma	alpha	beta	gamma	alpha	beta	gamma	alpha	beta	gamma
Plutonium-238	150.00	5.487	0.011	0.002	0.63	0.79	0.94	0.94	0.94	3.51E-03	7.04E-06	8.06E-07	3.51E-03	7.04E-06	1.01E-06	3.51E-03	7.04E-06	1.20E-06	3.51E-03	7.04E-06	1.20E-06	3.51E-03	7.04E-06	1.20E-06
Plutonium-239/240	4.17	5.148	0.007		0.63	0.79	0.94	0.94	0.94	9.16E-05	1.25E-07	0.00E+00	9.16E-05	1.25E-07	0.00E+00	9.16E-05	1.25E-07	0.00E+00	9.16E-05	1.25E-07	0.00E+00	9.16E-05	1.25E-07	0.00E+00
Thorium-228	2.81	5.4	0.021	0.003	0.63	0.79	0.94	0.94	0.94	6.47E-05	2.52E-07	2.27E-08	6.47E-05	2.52E-07	2.84E-08	6.47E-05	2.52E-07	3.38E-08	6.47E-05	2.52E-07	3.38E-08	6.47E-05	2.52E-07	3.38E-08
Radium-224	2.81	5.674	0.002	0.01	0.63	0.79	0.29	0.35	0.52	6.80E-05	2.40E-08	7.55E-08	6.80E-05	2.40E-08	9.47E-08	6.80E-05	2.40E-08	3.48E-08	6.80E-05	2.40E-08	4.20E-08	6.80E-05	2.40E-08	6.23E-08
Radon-220	2.81	6.288								7.54E-05	0.00E+00	0.00E+00	7.54E-05	0.00E+00	0.00E+00	7.54E-05	0.00E+00	0.00E+00	7.54E-05	0.00E+00	0.00E+00	7.54E-05	0.00E+00	0.00E+00
Polonium-216	2.81	6.779								8.13E-05	0.00E+00	0.00E+00	8.13E-05	0.00E+00	0.00E+00	8.13E-05	0.00E+00	0.00E+00	8.13E-05	0.00E+00	0.00E+00	8.13E-05	0.00E+00	0.00E+00
Lead-212	2.81		0.176	0.148	0.01	0.01	0.04	0.06	0.15	0.00E+00	2.11E-06	1.77E-08	0.00E+00	2.11E-06	1.95E-08	0.00E+00	2.11E-06	7.10E-08	0.00E+00	2.11E-06	1.06E-07	0.00E+00	2.11E-06	2.66E-07
Bismuth-212	2.81	2.174	0.472	0.188	0.01	0.01	0.04	0.06	0.14	2.61E-05	5.66E-06	2.23E-08	2.61E-05	5.66E-06	2.45E-08	2.61E-05	5.66E-06	8.92E-08	2.61E-05	5.66E-06	1.34E-07	2.61E-05	5.66E-06	3.12E-07
Polonium-212	1.80	8.785								6.74E-05	0.00E+00	0.00E+00	6.74E-05	0.00E+00	0.00E+00	6.74E-05	0.00E+00	0.00E+00	6.74E-05	0.00E+00	0.00E+00	6.74E-05	0.00E+00	0.00E+00
Thallium-208	1.01		0.598	3.375	0.01	0.01	0.03	0.04	0.11	0.00E+00	2.58E-06	1.46E-07	0.00E+00	2.58E-06	1.46E-07	0.00E+00	2.58E-06	4.37E-07	0.00E+00	2.58E-06	5.83E-07	0.00E+00	2.58E-06	1.60E-06
Lead-208	2.81									0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-230	7.99	4.671	0.015	0.002	0.63	0.79	0.94	0.94	0.94	1.59E-04	5.11E-07	4.30E-08	1.59E-04	5.11E-07	5.39E-08	1.59E-04	5.11E-07	6.41E-08	1.59E-04	5.11E-07	8.41E-08	1.59E-04	5.11E-07	8.41E-08
Radium-226	7.99	4.774	0.004	0.007	0.63	0.79	0.94	0.94	0.94	1.63E-04	1.36E-07	1.50E-07	1.63E-04	1.36E-07	1.89E-07	1.63E-04	1.36E-07	2.24E-07	1.63E-04	1.36E-07	2.24E-07	1.63E-04	1.36E-07	2.24E-07
Radon-220	7.99	6.288								2.14E-04	0.00E+00	0.00E+00	2.14E-04	0.00E+00	0.00E+00	2.14E-04	0.00E+00	0.00E+00	2.14E-04	0.00E+00	0.00E+00	2.14E-04	0.00E+00	0.00E+00
Polonium-218	7.99	6.001								2.05E-04	0.00E+00	0.00E+00	2.05E-04	0.00E+00	0.00E+00	2.05E-04	0.00E+00	0.00E+00	2.05E-04	0.00E+00	0.00E+00	2.05E-04	0.00E+00	0.00E+00
Lead-214	7.99		0.293	0.25	0.01	0.01	0.04	0.06	0.14	0.00E+00	9.99E-06	8.52E-08	0.00E+00	9.99E-06	8.52E-08	0.00E+00	9.99E-06	3.41E-07	0.00E+00	9.99E-06	5.11E-07	0.00E+00	9.99E-06	1.19E-06
Astatine-218	1.60E-03	6.697	0.04	0.007	0.63	0.79	0.94	0.94	0.94	4.57E-08	2.73E-10	3.01E-11	4.57E-08	2.73E-10	3.77E-11	4.57E-08	2.73E-10	4.49E-11	4.57E-08	2.73E-10	4.49E-11	4.57E-08	2.73E-10	4.49E-11
Bismuth-214	7.99		0.659	1.508	0.09	0.01	0.03	0.05	0.12	0.00E+00	2.25E-05	4.37E-06	0.00E+00	2.25E-05	6.32E-07	0.00E+00	2.25E-05	1.54E-06	0.00E+00	2.25E-05	2.57E-06	0.00E+00	2.25E-05	6.17E-06
Polonium-214	7.99	7.687								2.62E-04	0.00E+00	0.00E+00	2.62E-04	0.00E+00	0.00E+00	2.62E-04	0.00E+00	0.00E+00	2.62E-04	0.00E+00	0.00E+00	2.62E-04	0.00E+00	0.00E+00
Thallium-210	1.60E-03									0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-232	1.41	3.996	0.012	0.001	0.63	0.79	0.94	0.94	0.94	2.40E-05	7.22E-08	3.79E-09	2.40E-05	7.22E-08	4.75E-09	2.40E-05	7.22E-08	5.66E-09	2.40E-05	7.22E-08	5.66E-09	2.40E-05	7.22E-08	5.66E-09
Radium-228	1.41		0.017							0.00E+00	1.02E-07	0.00E+00	0.00E+00	1.02E-07	0.00E+00	0.00E+00	1.02E-07	0.00E+00	0.00E+00	1.02E-07	0.00E+00	0.00E+00	1.02E-07	0.00E+00
Actinium-228	1.41		0.475	0.971	0.01	0.01	0.04	0.06	0.14	0.00E+00	2.86E-06	5.84E-08	0.00E+00	2.86E-06	7.42E-08	0.00E+00	2.86E-06	2.34E-07	0.00E+00	2.86E-06	3.50E-07	0.00E+00	2.86E-06	8.18E-07
Tritium	79.60		0.006							0.00E+00	2.04E-06	0.00E+00	0.00E+00	2.04E-06	0.00E+00	0.00E+00	2.04E-06	0.00E+00	0.00E+00	2.04E-06	0.00E+00	0.00E+00	2.04E-06	0.00E+00
Uranium-234	1.28	4.758	0.013	0.002	0.63	0.79	0.94	0.94	0.94	2.60E-05	7.10E-08	6.88E-09	2.60E-05	7.10E-08	8.63E-09	2.60E-05	7.10E-08	1.03E-08	2.60E-05	7.10E-08	1.03E-08	2.60E-05	7.10E-08	1.03E-08
Uranium-235	0.27	4.396	0.049	0.156	0.01	0.01	0.04	0.06	0.14	5.06E-06	5.64E-08	1.80E-09	5.06E-06	5.64E-08	2.07E-09	5.06E-06	5.64E-08	7.19E-09	5.06E-06	5.64E-08	1.08E-08	5.06E-06	5.64E-08	2.52E-08
Thorium-231	0.27		0.165	0.026	0.09	0.13	0.16	0.21	0.36	0.00E+00	1.90E-07	2.70E-09	0.00E+00	1.90E-07	3.77E-09	0.00E+00	1.90E-07	4.79E-09	0.00E+00	1.90E-07	6.29E-09	0.00E+00	1.90E-07	1.08E-08
Uranium-238	1.62	4.187	0.01	0.001	0.63	0.79	0.94	0.94	0.94	2.89E-05	6.91E-08	4.35E-09	2.89E-05	6.91E-08	5.46E-09	2.89E-05	6.91E-08	6.50E-09	2.89E-05	6.91E-08	6.50E-09	2.89E-05	6.91E-08	6.50E-09
Thorium-234	1.62		0.06	0.009	0.63	0.79	0.94	0.94	0.94	0.00E+00	4.15E-07	3.92E-08	0.00E+00	4.15E-07	4.91E-08	0.00E+00	4.15E-07	5.85E-08	0.00E+00	4.15E-07	5.85E-08	0.00E+00	4.15E-07	5.85E-08
Protactinium-234	1.62									0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total Inhalation Exposure										1.01E-01	5.68E-05	5.86E-06	1.01E-01	5.68E-05	2.43E-06	1.01E-01	5.68E-05	4.37E-06	1.01E-01	5.68E-05	5.92E-06	1.01E-01	5.68E-05	1.21E-05
										1.02E-01			1.02E-01			1.02E-01			1.02E-01			1.02E-01		

Table C-2
Internal Exposure: Inhalation
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Parameter		Value	Units
Dinh	Internal dose rate from inhalation of contaminated soil	--	mrad/day
Fbelow	Dose rate reduction factor acounting for the time the receptor spends below ground	1	unitless
Csoil, I	Activity of radionuclide in surface soil		pCi/g
Cfa	Conversion factor to change MeV/nt to g mrad/pCi d	5.12E-02	--
ξI,αβγ	Energy for α,β,γ emissions by nuclide I	--	Me V/nt
A	Mass of respirable dust per volume of air breathed	0.1	g/m3

Parameter		Value	Units
AD	Air density	1200	g/m3
AF	Absorption factor	--	unitless
QF	factor to account for the greater biological	20	unitless, α
QF	Quality factor to account for the greater biological effectivenes s of α particles	1	unitless, β,γ

Table C-3
Internal Exposure: Ingestion of Soil
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Source: Sample et al., 1997
Ding (α, β) = Σ QF * Ctissue *ξi * CFa * 1
Ding (γ) = Σ QF * Ctissue *ξi * CFa * AF

COPC	Csoil, I pCi/g	ξI, α	ξI, β	ξI, γ	UF-herb plants	UF-invert	UF-mamma	Tissue Concentration from Soil Uptake: C-plant Cs * Ufplant	C-invert Cs * Ufinve	Cmammal Cs * Ufmammal	AF - A	AF-B	Dose based on soil uptake: plant alpha	plant beta	plant gamma	invertebrate alpha	invertebrate beta	invertebrate gamma	small mammal (group B) alpha	small mammal (group B) beta	small mammal (group B) gamma
Plutonium-238	150.00	5.487	0.011	0	3.00E-04			4.50E-02	0.00E+00	0.00E+00	0.63	0.79	2.53E-01	2.53E-05	2.90E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Plutonium-239/240	4.17	5.148	0.007		3.00E-04	9.12E-03		1.25E-03	3.80E-02	0.00E+00	0.63	0.79	6.59E-03	4.48E-07	0.00E+00	2.00E-01	1.36E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-228	2.81	5.4	0.021	0	9.00E-04	5.00E-03	3.20E-05	2.53E-03	1.41E-02	8.99E-05	0.63	0.79	1.40E-02	2.72E-06	2.45E-07	7.77E-02	1.51E-05	1.36E-06	4.97E-04	9.67E-08	1.09E-08
Radium-224	2.81	5.674	0.002	0.01	7.50E-02	7.50E-02		2.11E-01	2.11E-01	0.00E+00	0.63	0.79	1.22E+00	2.16E-05	6.80E-05	1.22E+00	2.16E-05	6.80E-05	0.00E+00	0.00E+00	0.00E+00
Radon-220	2.81	6.288						0.00E+00	0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Polonium-216	2.81	6.779						0.00E+00	0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead-212	2.81		0.176	0.15				0.00E+00	0.00E+00	0.00E+00	0.01	0.011	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bismuth-212	2.81	2.174	0.472	0.19	8.75E-03	2.00E-02		2.46E-02	5.62E-02	0.00E+00	0.01	0.011	5.47E-02	5.94E-04	2.34E-06	1.25E-01	1.36E-03	5.35E-06	0.00E+00	0.00E+00	0.00E+00
Polonium-212	1.80	8.785						0.00E+00	0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium-208	1.01		0.598	3.38	1.00E-03	2.00E+00		1.01E-03	2.02E+00	0.00E+00	0.01	0.01	0.00E+00	3.10E-05	1.75E-06	0.00E+00	6.19E-02	3.50E-03	0.00E+00	0.00E+00	0.00E+00
Lead-208	2.81							0.00E+00	0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-230	7.99	4.671	0.015	0	9.00E-04	5.00E-03	3.20E-05	7.19E-03	4.00E-02	2.56E-04	0.63	0.79	3.44E-02	5.52E-06	4.64E-07	1.91E-01	3.07E-05	2.58E-06	1.22E-03	1.96E-07	2.07E-08
Radium-226	7.99	4.774	0.004	0.01	7.50E-02	7.50E-02		5.99E-01	5.99E-01	0.00E+00	0.63	0.79	2.93E+00	1.23E-04	1.35E-04	2.93E+00	1.23E-04	1.35E-04	0.00E+00	0.00E+00	0.00E+00
Radon-220	7.99	6.288						0.00E+00	0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Polonium-218	7.99	6.001						0.00E+00	0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead-214	7.99		0.293	0.25				0.00E+00	0.00E+00	0.00E+00	0.01	0.01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Astatine-218	1.60E-03	6.697	0.04	0.01				0.00E+00	0.00E+00	0.00E+00	0.63	0.79	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bismuth-214	7.99		0.659	1.51	8.75E-03	2.00E-02		6.99E-02	1.60E-01	0.00E+00	0.085	0.012	0.00E+00	2.36E-03	4.59E-04	0.00E+00	5.39E-03	1.05E-03	0.00E+00	0.00E+00	0.00E+00
Polonium-214	7.99	7.687						0.00E+00	0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium-210	1.60E-03							0.00E+00	0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-232	1.41	3.996	0.012	0	9.00E-04	5.00E-03	3.20E-05	1.27E-03	7.05E-03	4.51E-05	0.63	0.79	5.19E-03	7.80E-07	4.09E-08	2.88E-02	4.33E-06	2.27E-07	1.85E-04	2.77E-08	1.83E-09
Radium-228	1.41		0.017		7.50E-02	7.50E-02		1.06E-01	1.06E-01	0.00E+00			0.00E+00	9.20E-05	0.00E+00	0.00E+00	9.20E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Actinium-228	1.41		0.475	0.97	8.75E-04	1.25E-03		1.23E-03	1.76E-03	0.00E+00	0.01	0.013	0.00E+00	3.00E-05	6.13E-07	0.00E+00	4.29E-05	8.76E-07	0.00E+00	0.00E+00	0.00E+00
Tritium	79.6		0.006					0.00E+00	0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-234	1.28	4.758	0.013	0	3.75E-03		3.20E-04	4.80E-03	0.00E+00	4.10E-04	0.63	0.79	2.34E-02	3.19E-06	3.10E-07	0.00E+00	0.00E+00	0.00E+00	2.00E-03	2.73E-07	3.31E-08
Uranium-235	0.27	4.396	0.049	0.16	3.75E-03		3.20E-04	1.01E-03	0.00E+00	8.64E-05	0.01	0.012	4.56E-03	2.54E-06	8.09E-08	0.00E+00	0.00E+00	0.00E+00	3.89E-04	2.17E-07	7.94E-09
Thorium-231	0.27		0.165	0.03				0.00E+00	0.00E+00	0.00E+00	0.09	0.126	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-238	1.62	4.187	0.01	0	3.75E-03		3.20E-04	6.08E-03	0.00E+00	5.18E-04	0.63	0.79	2.60E-02	3.11E-06	1.96E-07	0.00E+00	0.00E+00	0.00E+00	2.22E-03	2.65E-07	2.10E-08
Thorium-234	1.62		0.06	0.01	9.00E-04	5.00E-03		1.46E-03	8.10E-03	0.00E+00	0.63	0.79	0.00E+00	4.48E-06	4.23E-07	0.00E+00	2.49E-05	2.35E-06	0.00E+00	0.00E+00	0.00E+00
Protactinium-234r	1.62				6.23E-04			1.01E-03	0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total Soil Ingestion Exposure													4.58E+00	3.30E-03	6.71E-04	4.78E+00	6.91E-02	4.76E-03	6.51E-03	1.08E-06	9.55E-08

Parameter		Value	Units
Ding	Internal dose rate from ingestion of contaminated prey and soil	--	mrad/day
Csoil, I	Activity of radionuclide in surface soil	--	pCi/.g
Cfa	Conversion factor to change MeV/nt to g mrad/pCi d	5.12E-02	--
ξI,αβγ	Energy for α,β,γ emissions by nuclide I	--	Me V/nt
AF	Absorption factor	--	unitless
QF	Quality factor to account for the greater biological effectiveness of α particles	20	unitless, α
QF	Quality factor to account for the greater biological	1	unitless, β,γ

Table C-4
Internal Exposure: Ingestion of Prey
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Ding = Σ QF * Ctissue *ξi * CFa * AF
Source: Sample et al., 1997

COPC	Csoil, i pCi/g	ξi, α	ξi, β	ξi, γ	UF-herb plants	UF-invert	UF-mammal	Tissue Concentration from Soil Uptake			BAFmammal	Tissue concentration from prey ingestion			AF-B	Dose based on prey ingestion: Mammals - Group B								
								C-plant	C-invertebrate	Cmammal		Cmammal				prey:plants			prey: invertebrates			prey: small mammals (group B)		
												plant	invertebrate	mammal		alpha	beta	gamma	alpha	beta	gamma	alpha	beta	gamma
Plutonium-238	150.00	5.487	0.011	0.002	3.00E-04			4.50E-02	0.00E+00	0.00E+00	5.00E-04	2.25E-05	0.00E+00	0.00E+00	0.79	1.26E-04	1.27E-08	1.82E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Plutonium-239/240	4.17	5.148	0.007		3.00E-04	9.12E-03		1.25E-03	3.80E-02	0.00E+00	5.00E-04	6.26E-07	1.90E-05	0.00E+00	0.79	3.30E-06	2.24E-10	0.00E+00	1.00E-04	6.82E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-228	2.81	5.4	0.021	0.003	9.00E-04	5.00E-03	3.20E-05	2.53E-03	1.41E-02	8.99E-05	5.00E-03	1.26E-05	7.03E-05	4.50E-07	0.79	6.99E-05	1.36E-08	1.53E-09	3.88E-04	7.55E-08	8.52E-09	2.49E-06	4.63E-10	5.46E-11
Radium-224	2.81	5.674	0.002	0.01	7.50E-02	7.50E-02		2.11E-01	2.11E-01	0.00E+00	4.50E-02	9.48E-03	9.48E-03	0.00E+00	0.79	5.51E-02	9.71E-07	3.84E-06	5.51E-02	9.71E-07	3.84E-06	0.00E+00	0.00E+00	0.00E+00
Radon-220	2.81	6.288						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Polonium-216	2.81	6.779						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead-212	2.81		0.176	0.148				0.00E+00	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00	0.011	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bismuth-212	2.81	2.174	0.472	0.188	8.75E-03	2.00E-02		2.46E-02	5.62E-02	0.00E+00	2.00E-02	4.92E-04	1.12E-03	0.00E+00	0.011	1.09E-03	1.19E-05	5.15E-08	2.50E-03	2.72E-05	1.18E-07	0.00E+00	0.00E+00	0.00E+00
Polonium-212	1.80	8.785						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium-208	1.01		0.598	3.375	1.00E-03	2.00E+00		1.01E-03	2.02E+00	0.00E+00	2.00E+00	2.02E-03	4.05E+00	0.00E+00	0.01	0.00E+00	6.19E-05	3.50E-06	0.00E+00	1.24E-01	6.99E-03	0.00E+00	0.00E+00	0.00E+00
Lead-208	2.81							0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-230	7.99	4.671	0.015	0.002	9.00E-04	5.00E-03	3.20E-05	7.19E-03	4.00E-02	2.58E-04	5.00E-03	3.60E-05	2.00E-04	1.28E-06	0.79	1.72E-04	2.76E-08	2.91E-09	9.55E-04	1.53E-07	1.62E-08	6.11E-06	9.82E-10	1.03E-10
Radium-226	7.99	4.774	0.004	0.007	7.50E-02	7.50E-02		5.99E-01	5.99E-01	0.00E+00	4.50E-02	2.70E-02	2.70E-02	0.00E+00	0.79	1.32E-01	5.52E-06	7.64E-06	1.32E-01	5.52E-06	7.64E-06	0.00E+00	0.00E+00	0.00E+00
Radon-220	7.99	6.288						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Polonium-218	7.99	6.001						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead-214	7.99		0.293	0.25				0.00E+00	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00	0.01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Astatine-218	1.60E-03	6.697	0.04	0.007				0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.79	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bismuth-214	7.99		0.659	1.508	8.75E-03	2.00E-02		6.99E-02	1.60E-01	0.00E+00	2.00E-02	1.40E-03	3.20E-03	0.00E+00	0.0123	0.00E+00	4.72E-05	1.33E-06	0.00E+00	1.08E-04	3.04E-06	0.00E+00	0.00E+00	0.00E+00
Polonium-214	7.99	7.687						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium-210	1.60E-03							0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-232	1.41	3.996	0.012	0.001	9.00E-04	5.00E-03	3.20E-05	1.27E-03	7.05E-03	4.51E-05	5.00E-03	6.35E-06	3.53E-05	2.26E-07	0.79	2.60E-05	3.90E-09	2.57E-10	1.44E-04	2.17E-08	1.43E-09	9.23E-07	1.39E-10	9.13E-12
Radium-228	1.41		0.017		7.50E-02	7.50E-02		1.06E-01	1.06E-01	0.00E+00	4.50E-02	4.76E-03	4.76E-03	0.00E+00		0.00E+00	4.14E-06	0.00E+00	0.00E+00	4.14E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Actinium-228	1.41		0.475	0.971	8.75E-04	1.25E-03		1.23E-03	1.78E-03	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.0127	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tritium	79.6		0.006					0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-234	1.28	4.758	0.013	0.002	3.75E-03		3.20E-04	4.80E-03	0.00E+00	4.10E-04	1.50E-02	7.20E-05	0.00E+00	6.14E-06	0.79	3.51E-04	4.79E-08	5.82E-09	0.00E+00	0.00E+00	0.00E+00	2.99E-05	4.09E-09	4.97E-10
Uranium-235	0.27	4.398	0.049	0.156	3.75E-03		3.20E-04	1.01E-03	0.00E+00	8.64E-05	1.50E-02	1.52E-05	0.00E+00	1.30E-06	0.0115	6.84E-05	3.81E-08	1.40E-09	0.00E+00	0.00E+00	0.00E+00	5.83E-06	3.25E-09	1.19E-10
Thorium-231	0.27		0.165	0.026				0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.126	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-238	1.62	4.187	0.01	0.001	3.75E-03		3.20E-04	6.08E-03	0.00E+00	5.18E-04	1.50E-02	9.11E-05	0.00E+00	7.78E-06	0.79	3.91E-04	4.67E-08	3.69E-09	0.00E+00	0.00E+00	0.00E+00	3.33E-05	3.98E-09	3.15E-10
Thorium-234	1.62		0.06	0.009	9.00E-04	5.00E-03		1.46E-03	8.10E-03	0.00E+00	5.00E-03	7.29E-06	4.05E-05	0.00E+00	0.79	0.00E+00	2.24E-08	2.65E-09	0.00E+00	1.24E-07	1.47E-08	0.00E+00	0.00E+00	0.00E+00
Protactinium-234m	1.62				6.23E-04			1.01E-03	0.00E+00	0.00E+00	5.00E-02	5.05E-05	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total ingestion exposure from prey																1.89E-01	1.32E-04	1.64E-05	1.91E-01	1.24E-01	7.01E-03	7.86E-05	1.29E-08	1.10E-09
																5.12E-01								

Parameter		Value	Units
Ding	Internal dose rate from ingestion of contaminated prey and soil	–	mrad/day
Csoil, i	Activity of radionuclide in surface soil		pCi/.g
Cfa	Conversion factor to change MeV/mt to g mrad/pCi d	5.12E-02	–
ξi,αβγ	Energy for α,β,γ emissions by nuclide i		Me V/nt
AF	Absorption factor	–	unitless
QF	Quality factor to account for the greater biological effectiveness of α particles	20	unitless, α
QF	account for the greater biological effectiveness of α	1	unitless, β,γ

Table C-5
Internal Exposure: Ingestion of Prey
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Ding = Σ QF * Ctissue *ξi * CFa * AF
Source: Sample et al., 1997

COPC	Csoil, i pCi/g	ξi, α	ξi, β	ξi, γ	UF-herb plants	UF-invert	UF-mammal	Tissue Concentration from Soil Uptake C-plant	C-invert	Cmammal	BAFmammal	Tissue concentration from prey ingestion Cmammal plant	invert	mammal	AF-C	Dose based on prey ingestion: Mammals - Group C prey:plants alpha	beta	gamma	prey: invertebrates alpha	beta	gamma	prey: small mammals (group B) alpha	beta	gamma
Plutonium-238	150.00	5.487	0.011	0.002	3.00E-04			4.50E-02	0.00E+00	0.00E+00	5.00E-04	2.25E-05	0.00E+00	0.00E+00	0.94	1.26E-04	1.27E-08	2.17E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Plutonium-239/240	4.17	5.148	0.007		3.00E-04	9.12E-03		1.25E-03	3.80E-02	0.00E+00	5.00E-04	6.26E-07	1.90E-05	0.00E+00	0.94	3.30E-06	2.24E-10	0.00E+00	1.00E-04	6.82E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-228	2.81	5.4	0.021	0.003	9.00E-04	5.00E-03	3.20E-05	2.53E-03	1.41E-02	8.99E-05	5.00E-03	1.26E-05	7.03E-05	4.50E-07	0.94	6.99E-05	1.36E-08	1.83E-09	3.88E-04	7.55E-08	1.01E-08	2.49E-08	4.83E-10	6.49E-11
Radium-224	2.81	5.674	0.002	0.01	7.50E-02	7.50E-02		2.11E-01	2.11E-01	0.00E+00	4.50E-02	9.48E-03	9.48E-03	0.00E+00	0.29	5.51E-02	9.71E-07	1.41E-06	5.51E-02	9.71E-07	1.41E-06	0.00E+00	0.00E+00	0.00E+00
Radon-220	2.81	6.288						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Polonium-216	2.81	6.779						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead-212	2.81		0.176	0.148				0.00E+00	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00	0.04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bismuth-212	2.81	2.174	0.472	0.186	8.75E-03	2.00E-02		2.46E-02	5.62E-02	0.00E+00	2.00E-02	4.92E-04	1.12E-03	0.00E+00	0.04	1.09E-03	1.19E-05	1.87E-07	2.50E-03	2.72E-05	4.28E-07	0.00E+00	0.00E+00	0.00E+00
Polonium-212	1.80	8.785						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium-208	1.01		0.598	3.375	1.00E-03	2.00E+00		1.01E-03	2.02E+00	0.00E+00	2.00E+00	2.02E-03	4.05E+00	0.00E+00	0.03	0.00E+00	6.19E-05	1.05E-05	0.00E+00	1.24E-01	2.10E-02	0.00E+00	0.00E+00	0.00E+00
Lead-208	2.81							0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-230	7.99	4.671	0.015	0.002	9.00E-04	5.00E-03	3.20E-05	7.19E-03	4.00E-02	2.56E-04	5.00E-03	3.60E-05	2.00E-04	1.28E-06	0.94	1.72E-04	2.76E-08	3.46E-09	9.55E-04	1.53E-07	1.92E-08	6.11E-08	9.82E-10	1.23E-10
Radium-226	7.99	4.774	0.004	0.007	7.50E-02	7.50E-02		5.99E-01	5.99E-01	0.00E+00	4.50E-02	2.70E-02	2.70E-02	0.00E+00	0.94	1.32E-01	5.52E-06	9.08E-06	1.32E-01	5.52E-06	9.08E-06	0.00E+00	0.00E+00	0.00E+00
Radon-220	7.99	6.288						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Polonium-218	7.99	6.001						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead-214	7.99		0.293	0.25				0.00E+00	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00	0.04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Astatine-218	1.60E-03	6.697	0.04	0.007				0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bismuth-214	7.99		0.659	1.508	8.75E-03	2.00E-02		6.99E-02	1.60E-01	0.00E+00	2.00E-02	1.40E-03	3.20E-03	0.00E+00	0.03	0.00E+00	4.72E-05	3.24E-06	0.00E+00	1.08E-04	7.40E-06	0.00E+00	0.00E+00	0.00E+00
Polonium-214	7.99	7.687						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium-210	1.60E-03							0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-232	1.41	3.996	0.012	0.001	9.00E-04	5.00E-03	3.20E-05	1.27E-03	7.05E-03	4.51E-05	5.00E-03	6.35E-06	3.53E-05	2.26E-07	0.94	2.60E-05	3.90E-09	3.05E-10	1.44E-04	2.17E-08	1.70E-09	9.23E-07	1.39E-10	1.09E-11
Radium-228	1.41		0.017		7.50E-02	7.50E-02		1.06E-01	1.06E-01	0.00E+00	4.50E-02	4.76E-03	4.76E-03	0.00E+00		0.00E+00	4.14E-06	0.00E+00	0.00E+00	4.14E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Actinium-228	1.41		0.475	0.971	8.75E-04	1.25E-03		1.23E-03	1.76E-03	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tritium	79.6		0.006					0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-234	1.28	4.758	0.013	0.002	3.75E-03		3.20E-04	4.80E-03	0.00E+00	4.10E-04	1.50E-02	7.20E-05	0.00E+00	6.14E-06	0.94	3.51E-04	4.79E-08	6.93E-09	0.00E+00	0.00E+00	0.00E+00	2.99E-05	4.09E-09	5.91E-10
Uranium-235	0.27	4.396	0.049	0.156	3.75E-03		3.20E-04	1.01E-03	0.00E+00	8.64E-05	1.50E-02	1.52E-05	0.00E+00	1.30E-06	0.04	6.84E-05	3.81E-08	4.85E-09	0.00E+00	0.00E+00	0.00E+00	5.83E-06	3.25E-09	4.14E-10
Thorium-231	0.27		0.165	0.026				0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-238	1.62	4.187	0.01	0.001	3.75E-03		3.20E-04	6.08E-03	0.00E+00	5.18E-04	1.50E-02	9.11E-05	0.00E+00	7.78E-06	0.94	3.91E-04	4.67E-08	4.39E-09	0.00E+00	0.00E+00	0.00E+00	3.33E-05	3.98E-09	3.74E-10
Thorium-234	1.62		0.06	0.009	9.00E-04	5.00E-03		1.46E-03	8.10E-03	0.00E+00	5.00E-03	7.29E-06	4.05E-05	0.00E+00	0.94	0.00E+00	2.24E-08	3.16E-09	0.00E+00	1.24E-07	1.75E-08	0.00E+00	0.00E+00	0.00E+00
Protactinium-234m	1.62				6.23E-04			1.01E-03	0.00E+00	0.00E+00	5.00E-02	5.05E-05	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total Ingestion Exposure from Prey																1.89E-01	1.32E-04	2.44E-05	1.91E-01	1.24E-01	2.10E-02	7.86E-05	1.29E-08	1.58E-09
																5.26E-01								

Parameter		Value	Units
Ding	Internal dose rate from ingestion of contaminated prey and soil	–	mrad/day
Csoil, i	Activity of radionuclide in surface soil		pCi/.g
Cfa	Conversion factor to change MeV/nt to g mrad/pCi d	5.12E-02	–
ξiαβγ	Energy for α,β,γ emissions by nuclide i		Me V/nt
AF	Absorption factor	–	unitless
QF	Quality factor to account for the greater biological effectiveness of α particles	20	unitless, α
QF	account for the greater biological effectiveness of α	1	unitless, β,γ

Table C-6
Internal Exposure: Ingestion of Prey
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Ding = Σ QF * Ctissue *ξj * CFa * AF
Source: Sample et al., 1997

COPC	Csoil, I pCi/g	ξj, α	ξj, β	ξj, γ	UF-herb plants	UF-invert	UF-mammal	Tissue Concentration from Soil Uptake: C-plant	C-invert	Cmammal	BAFmammal	Tissue concentration from prey ingestion: Cmammal: plant	invertebrate	mammal	AF-D	Dose based on prey ingestion: Mammals - Group D: prey:plants: alpha	beta	gamma	prey: invertebrates: alpha	beta	gamma	prey: small mammals (group B): alpha	beta	gamma
Plutonium-238	150.00	5.487	0.011	0.002	3.00E-04			4.50E-02	0.00E+00	0.00E+00	5.00E-04	2.25E-05	0.00E+00	0.00E+00	0.94	0.00012642	1.2672E-08	2.1658E-09	0	0	0	0	0	0
Plutonium-239/240	4.17	5.148	0.007		3.00E-04	9.12E-03		1.25E-03	3.80E-02	0.00E+00	5.00E-04	6.26E-07	1.90E-05	0.00E+00	0.94	3.30E-06	2.24E-10	0.00E+00	1.00E-04	6.82E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-228	2.81	5.4	0.021	0.003	9.00E-04	5.00E-03	3.20E-05	2.53E-03	1.41E-02	8.99E-05	5.00E-03	1.26E-05	7.03E-05	4.50E-07	0.94	6.99E-05	1.36E-08	1.83E-09	3.88E-04	7.55E-08	1.01E-08	2.49E-06	4.83E-10	6.49E-11
Radium-224	2.81	5.674	0.002	0.01	7.50E-02	7.50E-02		2.11E-01	2.11E-01	0.00E+00	4.50E-02	9.48E-03	9.48E-03	0.00E+00	0.35	5.51E-02	9.71E-07	1.70E-06	5.51E-02	9.71E-07	1.70E-06	0.00E+00	0.00E+00	0.00E+00
Radon-220	2.81	6.288						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Polonium-216	2.81	6.779						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead-212	2.81		0.176	0.148				0.00E+00	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00	0.06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bismuth-212	2.81	2.174	0.472	0.166	8.75E-03	2.00E-02		2.46E-02	5.62E-02	0.00E+00	2.00E-02	4.92E-04	1.12E-03	0.00E+00	0.06	1.09E-03	1.19E-05	2.81E-07	2.50E-03	2.72E-05	6.42E-07	0.00E+00	0.00E+00	0.00E+00
Polonium-212	1.80	8.785						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium-208	1.01		0.598	3.375	1.00E-03	2.00E+00		1.01E-03	2.02E+00	0.00E+00	2.00E+00	2.02E-03	4.05E+00	0.00E+00	0.04	0.00E+00	6.19E-05	1.40E-05	0.00E+00	1.24E-01	2.80E-02	0.00E+00	0.00E+00	0.00E+00
Lead-208	2.81							0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-230	7.99	4.671	0.015	0.002	9.00E-04	5.00E-03	3.20E-05	7.19E-03	4.00E-02	2.56E-04	5.00E-03	3.60E-05	2.00E-04	1.28E-06	0.94	1.72E-04	2.76E-08	3.46E-09	9.55E-04	1.53E-07	1.92E-08	6.11E-06	9.82E-10	1.23E-10
Radium-226	7.99	4.774	0.004	0.007	7.50E-02	7.50E-02		5.99E-01	5.99E-01	0.00E+00	4.50E-02	2.70E-02	2.70E-02	0.00E+00	0.94	1.32E-01	5.52E-06	9.08E-06	1.32E-01	5.52E-06	9.08E-06	0.00E+00	0.00E+00	0.00E+00
Radon-220	7.99	6.288						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Polonium-218	7.99	6.001						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead-214	7.99		0.293	0.25				0.00E+00	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00	0.06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Astatine-218	1.60E-03	6.697	0.04	0.007				0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bismuth-214	7.99		0.659	1.508	8.75E-03	2.00E-02		6.99E-02	1.60E-01	0.00E+00	2.00E-02	1.40E-03	3.20E-03	0.00E+00	0.05	0.00E+00	4.72E-05	5.40E-06	0.00E+00	1.08E-04	1.23E-05	0.00E+00	0.00E+00	0.00E+00
Polonium-214	7.99	7.687						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium-210	1.60E-03							0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-232	1.41	3.996	0.012	0.001	9.00E-04	5.00E-03	3.20E-05	1.27E-03	7.05E-03	4.51E-05	5.00E-03	6.35E-06	3.53E-05	2.26E-07	0.94	2.60E-05	3.90E-09	3.05E-10	1.44E-04	2.17E-08	1.70E-09	9.23E-07	1.39E-10	1.09E-11
Radium-228	1.41		0.017		7.50E-02	7.50E-02		1.06E-01	1.06E-01	0.00E+00	4.50E-02	4.76E-03	4.76E-03	0.00E+00		0.00E+00	4.14E-06	0.00E+00	0.00E+00	4.14E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Actinium-228	1.41		0.475	0.971	8.75E-04	1.25E-03		1.23E-03	1.76E-03	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tritium	79.6		0.006					0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-234	1.28	4.758	0.013	0.002	3.75E-03		3.20E-04	4.80E-03	0.00E+00	4.10E-04	1.50E-02	7.20E-05	0.00E+00	6.14E-06	0.94	3.51E-04	4.79E-08	6.93E-09	0.00E+00	0.00E+00	0.00E+00	2.99E-05	4.09E-09	5.91E-10
Uranium-235	0.27	4.398	0.049	0.158	3.75E-03		3.20E-04	1.01E-03	0.00E+00	8.64E-05	1.50E-02	1.52E-05	0.00E+00	1.30E-06	0.06	6.84E-05	3.81E-08	7.28E-09	0.00E+00	0.00E+00	0.00E+00	5.83E-06	3.25E-09	6.21E-10
Thorium-231	0.27		0.165	0.026				0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-238	1.62	4.187	0.01	0.001	3.75E-03		3.20E-04	6.08E-03	0.00E+00	5.18E-04	1.50E-02	9.11E-05	0.00E+00	7.78E-06	0.94	3.91E-04	4.67E-08	4.39E-09	0.00E+00	0.00E+00	0.00E+00	3.33E-05	3.98E-09	3.74E-10
Thorium-234	1.62		0.06	0.009	9.00E-04	5.00E-03		1.46E-03	8.10E-03	0.00E+00	5.00E-03	7.29E-06	4.05E-05	0.00E+00	0.94	0.00E+00	2.24E-08	3.16E-09	0.00E+00	1.24E-07	1.75E-08	0.00E+00	0.00E+00	0.00E+00
Protactinium-234m	1.62				6.23E-04			1.01E-03	0.00E+00	0.00E+00	5.00E-02	5.05E-05	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total Ingestion Exposure from Prey																1.89E-01 5.33E-01	1.32E-04	3.05E-05	1.91E-01	1.24E-01	2.80E-02	7.86E-05	1.29E-08	1.79E-09

Parameter		Value	Units
Ding	Internal dose rate from ingestion of contaminated prey and soil	--	mrad/day
Csoil, I	Activity of radionuclide in surface soil		pCi/g
Cfa	Conversion factor to change MeV/nt to g mrad/pCi d	5.12E-02	--
ξj,αβγ	Energy for α,β,γ emissions by nuclide I		Me V/nt
AF	Absorption factor	--	unitless
QF	Quality factor to account for the greater biological effectiveness of α particles	20	unitless, α
QF	Quality factor to account for the greater biological effectiveness of α particles	1	unitless, β,γ

Table C-7
Internal Exposure: Ingestion of Prey
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Ding = Σ QF * Ctissue *ξi * CFa * AF
Source: Sample et al., 1997

COPC	Csoil, i pCi/g	ξi, α	ξi, β	ξi, γ	UF-herb plants	UF-invert	UF-mammal	Tissue Concentration from Soil Uptake			BAFmammal	Tissue concentration from prey ingestion			AF-E	Dose based on prey ingestion: Mammals - Group E								
								C-plant	C-invert	Cmammal		Cmammal				prey:plants			prey: invertebrates			prey: small mammals (group B)		
												plant	invert	mammal		alpha	beta	gamma	alpha	beta	gamma	alpha	beta	gamma
Plutonium-238	150.00	5.487	0.011	0.002	3.00E-04			4.50E-02	0.00E+00	0.00E+00	5.00E-04	2.25E-05	0.00E+00	0.00E+00	0.94	1.26E-04	1.27E-08	2.17E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Plutonium-239/240	4.17	5.148	0.007		3.00E-04	9.12E-03		1.25E-03	3.80E-02	0.00E+00	5.00E-04	6.26E-07	1.90E-05	0.00E+00	0.94	3.30E-06	2.24E-10	0.00E+00	1.00E-04	6.82E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-228	2.81	5.4	0.021	0.003	9.00E-04	5.00E-03	3.20E-05	2.53E-03	1.41E-02	8.99E-05	5.00E-03	1.26E-05	7.03E-05	4.50E-07	0.94	6.99E-05	1.36E-08	1.83E-09	3.88E-04	7.55E-08	1.01E-08	2.49E-06	4.83E-10	6.49E-11
Radium-224	2.81	5.674	0.002	0.01	7.50E-02	7.50E-02		2.11E-01	2.11E-01	0.00E+00	4.50E-02	9.48E-03	9.48E-03	0.00E+00	0.52	5.51E-02	9.71E-07	2.52E-06	5.51E-02	9.71E-07	2.52E-08	0.00E+00	0.00E+00	0.00E+00
Radon-220	2.81	6.288						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Polonium-216	2.81	6.779						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead-212	2.81		0.176	0.148				0.00E+00	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00	0.15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bismuth-212	2.81	2.174	0.472	0.186	8.75E-03	2.00E-02		2.46E-02	5.62E-02	0.00E+00	2.00E-02	4.92E-04	1.12E-03	0.00E+00	0.14	1.09E-03	1.19E-05	6.56E-07	2.50E-03	2.72E-05	1.50E-08	0.00E+00	0.00E+00	0.00E+00
Polonium-212	1.80	8.785						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium-208	1.01		0.598	3.375	1.00E-03	2.00E+00		1.01E-03	2.02E+00	0.00E+00	2.00E+00	2.02E-03	4.05E+00	0.00E+00	0.11	0.00E+00	6.19E-05	3.85E-05	0.00E+00	1.24E-01	7.69E-02	0.00E+00	0.00E+00	0.00E+00
Lead-208	2.81							0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-230	7.99	4.671	0.015	0.002	9.00E-04	5.00E-03	3.20E-05	7.19E-03	4.00E-02	2.56E-04	5.00E-03	3.60E-05	2.00E-04	1.28E-06	0.94	1.72E-04	2.76E-08	3.46E-09	9.55E-04	1.53E-07	1.92E-08	6.11E-06	9.82E-10	1.23E-10
Radium-226	7.99	4.774	0.004	0.007	7.50E-02	7.50E-02		5.99E-01	5.99E-01	0.00E+00	4.50E-02	2.70E-02	2.70E-02	0.00E+00	0.94	1.32E-01	5.52E-06	9.08E-06	1.32E-01	5.52E-06	9.08E-06	0.00E+00	0.00E+00	0.00E+00
Radon-220	7.99	6.288						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Polonium-218	7.99	6.001						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead-214	7.99		0.293	0.25				0.00E+00	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00	0.14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Astatine-218	1.60E-03	6.697	0.04	0.007				0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bismuth-214	7.99		0.659	1.508	8.75E-03	2.00E-02		6.99E-02	1.60E-01	0.00E+00	2.00E-02	1.40E-03	3.20E-03	0.00E+00	0.12	0.00E+00	4.72E-05	1.30E-05	0.00E+00	1.08E-04	2.96E-05	0.00E+00	0.00E+00	0.00E+00
Polonium-214	7.99	7.687						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium-210	1.60E-03							0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-232	1.41	3.996	0.012	0.001	9.00E-04	5.00E-03	3.20E-05	1.27E-03	7.05E-03	4.51E-05	5.00E-03	6.35E-06	3.53E-05	2.26E-07	0.94	2.60E-05	3.90E-09	3.05E-10	1.44E-04	2.17E-08	1.70E-09	9.23E-07	1.39E-10	1.09E-11
Radium-228	1.41		0.017		7.50E-02	7.50E-02		1.06E-01	1.06E-01	0.00E+00	4.50E-02	4.76E-03	4.76E-03	0.00E+00		0.00E+00	4.14E-06	0.00E+00	0.00E+00	4.14E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Actinium-228	1.41		0.475	0.971	8.75E-04	1.25E-03		1.23E-03	1.76E-03	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tritium	79.6		0.006					0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-234	1.28	4.758	0.013	0.002	3.75E-03		3.20E-04	4.80E-03	0.00E+00	4.10E-04	1.50E-02	7.20E-05	0.00E+00	6.14E-08	0.94	3.51E-04	4.79E-08	6.93E-09	0.00E+00	0.00E+00	0.00E+00	2.99E-05	4.09E-09	5.91E-10
Uranium-235	0.27	4.396	0.049	0.156	3.75E-03		3.20E-04	1.01E-03	0.00E+00	8.64E-05	1.50E-02	1.52E-05	0.00E+00	1.30E-06	0.14	6.84E-05	3.81E-08	1.70E-08	0.00E+00	0.00E+00	0.00E+00	5.83E-06	3.25E-09	1.45E-09
Thorium-231	0.27		0.165	0.026				0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.36	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-238	1.62	4.187	0.01	0.001	3.75E-03		3.20E-04	6.08E-03	0.00E+00	5.18E-04	1.50E-02	9.11E-05	0.00E+00	7.78E-06	0.94	3.91E-04	4.67E-08	4.39E-09	0.00E+00	0.00E+00	0.00E+00	3.33E-05	3.98E-09	3.74E-10
Thorium-234	1.62		0.06	0.009	9.00E-04	5.00E-03		1.46E-03	8.10E-03	0.00E+00	5.00E-03	7.29E-06	4.05E-05	0.00E+00	0.94	0.00E+00	2.24E-08	3.16E-09	0.00E+00	1.24E-07	1.75E-08	0.00E+00	0.00E+00	0.00E+00
Protactinium-234m	1.62				6.23E-04			1.01E-03	0.00E+00	0.00E+00	5.00E-02	5.05E-05	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total Ingestion Exposure from Prey																1.89E-01	1.32E-04	6.37E-05	1.91E-01	1.24E-01	7.70E-02	7.86E-05	1.29E-08	2.61E-09
																5.82E-01								

Parameter		Value	Units
Ding	Internal dose rate from ingestion of contaminated prey and soil	--	mrad/day
Csoil, i	Activity of radionuclide in surface soil		pCi/g
Cfa	Conversion factor to change MeV/nt to g mrad/pCi d	5.12E-02	--
ξi,αβγ	Energy for α,β,γ emissions by nuclide i		Me V/nt
AF	Absorption factor	--	unitless
QF	Quality factor to account for the greater biological effectiveness of α particles	20	unitless, α
QF	account for the greater biological effectiveness of α	1	unitless, β,γ

Table C-8
Internal Exposure: Ingestion of Prey
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Ding = Σ QF * Ctissue *ξi * CFa * AF
Source: Sample et al., 1997

COPC	Csoil, i pCi/g	ξi, α	ξi, β	ξi, γ	UF-herb plants	UF-invert	UF-mammal	Tissue Concentration from Soil Uptake			BAFbird	Tissue concentration from prey ingestion			AF-B	Dose based on prey ingestion: Birds - Group B								
								C-plant	C-invert	Cmammal		C-bird				prey:plants			prey: invertebrates			prey: small mammals (group B)		
												plant	invert	mammal		a	b	g	a	b	g	a	b	g
Plutonium-238	150.00	5.487	0.011	0.002	3.00E-04			4.50E-02	0.00E+00	0.00E+00	2.10E-03	9.45E-05	0.00E+00	0.00E+00	0.79	5.31E-04	5.32E-08	7.64E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Plutonium-239/240	4.17	5.148	0.007		3.00E-04	9.12E-03		1.25E-03	3.80E-02	0.00E+00	2.10E-03	2.63E-06	7.99E-05	0.00E+00	0.79	1.38E-05	9.42E-10	0.00E+00	4.21E-04	2.86E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-228	2.81	5.4	0.021	0.003	9.00E-04	5.00E-03	3.20E-05	2.53E-03	1.41E-02	8.99E-05	5.00E-03	1.26E-05	7.03E-05	4.50E-07	0.79	6.99E-05	1.36E-08	1.53E-09	3.88E-04	7.55E-08	8.52E-09	2.49E-08	4.83E-10	5.46E-11
Radium-224	2.81	5.674	0.002	0.01	7.50E-02	7.50E-02		2.11E-01	2.11E-01	0.00E+00	4.50E-02	9.48E-03	9.48E-03	0.00E+00	0.79	5.51E-02	9.71E-07	3.84E-06	5.51E-02	9.71E-07	3.84E-06	0.00E+00	0.00E+00	0.00E+00
Radon-220	2.81	6.288						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Polonium-216	2.81	6.779						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead-212	2.81		0.176	0.148				0.00E+00	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00	0.011	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bismuth-212	2.81	2.174	0.472	0.186	8.75E-03	2.00E-02		2.46E-02	5.62E-02	0.00E+00	2.00E-02	4.92E-04	1.12E-03	0.00E+00	0.011	1.09E-03	1.19E-05	5.15E-08	2.50E-03	2.72E-05	1.18E-07	0.00E+00	0.00E+00	0.00E+00
Polonium-212	1.80	8.785						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium-208	1.01		0.598	3.375	1.00E-03	2.00E+00		1.01E-03	2.02E+00	0.00E+00	2.00E+00	2.02E-03	4.05E+00	0.00E+00	0.01	0.00E+00	6.19E-05	3.50E-06	0.00E+00	1.24E-01	6.99E-03	0.00E+00	0.00E+00	0.00E+00
Lead-208	2.81							0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-230	7.99	4.671	0.015	0.002	9.00E-04	5.00E-03	3.20E-05	7.19E-03	4.00E-02	2.56E-04	5.00E-03	3.60E-05	2.00E-04	1.28E-06	0.79	1.72E-04	2.76E-08	2.91E-09	9.55E-04	1.53E-07	1.62E-08	6.11E-06	9.82E-10	1.03E-10
Radium-226	7.99	4.774	0.004	0.007	7.50E-02	7.50E-02		5.99E-01	5.99E-01	0.00E+00	4.50E-02	2.70E-02	2.70E-02	0.00E+00	0.79	1.32E-01	5.52E-06	7.64E-06	1.32E-01	5.52E-06	7.64E-06	0.00E+00	0.00E+00	0.00E+00
Radon-220	7.99	6.288						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Polonium-218	7.99	6.001						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead-214	7.99		0.293	0.25				0.00E+00	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00	0.01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Astatine-218	1.60E-03	6.697	0.04	0.007				0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.79	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bismuth-214	7.99		0.659	1.508	8.75E-03	2.00E-02		6.99E-02	1.60E-01	0.00E+00	2.00E-02	1.40E-03	3.20E-03	0.00E+00	0.0123	0.00E+00	4.72E-05	1.33E-06	0.00E+00	1.08E-04	3.04E-06	0.00E+00	0.00E+00	0.00E+00
Polonium-214	7.99	7.687						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium-210	1.60E-03							0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-232	1.41	3.996	0.012	0.001	9.00E-04	5.00E-03	3.20E-05	1.27E-03	7.05E-03	4.51E-05	5.00E-03	6.35E-06	3.53E-05	2.26E-07	0.79	2.60E-05	3.90E-09	2.57E-10	1.44E-04	2.17E-08	1.43E-09	9.23E-07	1.39E-10	9.13E-12
Radium-228	1.41		0.017		7.50E-02	7.50E-02		1.06E-01	1.06E-01	0.00E+00	4.50E-02	4.76E-03	4.76E-03	0.00E+00		0.00E+00	4.14E-06	0.00E+00	0.00E+00	4.14E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Actinium-228	1.41		0.475	0.971	8.75E-04	1.25E-03		1.23E-03	1.76E-03	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.0127	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tritium	79.6		0.006					0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-234	1.28	4.758	0.013	0.002	3.75E-03		3.20E-04	4.80E-03	0.00E+00	4.10E-04	7.00E-01	3.36E-03	0.00E+00	2.87E-04	0.79	1.64E-02	2.24E-06	2.72E-07	0.00E+00	0.00E+00	0.00E+00	1.40E-03	1.91E-07	2.32E-08
Uranium-235	0.27	4.396	0.049	0.156	3.75E-03		3.20E-04	1.01E-03	0.00E+00	8.64E-05	7.00E-01	7.09E-04	0.00E+00	6.05E-05	0.0115	3.19E-03	1.78E-06	6.51E-08	0.00E+00	0.00E+00	0.00E+00	2.72E-04	1.52E-07	5.56E-09
Thorium-231	0.27		0.165	0.026				0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.126	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-238	1.62	4.187	0.01	0.001	3.75E-03		3.20E-04	6.08E-03	0.00E+00	5.18E-04	7.00E-01	4.25E-03	0.00E+00	3.63E-04	0.79	1.82E-02	2.18E-06	1.72E-07	0.00E+00	0.00E+00	0.00E+00	1.56E-03	1.86E-07	1.47E-08
Thorium-234	1.62		0.06	0.009	9.00E-04	5.00E-03		1.46E-03	8.10E-03	0.00E+00	5.00E-03	7.29E-06	4.05E-05	0.00E+00	0.79	0.00E+00	2.24E-08	2.65E-09	0.00E+00	1.24E-07	1.47E-08	0.00E+00	0.00E+00	0.00E+00
Protactinium-234m	1.62				6.23E-04			1.01E-03	0.00E+00	0.00E+00	5.00E-02	5.05E-05	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total Ingestion Exposure from Prey																2.27E-01	1.38E-04	1.69E-05	1.91E-01	1.24E-01	7.01E-03	3.23E-03	5.30E-07	4.36E-08
																5.52E-01								

Parameter	Definition	Value	Units
Ding	Internal dose rate from ingestion of contaminated prey and soil	--	mrad/day
Csoil, i	Activity of radionuclide in surface soil		pCi/g
Cfa	Conversion factor to change MeV/nt to g mrad/pCi d	5.12E-02	--
ξi,αβγ	Energy for α,β,γ emissions by nuclide i		Me V/nt
AF	Absorption factor	--	unitless
QF	Quality factor to account for the greater biological effectiveness of α particles	20	unitless, α
QF	account for the greater biological effectiveness of α	1	unitless, β,γ

Table C-9
Internal Exposure: Ingestion of Prey
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Ding = Σ QF * Cissue *ξi * CFa * AF
Source: Sample et al., 1997

COPC	Csoil, i pCi/g	ξi, α	ξi, β	ξi, γ	UF-herb plants	UF-invert	UF-mammal	Tissue Concentration from Soil Uptake C-plant	C-invert	Cmammal	BAFbird	Tissue concentration from prey ingestion C-bird plant	invert	mammal	AF-C	Dose based on prey ingestion: Birds - Group C prey:plants alpha	beta	gamma	prey: invertebrates alpha	beta	gamma	prey: small mammals (group B) alpha	beta	gamma
Plutonium-238	150.00	5.487	0.011	0.002	3.00E-04			4.50E-02	0.00E+00	0.00E+00	2.10E-03	9.45E-05	0.00E+00	0.00E+00	0.94	5.31E-04	5.32E-08	9.10E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Plutonium-239/240	4.17	5.148	0.007		3.00E-04	9.12E-03		1.25E-03	3.80E-02	0.00E+00	2.10E-03	2.63E-06	7.99E-05	0.00E+00	0.94	1.38E-05	9.42E-10	0.00E+00	4.21E-04	2.86E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-228	2.81	5.4	0.021	0.003	9.00E-04	5.00E-03	3.20E-05	2.53E-03	1.41E-02	8.99E-05	5.00E-03	1.26E-05	7.03E-05	4.50E-07	0.94	6.99E-05	1.36E-08	1.83E-09	3.88E-04	7.55E-08	1.01E-08	2.49E-06	4.83E-10	6.49E-11
Radium-224	2.81	5.674	0.002	0.01	7.50E-02	7.50E-02		2.11E-01	2.11E-01	0.00E+00	4.50E-02	9.48E-03	9.48E-03	0.00E+00	0.29	5.51E-02	9.71E-07	1.41E-06	5.51E-02	9.71E-07	1.41E-06	0.00E+00	0.00E+00	0.00E+00
Radon-220	2.81	6.288						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Polonium-216	2.81	6.779						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead-212	2.81		0.178	0.148				0.00E+00	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00	0.04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bismuth-212	2.81	2.174	0.472	0.186	8.75E-03	2.00E-02		2.46E-02	5.62E-02	0.00E+00	2.00E-02	4.92E-04	1.12E-03	0.00E+00	0.04	1.09E-03	1.19E-05	1.87E-07	2.50E-03	2.72E-05	4.28E-07	0.00E+00	0.00E+00	0.00E+00
Polonium-212	1.80	8.785						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium-208	1.01		0.598	3.375	1.00E-03	2.00E+00		1.01E-03	2.02E+00	0.00E+00	2.00E+00	2.02E-03	4.05E+00	0.00E+00	0.03	0.00E+00	6.19E-05	1.05E-05	0.00E+00	1.24E-01	2.10E-02	0.00E+00	0.00E+00	0.00E+00
Lead-208	2.81							0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-230	7.99	4.671	0.015	0.002	9.00E-04	5.00E-03	3.20E-05	7.19E-03	4.00E-02	2.56E-04	5.00E-03	3.60E-05	2.00E-04	1.28E-06	0.94	1.72E-04	2.76E-08	3.46E-09	9.55E-04	1.53E-07	1.92E-08	8.11E-06	9.82E-10	1.23E-10
Radium-226	7.99	4.774	0.004	0.007	7.50E-02	7.50E-02		5.99E-01	5.99E-01	0.00E+00	4.50E-02	2.70E-02	2.70E-02	0.00E+00	0.94	1.32E-01	5.52E-06	9.08E-06	1.32E-01	5.52E-06	9.08E-06	0.00E+00	0.00E+00	0.00E+00
Radon-220	7.99	6.288						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Polonium-218	7.99	6.001						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead-214	7.99		0.293	0.25				0.00E+00	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00	0.04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Astatine-218	1.60E-03	6.697	0.04	0.007				0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bismuth-214	7.99		0.659	1.508	8.75E-03	2.00E-02		6.99E-02	1.60E-01	0.00E+00	2.00E-02	1.40E-03	3.20E-03	0.00E+00	0.03	0.00E+00	4.72E-05	3.24E-06	0.00E+00	1.08E-04	7.40E-06	0.00E+00	0.00E+00	0.00E+00
Polonium-214	7.99	7.687						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium-210	1.60E-03							0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-232	1.41	3.998	0.012	0.001	9.00E-04	5.00E-03	3.20E-05	1.27E-03	7.05E-03	4.51E-05	5.00E-03	6.35E-06	3.53E-05	2.26E-07	0.94	2.60E-05	3.90E-09	3.05E-10	1.44E-04	2.17E-08	1.70E-09	9.23E-07	1.39E-10	1.09E-11
Radium-228	1.41		0.017		7.50E-02	7.50E-02		1.06E-01	1.06E-01	0.00E+00	4.50E-02	4.76E-03	4.76E-03	0.00E+00		0.00E+00	4.14E-06	0.00E+00	0.00E+00	4.14E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Actinium-228	1.41		0.475	0.971	8.75E-04	1.25E-03		1.23E-03	1.78E-03	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tritium	79.8		0.006					0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-234	1.28	4.758	0.013	0.002	3.75E-03		3.20E-04	4.80E-03	0.00E+00	4.10E-04	7.00E-01	3.36E-03	0.00E+00	2.87E-04	0.94	1.64E-02	2.24E-06	3.23E-07	0.00E+00	0.00E+00	0.00E+00	1.40E-03	1.91E-07	2.76E-08
Uranium-235	0.27	4.396	0.049	0.156	3.75E-03		3.20E-04	1.01E-03	0.00E+00	8.64E-05	7.00E-01	7.09E-04	0.00E+00	6.05E-05	0.04	3.19E-03	1.78E-06	2.26E-07	0.00E+00	0.00E+00	0.00E+00	2.72E-04	1.52E-07	1.93E-08
Thorium-231	0.27		0.165	0.028				0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-238	1.62	4.187	0.01	0.001	3.75E-03		3.20E-04	6.08E-03	0.00E+00	5.18E-04	7.00E-01	4.25E-03	0.00E+00	3.63E-04	0.94	1.82E-02	2.18E-06	2.05E-07	0.00E+00	0.00E+00	0.00E+00	1.56E-03	1.86E-07	1.75E-08
Thorium-234	1.62		0.06	0.009	9.00E-04	5.00E-03		1.46E-03	8.10E-03	0.00E+00	5.00E-03	7.29E-06	4.05E-05	0.00E+00	0.94	0.00E+00	2.24E-08	3.16E-09	0.00E+00	1.24E-07	1.75E-08	0.00E+00	0.00E+00	0.00E+00
Protactinium-234m	1.62				6.23E-04			1.01E-03	0.00E+00	0.00E+00	5.00E-02	5.05E-05	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total Ingestion Exposure from Prey																2.27E-01 5.66E-01	1.38E-04	2.52E-05	1.91E-01	1.24E-01	2.10E-02	3.23E-03	5.30E-07	6.46E-08

Parameter		Value	Units
Ding	Internal dose rate from ingestion of contaminated prey and soil	--	mrad/day
Csoil, i	Activity of radionuclide in surface soil		pCi/g
Cfa	Conversion factor to change MeV/nt to g mrad/pCi d	5.12E-02	--
ξi,αβγ	Energy for α,β,γ emissions by nuclide i		Me V/nt
AF	Absorption factor	--	unitless
QF	Quality factor to account for the greater biological effectiveness of α particles	20	unitless, α
QF	account for the greater biological effectiveness of α	1	unitless, β,γ

Table C-10
Internal Exposure: Ingestion of Prey
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Ding = Σ QF * Ctissue *ξi * CFa * AF
Source: Sample et al., 1997

COPC	Csoil, i pCi/g	ξi, α	ξi, β	ξi, γ	UF-herb plants	UF-invert	UF-mammal	Tissue Concentration from Soil Uptake			BAFbird	Tissue concentration from prey ingestion			AF-D	Dose based on prey ingestion: Birds - Group D								
								C-plant	C-invert	Cmammal		C-bird				prey:plants			prey: invertebrates			prey: small mammals (group B)		
												plant	invert	mammal		alpha	beta	gamma	alpha	beta	gamma	alpha	beta	bamma
Plutonium-238	150.00	5.487	0.011	0.002	3.00E-04			4.50E-02	0.00E+00	0.00E+00	2.10E-03	9.45E-05	0.00E+00	0.00E+00	0.94	5.31E-04	5.32E-08	9.10E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Plutonium-239/240	4.17	5.148	0.007		3.00E-04	9.12E-03		1.25E-03	3.80E-02	0.00E+00	2.10E-03	2.63E-06	7.99E-05	0.00E+00	0.94	1.38E-05	9.42E-10	0.00E+00	4.21E-04	2.86E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-228	2.81	5.4	0.021	0.003	9.00E-04	5.00E-03	3.20E-05	2.53E-03	1.41E-02	8.99E-05	5.00E-03	1.28E-05	7.03E-05	4.50E-07	0.94	6.99E-05	1.36E-08	1.83E-09	3.88E-04	7.55E-08	1.01E-08	2.49E-06	4.83E-10	6.49E-11
Radium-224	2.81	5.674	0.002	0.01	7.50E-02	7.50E-02		2.11E-01	2.11E-01	0.00E+00	4.50E-02	9.48E-03	9.48E-03	0.00E+00	0.35	5.51E-02	9.71E-07	1.70E-08	5.51E-02	9.71E-07	1.70E-08	0.00E+00	0.00E+00	0.00E+00
Radon-220	2.81	6.288						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Polonium-216	2.81	6.779						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead-212	2.81		0.176	0.148				0.00E+00	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00	0.06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bismuth-212	2.81	2.174	0.472	0.186	8.75E-03	2.00E-02		2.46E-02	5.62E-02	0.00E+00	2.00E-02	4.92E-04	1.12E-03	0.00E+00	0.06	1.09E-03	1.19E-05	2.81E-07	2.50E-03	2.72E-05	6.42E-07	0.00E+00	0.00E+00	0.00E+00
Polonium-212	1.80	8.785						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium-208	1.01		0.598	3.375	1.00E-03	2.00E+00		1.01E-03	2.02E+00	0.00E+00	2.00E+00	2.02E-03	4.05E+00	0.00E+00	0.04	0.00E+00	6.19E-05	1.40E-05	0.00E+00	1.24E-01	2.80E-02	0.00E+00	0.00E+00	0.00E+00
Lead-208	2.81							0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-230	7.99	4.671	0.015	0.002	9.00E-04	5.00E-03	3.20E-05	7.19E-03	4.00E-02	2.56E-04	5.00E-03	3.60E-05	2.00E-04	1.28E-06	0.94	1.72E-04	2.76E-08	3.46E-09	9.55E-04	1.53E-07	1.92E-08	6.11E-06	9.82E-10	1.23E-10
Radium-226	7.99	4.774	0.004	0.007	7.50E-02	7.50E-02		5.99E-01	5.99E-01	0.00E+00	4.50E-02	2.70E-02	2.70E-02	0.00E+00	0.94	1.32E-01	5.52E-08	9.08E-06	1.32E-01	5.52E-08	9.08E-06	0.00E+00	0.00E+00	0.00E+00
Radon-220	7.99	6.288						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Polonium-218	7.99	6.001						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead-214	7.99		0.293	0.25				0.00E+00	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00	0.06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Astatine-218	1.60E-03	6.697	0.04	0.007				0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bismuth-214	7.99		0.659	1.508	8.75E-03	2.00E-02		6.99E-02	1.60E-01	0.00E+00	2.00E-02	1.40E-03	3.20E-03	0.00E+00	0.05	0.00E+00	4.72E-05	5.40E-08	0.00E+00	1.08E-04	1.23E-05	0.00E+00	0.00E+00	0.00E+00
Polonium-214	7.99	7.687						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium-210	1.60E-03							0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-232	1.41	3.996	0.012	0.001	9.00E-04	5.00E-03	3.20E-05	1.27E-03	7.05E-03	4.51E-05	5.00E-03	6.35E-06	3.53E-05	2.26E-07	0.94	2.60E-05	3.90E-09	3.05E-10	1.44E-04	2.17E-08	1.70E-09	9.23E-07	1.39E-10	1.09E-11
Radium-228	1.41		0.017		7.50E-02	7.50E-02		1.06E-01	1.06E-01	0.00E+00	4.50E-02	4.76E-03	4.76E-03	0.00E+00		0.00E+00	4.14E-08	0.00E+00	0.00E+00	4.14E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Actinium-228	1.41		0.475	0.971	8.75E-04	1.25E-03		1.23E-03	1.76E-03	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tritium	79.6		0.006					0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-234	1.28	4.758	0.013	0.002	3.75E-03		3.20E-04	4.80E-03	0.00E+00	4.10E-04	7.00E-01	3.36E-03	0.00E+00	2.87E-04	0.94	1.64E-02	2.24E-06	3.23E-07	0.00E+00	0.00E+00	0.00E+00	1.40E-03	1.91E-07	2.76E-08
Uranium-235	0.27	4.396	0.049	0.158	3.75E-03		3.20E-04	1.01E-03	0.00E+00	8.64E-05	7.00E-01	7.09E-04	0.00E+00	6.05E-05	0.06	3.19E-03	1.78E-06	3.40E-07	0.00E+00	0.00E+00	0.00E+00	2.72E-04	1.52E-07	2.90E-08
Thorium-231	0.27		0.165	0.026				0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-238	1.62	4.187	0.01	0.001	3.75E-03		3.20E-04	6.08E-03	0.00E+00	5.18E-04	7.00E-01	4.25E-03	0.00E+00	3.63E-04	0.94	1.82E-02	2.18E-06	2.05E-07	0.00E+00	0.00E+00	0.00E+00	1.56E-03	1.86E-07	1.75E-08
Thorium-234	1.62		0.06	0.009	9.00E-04	5.00E-03		1.46E-03	8.10E-03	0.00E+00	5.00E-03	7.29E-06	4.05E-05	0.00E+00	0.94	0.00E+00	2.24E-08	3.16E-09	0.00E+00	1.24E-07	1.75E-08	0.00E+00	0.00E+00	0.00E+00
Protactinium-234m	1.62				6.23E-04			1.01E-03	0.00E+00	0.00E+00	5.00E-02	5.05E-05	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total Ingestion Exposure from Prey																2.27E-01 5.73E-01	1.38E-04	3.13E-05	1.91E-01	1.24E-01	2.80E-02	3.23E-03	5.30E-07	7.42E-08

Parameter		Value	Units
Ding	Internal dose rate from ingestion of contaminated prey and soil	--	mrad/day
Csoil, i	Activity of radionuclide in surface soil		pCi/g
Cfa	Conversion factor to change MeV/nt to g mrad/pCi d	5.12E-02	--
ξi,αβγ	Energy for α,β,γ emissions by nuclide i		Me V/nt
AF	Absorption factor	--	unitless
QF	Quality factor to account for the greater biological effectiveness of α particles	20	unitless, α
QF	account for the greater biological effectiveness of α	1	unitless, β,γ

Table C-11
Internal Exposure: Ingestion of Prey
Miami-Erie Canal, Mound Plant
Miamisburg, Ohio

Ding = Σ QF * Ctissue *ξi * CFa * AF
Source: Sample et al., 1997

COPC	Csoil, i pCi/g	ξi, α	ξi, β	ξi, γ	UF-herb plants	UF-invert	UF-mammal	Tissue Concentration from Soil Uptake C-plant	C-invert	Cmammal	BAFbird	Tissue concentration from Prey Ingestion C-bird plant	invert	mammal	AF-E	Dose based on prey ingestion: Birds - Group E prey:plants a	b	g	prey: invertebrates a	b	g	prey: small mammals (group B) a	b	g
Plutonium-238	150.00	5.487	0.011	0.002	3.00E-04			4.50E-02	0.00E+00	0.00E+00	2.10E-03	9.45E-05	0.00E+00	0.00E+00	0.94	5.31E-04	5.32E-08	9.10E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Plutonium-239/240	4.17	5.148	0.007		3.00E-04	9.12E-03		1.25E-03	3.80E-02	0.00E+00	2.10E-03	2.63E-06	7.99E-05	0.00E+00	0.94	1.38E-05	9.42E-10	0.00E+00	4.21E-04	2.86E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-228	2.81	5.4	0.021	0.003	9.00E-04	5.00E-03	3.20E-05	2.53E-03	1.41E-02	8.99E-05	5.00E-03	1.26E-05	7.03E-05	4.50E-07	0.94	6.99E-05	1.36E-08	1.63E-09	3.88E-04	7.55E-08	1.01E-08	2.49E-06	4.83E-10	6.49E-11
Radium-224	2.81	5.674	0.002	0.01	7.50E-02	7.50E-02		2.11E-01	2.11E-01	0.00E+00	4.50E-02	9.48E-03	9.48E-03	0.00E+00	0.52	5.51E-02	9.71E-07	2.52E-06	5.51E-02	9.71E-07	2.52E-06	0.00E+00	0.00E+00	0.00E+00
Radon-220	2.81	6.288						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Polonium-216	2.81	6.779						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead-212	2.81		0.176	0.148				0.00E+00	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00	0.15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bismuth-212	2.81	2.174	0.472	0.186	8.75E-03	2.00E-02		2.46E-02	5.62E-02	0.00E+00	2.00E-02	4.92E-04	1.12E-03	0.00E+00	0.14	1.09E-03	1.19E-05	6.56E-07	2.50E-03	2.72E-05	1.50E-06	0.00E+00	0.00E+00	0.00E+00
Polonium-212	1.80	8.785						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium-208	1.01		0.598	3.375	1.00E-03	2.00E+00		1.01E-03	2.02E+00	0.00E+00	2.00E+00	2.02E-03	4.05E+00	0.00E+00	0.11	0.00E+00	6.19E-05	3.85E-05	0.00E+00	1.24E-01	7.69E-02	0.00E+00	0.00E+00	0.00E+00
Lead-208	2.81							0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-230	7.99	4.671	0.015	0.002	9.00E-04	5.00E-03	3.20E-05	7.19E-03	4.00E-02	2.56E-04	5.00E-03	3.60E-05	2.00E-04	1.28E-06	0.94	1.72E-04	2.76E-08	3.46E-09	9.55E-04	1.53E-07	1.92E-08	6.11E-06	9.82E-10	1.23E-10
Radium-226	7.99	4.774	0.004	0.007	7.50E-02	7.50E-02		5.99E-01	5.99E-01	0.00E+00	4.50E-02	2.70E-02	2.70E-02	0.00E+00	0.94	1.32E-01	5.52E-06	9.08E-06	1.32E-01	5.52E-06	9.08E-06	0.00E+00	0.00E+00	0.00E+00
Radon-220	7.99	6.288						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Polonium-218	7.99	6.001						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Lead-214	7.99		0.293	0.25				0.00E+00	0.00E+00	0.00E+00	2.00E-02	0.00E+00	0.00E+00	0.00E+00	0.14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Astatine-218	1.60E-03	6.697	0.04	0.007				0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.94	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Bismuth-214	7.99		0.659	1.508	8.75E-03	2.00E-02		6.99E-02	1.60E-01	0.00E+00	2.00E-02	1.40E-03	3.20E-03	0.00E+00	0.12	0.00E+00	4.72E-05	1.30E-05	0.00E+00	1.08E-04	2.96E-05	0.00E+00	0.00E+00	0.00E+00
Polonium-214	7.99	7.687						0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thallium-210	1.60E-03							0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-232	1.41	3.996	0.012	0.001	9.00E-04	5.00E-03	3.20E-05	1.27E-03	7.05E-03	4.51E-05	5.00E-03	6.35E-06	3.53E-05	2.26E-07	0.94	2.60E-05	3.90E-09	3.05E-10	1.44E-04	2.17E-08	1.70E-09	9.23E-07	1.39E-10	1.09E-11
Radium-228	1.41		0.017		7.50E-02	7.50E-02		1.06E-01	1.06E-01	0.00E+00	4.50E-02	4.76E-03	4.76E-03	0.00E+00		0.00E+00	4.14E-06	0.00E+00	0.00E+00	4.14E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Actinium-228	1.41		0.475	0.971	8.75E-04	1.25E-03		1.23E-03	1.76E-03	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tritium	79.6		0.006					0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-234	1.28	4.758	0.013	0.002	3.75E-03		3.20E-04	4.80E-03	0.00E+00	4.10E-04	7.00E-01	3.36E-03	0.00E+00	2.87E-04	0.94	1.64E-02	2.24E-08	3.23E-07	0.00E+00	0.00E+00	0.00E+00	1.40E-03	1.91E-07	2.76E-08
Uranium-235	0.27	4.396	0.049	0.158	3.75E-03		3.20E-04	1.01E-03	0.00E+00	8.64E-05	7.00E-01	7.09E-04	0.00E+00	6.05E-05	0.14	3.19E-03	1.78E-06	7.93E-07	0.00E+00	0.00E+00	0.00E+00	2.72E-04	1.52E-07	6.76E-08
Thorium-231	0.27		0.165	0.028				0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.36	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-238	1.62	4.187	0.01	0.001	3.75E-03		3.20E-04	6.08E-03	0.00E+00	5.18E-04	7.00E-01	4.25E-03	0.00E+00	3.63E-04	0.94	1.82E-02	2.18E-06	2.05E-07	0.00E+00	0.00E+00	0.00E+00	1.56E-03	1.86E-07	1.75E-08
Thorium-234	1.62		0.06	0.009	9.00E-04	5.00E-03		1.46E-03	8.10E-03	0.00E+00	5.00E-03	7.29E-06	4.05E-05	0.00E+00	0.94	0.00E+00	2.24E-08	3.16E-09	0.00E+00	1.24E-07	1.75E-08	0.00E+00	0.00E+00	0.00E+00
Protactinium-234m	1.62				6.23E-04			1.01E-03	0.00E+00	0.00E+00	5.00E-02	5.05E-05	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total Ingestion Exposure from Prey																2.27E-01 6.22E-01	1.38E-04	6.50E-05	1.91E-01	1.24E-01	7.70E-02	3.23E-03	5.30E-07	1.13E-07

Parameter	Definition	Value	Units
Ding	Internal dose rate from ingestion of contaminated prey and soil	--	mrad/day
Csoil, i	Activity of radionuclide in surface soil		pCi/g
Cfa	Conversion factor to change MeV/nt to g mrad/pCi d	5.12E-02	--
ξi,αβγ	Energy for α,β,γ emissions by nuclide i		Me V/nt
AF	Absorption factor	--	unitless
QF	Quality factor to account for the greater biological effectiveness of α particles	20	unitless, α
QF	account for the greater biological effectiveness of α	1	unitless, β,γ

APPENDIX D

LOCATIONS EXCEEDING WILDLIFE PRGs

Benzo(a)anthracene

At HQ=10, PRG = 0.288 mg/kg
EDQL = 5.21mg/kg

PRGs:		
	shrew	5.25 mg/kg
	vole	1.97 mg/kg
	robin	0.0288 mg/kg

Location_name	Value_name	Measured	Value_unit	Detection_	Data_quali	Lab_qualifi	Cas_numb	Elevation	Error_valu	Sam_type
97VN4L22	Benzo(a)anthracene	5300	UG/KG				56-55-3	707.51		Grab
97VN21L17	Benzo(a)anthracene	5700	UG/KG			D	56-55-3	694.14		Grab
97VN21L17	Benzo(a)anthracene	6500	UG/KG				56-55-3	694.14		Grab
97VN5N20	Benzo(a)anthracene	7300	UG/KG				56-55-3	700.606		Grab

Benzo(a)pyrene

At HQ=10, PRG = 0.222 mg/kg
EDQL = 1.52 mg/kg

PRGs:		
	shrew	17.9 mg/kg
	vole	14.9 mg/kg
	robin	0.0222 mg/kg

Location_name	Value_name	Measured	Value_unit	Detection_	Data_quali	Lab_qualifi	Cas_numb	Elevation	Error_valu	Sam_type
97VEWRL5	Benzo(a)pyrene	1700	UG/KG				50-32-8	690		Grab
97VN2L6	Benzo(a)pyrene	1700	UG/KG		J		50-32-8	707.67		Grab
97VS46N12	Benzo(a)pyrene	1800	UG/KG				50-32-8	698.344		Grab
97VN5L2	Benzo(a)pyrene	1800	UG/KG				50-32-8	707.14		Field Duplicate
97VN5L2	Benzo(a)pyrene	1800	UG/KG				50-32-8	707.14		Field Duplicate
97VEWRL5	Benzo(a)pyrene	2000	UG/KG			D	50-32-8	690		Grab
97VN53N1	Benzo(a)pyrene	2700	UG/KG				50-32-8	697.62		Grab
97VN53N1	Benzo(a)pyrene	2700	UG/KG			D	50-32-8	697.62		Grab
97VN6N21	Benzo(a)pyrene	2700	UG/KG				50-32-8	699.708		Grab
97VN53N1	Benzo(a)pyrene	2900	UG/KG				50-32-8	697.62		Field Duplicate
97VS1N23	Benzo(a)pyrene	3000	UG/KG				50-32-8	702.711		Grab
97VN53N1	Benzo(a)pyrene	3100	UG/KG			JD	50-32-8	697.62		Field Duplicate
97VN5L2	Benzo(a)pyrene	3600	UG/KG				50-32-8	707.14		Grab
97VN5L2	Benzo(a)pyrene	3800	UG/KG				50-32-8	707.14		Field Duplicate
97VN5L2	Benzo(a)pyrene	3800	UG/KG			D	50-32-8	707.14		Field Duplicate
97VN3L15	Benzo(a)pyrene	4000	UG/KG				50-32-8	700.31		Grab
97VN4L22	Benzo(a)pyrene	4500	UG/KG				50-32-8	707.51		Grab
97VN4L22	Benzo(a)pyrene	5200	UG/KG			D	50-32-8	707.51		Grab
97VN4L22	Benzo(a)pyrene	5400	UG/KG				50-32-8	707.51		Grab
97VN4L22	Benzo(a)pyrene	5700	UG/KG				50-32-8	707.51		Grab
97VN21L17	Benzo(a)pyrene	5800	UG/KG			D	50-32-8	694.14		Grab
97VN21L17	Benzo(a)pyrene	6600	UG/KG				50-32-8	694.14		Grab
97VN5N20	Benzo(a)pyrene	7900	UG/KG				50-32-8	700.606		Grab

Bis(2-ethylhexyl)phthalate

At HQ=10, PRG = 0.0193 mg/kg
EDQL = 0.92594 mg/kg

PRGs:		
	shrew	0.0764 mg/kg
	vole	505 mg/kg
	robin	0.00193 mg/kg

Location_name	Value_name	Measured	Value_unit	Detection_	Data_quali	Lab_qualifi	Cas_numb	Elevation	Error_valu	Sam_type
97VN35L13	Bis(2-ethylhexyl)phth	44000	UG/KG			D	117-81-7	801.8		Grab
97VN35L13	Bis(2-ethylhexyl)phth	44000	UG/KG			D	117-81-7	801.8		Grab

Chrysene

At HQ=10, PRG = 0.314 mg/kg
EDQL = 4.73 mg/kg

PRGs:		
	shrew	–
	vole	–
	robin	0.0314 mg/kg

Location_name	Value_name	Measured	Value_unit	Detection_	Data_quali	Lab_qualifi	Cas_numb	Elevation	Error_valu	Sam_type
97VN5L2	Chrysene	4900	UG/KG				218-01-9	707.14		Grab
97VN5L2	Chrysene	5200	UG/KG			D	218-01-9	707.14		Field Duplicate
97VN4L22	Chrysene	5400	UG/KG				218-01-9	707.51		Grab
97VN4L22	Chrysene	5500	UG/KG				218-01-9	707.51		Grab
97VN5L2	Chrysene	5600	UG/KG				218-01-9	707.14		Field Duplicate
97VN4L22	Chrysene	5900	UG/KG			D	218-01-9	707.51		Grab
97VN21L17	Chrysene	6100	UG/KG			D	218-01-9	694.14		Grab
97VN4L22	Chrysene	6200	UG/KG				218-01-9	707.51		Grab
97VN21L17	Chrysene	7100	UG/KG				218-01-9	694.14		Grab
97VN5N20	Chrysene	8100	UG/KG				218-01-9	700.606		Grab

Di-n-butyl Phthalate

At HQ=10, PRG = 0.00598 mg/kg
EDQL = 0.14979 mg/kg

PRGs:		
	shrew	2.19 mg/kg
	vole	2625 mg/kg
	robin	0.000598 mg/kg

Location_name	Value_name	Measured	Value_unit	Detection_	Data_quali	Lab_qualifi	Cas_numb	Elevation	Error_valu	Sam_type
97VS52L10	Di-n-butyl Phthalate	160	UG/KG			JB	84-74-2	698.29		Grab
97VN45L17	Di-n-butyl Phthalate	220	UG/KG			J	84-74-2	697.48		Grab
97VN2L6	Di-n-butyl Phthalate	240	UG/KG			J	84-74-2	707.67		Grab
97VS29N26	Di-n-butyl Phthalate	390	UG/KG			J	84-74-2	698.643		Grab
97VN52HL2	Di-n-butyl Phthalate	470	UG/KG				84-74-2	695		Grab
97VN22L6	Di-n-butyl Phthalate	550	UG/KG			B	84-74-2	697		Grab
97VN26L6	Di-n-butyl Phthalate	650	UG/KG			B	84-74-2	702.27		Grab
97VN28L21	Di-n-butyl Phthalate	780	UG/KG			B	84-74-2	710.89		Grab
97VN44L1	Di-n-butyl Phthalate	830	UG/KG				84-74-2	702.13		Grab
97VN44L1	Di-n-butyl Phthalate	920	UG/KG			D	84-74-2	702.13		Grab
97VN29L14	Di-n-butyl Phthalate	960	UG/KG			B	84-74-2	695.89		Grab
97VN36L26	Di-n-butyl Phthalate	1200	UG/KG			B	84-74-2	702.61		Grab
97VN7L13	Di-n-butyl Phthalate	1700	UG/KG				84-74-2	697.03		Grab
97VN3L15	Di-n-butyl Phthalate	2000	UG/KG				84-74-2	700.31		Grab
97VS25N33	Di-n-butyl Phthalate	2600	UG/KG				84-74-2	693.4565		Grab
97VS20N23	Di-n-butyl Phthalate	4300	UG/KG				84-74-2	695.144		Grab

Naphthalene

At HQ=10, PRG = 2.64 mg/kg
EDQL = 0.09939 mg/kg

PRGs:		
	shrew	0.910 mg/kg
	vole	14.8 mg/kg
	robin	0.264 mg/kg

No Locations

Table D-2 Inorganics

Antimony

At HQ = 10, PRG = 1.53 mg/kg
EDQI = 0.142 mg/kg
Bkg = --

PRGs:	
shrew	0.453 mg/kg
vole	0.153 mg/kg
robin	--

Location_name	Value_nam	Measured_	Value_unit	Detection_limit	Data_qualif	Lab_qualifi	Elevation	Sample_type
97VS43N24	Antimony	1.6	MG/KG			B	697.955	Grab
97VN5L2	Antimony	81.1	MG/KG				707.14	Grab

Arsenic

At HQ = 10, PRG = 109 mg/kg
EDQI = 5.7 mg/kg
Bkg = 8.6 mg/kg

PRGs:	
shrew	15.7 mg/kg
vole	10.9 mg/kg
robin	39.3 mg/kg

No Locations

Barium

At HQ = 10, PRG = 152 mg/kg
EDQI = 1.04 mg/kg
Bkg = 180 mg/kg

PRGs:	
shrew	35 mg/kg
vole	15.2 mg/kg
robin	188 mg/kg

Location_name	Value_nam	Measured_	Value_unit	Detection_limit	Data_qualif	Lab_qualifi	Elevation	Sample_type
97VRHN1	Barium	234	MG/KG				718.757	Grab

Cadmium

At HQ = 10, PRG = 13.4 mg/kg
EDQI = 0.0022 mg/kg
Bkg = 2.1 mg/kg

PRGs:	
shrew	1.7 mg/kg
vole	1.34 mg/kg
robin	3.321 mg/kg

No Locations

Chromium

At HQ = 10, PRG = 536 mg/kg
EDQI = 0.4 mg/kg
Bkg = 20 mg/kg

PRGs:	
shrew	177 mg/kg
vole	58.2 mg/kg
robin	53.6 mg/kg

No Locations

Copper

At HQ = 10, PRG = 147 mg/kg
EDQI = 0.31 mg/kg
Bkg = 26 mg/kg

PRGs:	
shrew	317 mg/kg
vole	14.7 mg/kg
robin	1475 mg/kg

No Locations

Iron

At HQ = 10, PRG = 7500 mg/kg
EDQI = -- mg/kg
Bkg = 35000 mg/kg

PRGs:	
shrew	796 mg/kg
vole	750 mg/kg
robin	--

Location_name	Value_nam	Measured_	Value_unit	Detection_limit	Data_qualif	Lab_qualifi	Elevation	Sample_type
97VS43N24	Iron	39600	MG/KG				697.955	Grab
97VN35L13	Iron	46800	MG/KG				801.8	Grab

Table D-2 Inorganics

Lead

At HQ = 10, PRG = 412 mg/kg
EDQI = 0.05 mg/kg
Bkg = 48 mg/kg

PRGs:		
	shrew	25.2 mg/kg
	vole	60.4 mg/kg
	robin	41.2 mg/kg

Location_name	Value_nam	Measured_	Value_unit	Detection_limit	Data_qualif	Lab_qualifi	Elevation	Sample_type
97VS41N2	Lead	647	MG/KG				699.047	Grab
97VS40N17	Lead	835	MG/KG				696.626	Grab
97VS43N24	Lead	8190	MG/KG				697.955	Grab

Selenium

At HQ = 10, PRG = 13.7 mg/kg
EDQI = 0.03 mg/kg
Bkg = -- mg/kg

PRGs:		
	shrew	1.37 mg/kg
	vole	2.61 mg/kg
	robin	4.50 mg/kg

No Locations

Silver

At HQ = 10, PRG = 4.59 mg/kg
EDQI = 4.04 mg/kg
Bkg = 1.7 mg/kg

PRGs:		
	shrew	2.57 mg/kg
	vole	0.459 mg/kg
	robin	1603 mg/kg

Location_name	Value_nam	Measured_	Value_unit	Detection_limit	Data_qualif	Lab_qualifi	Elevation	Sample_type
97VS19N5	Silver	11.2	MG/KG				695.333	Grab

Thallium

At HQ = 10, PRG = 0.898 mg/kg
EDQI = 0.06 mg/kg
Bkg = 0.46 mg/kg

PRGs:		
	shrew	0.0898 mg/kg
	vole	0.246 mg/kg
	robin	3.15 mg/kg

Location_name	Value_nam	Measured_	Value_unit	Detection_limit	Data_qualif	Lab_qualifi	Elevation	Sample_type
97VS5N20	Thallium	1.3	MG/KG			B	702.097	Grab
97VS29N26	Thallium	1.3	MG/KG			B	698.643	Grab
97VS10N23	Thallium	1.3	MG/KG			B	699.229	Grab
97VS23N22	Thallium	1.3	MG/KG			B	689.9637	Grab
97VRHN1	Thallium	1.4	MG/KG			B	718.757	Grab
97VS43N24	Thallium	1.4	MG/KG			B	697.955	Grab
97VS41N2	Thallium	1.4	MG/KG			B	699.047	Grab
97VN19N11	Thallium	1.4	MG/KG			B	700.702	Grab
97VS26N25	Thallium	1.5	MG/KG			B	697.905	Grab
97VS27N16	Thallium	1.5	MG/KG			B	698.46	Grab
97VS30N7	Thallium	1.6	MG/KG			B	699.038	Grab
97VS50N19	Thallium	1.6	MG/KG			B	697.174	Grab
97VS17N6	Thallium	1.7	MG/KG			B	695.407	Grab
97VS3N1	Thallium	1.7	MG/KG			B	703.009	Field Duplicate
97VS4N25	Thallium	1.8	MG/KG			B	702.919	Grab
97VS24N5	Thallium	1.8	MG/KG			B	694.3012	Grab
97VS18N20	Thallium	1.9	MG/KG			B	695.394	Grab
97VS31N17	Thallium	1.9	MG/KG			B	698.88	Grab
97VS20N23	Thallium	1.9	MG/KG			B	695.144	Grab
97VS1AN13	Thallium	1.9	MG/KG			B	702.3759	Grab
97VS1CN7	Thallium	1.9	MG/KG			B	701.5093	Grab
97VS15N22	Thallium	2	MG/KG			B	696.256	Grab
97VS28N5	Thallium	2.1	MG/KG			B	698.577	Grab
97VS19N5	Thallium	2.1	MG/KG			B	695.333	Grab
97VS40N17	Thallium	2.5	MG/KG				696.626	Grab
97VS1N23	Thallium	2.5	MG/KG				702.711	Grab
97VS55L3	Thallium	3.2	MG/KG				683	Grab

Table D-2 Inorganics

Vanadium

At HQ = 10, PRG = 14.4 mg/kg
EDQI = 1.59 mg/kg
Bkg = 25 mg/kg

PRGs:		
	shrew	1.44 mg/kg
	vole	3.81 mg/kg
	robin	103 mg/kg

Location_name	Value_nam	Measured_	Value_unit	Detection_limit	Data_qualif	Lab_qualifi	Elevation	Sample_type
97VS49N1	Vanadium	25.1	MG/KG				697.959	Grab
97VS52L10	Vanadium	25.1	MG/KG				698.29	Grab
97VN20L12	Vanadium	25.2	MG/KG				698.11	Grab
97VS36N13	Vanadium	25.3	MG/KG				698.418	Grab
97VN41L10	Vanadium	25.6	MG/KG				806.27	Grab
97VS37N2	Vanadium	25.7	MG/KG				699.069	Grab
97VN37L15	Vanadium	25.7	MG/KG				808.44	Grab
97VN18L12	Vanadium	25.7	MG/KG				696.9	Grab
97VN19L6	Vanadium	25.8	MG/KG				692.92	Grab
97VS37N2	Vanadium	26.2	MG/KG				699.069	Field Duplicate
97VN29L14	Vanadium	26.2	MG/KG				695.89	Grab
97VS48N4	Vanadium	26.4	MG/KG				697.94	Grab
97VN27L15	Vanadium	26.7	MG/KG				697.64	Grab
97VN22L6	Vanadium	26.8	MG/KG				697	Grab
97VS32N5	Vanadium	27	MG/KG				699.537	Grab
97VN51L21	Vanadium	27.4	MG/KG				689.09	Grab
97VN46L10	Vanadium	27.6	MG/KG				701.18	Grab
97VS24N5	Vanadium	27.7	MG/KG				694.3012	Grab
97VN45L17	Vanadium	27.8	MG/KG				697.48	Grab
97VS50N19	Vanadium	28	MG/KG				697.174	Grab
97VS55L23	Vanadium	28.5	MG/KG				688.05	Grab
97VS51L6	Vanadium	29	MG/KG				688.17	Grab
97VN49L	Vanadium	29.1	MG/KG				697.74	Grab
97VS11N17	Vanadium	29.6	MG/KG				698.379	Grab
97VS17N6	Vanadium	29.7	MG/KG				695.407	Grab
97VRHN1	Vanadium	30	MG/KG				718.757	Grab
97VS27N16	Vanadium	30.3	MG/KG				698.46	Grab
97VS31N17	Vanadium	30.4	MG/KG				698.88	Grab
97VS18N20	Vanadium	31.5	MG/KG				695.394	Grab
97VS19N5	Vanadium	32.1	MG/KG				695.333	Grab
97VN47L14	Vanadium	32.4	MG/KG				698.39	Grab
97VS55L23	Vanadium	32.8	MG/KG				688.05	Field Duplicate
97VN35L13	Vanadium	33.2	MG/KG				801.8	Grab
97VS1AN13	Vanadium	34.4	MG/KG				702.3759	Grab

Zinc

At HQ = 10, PRG = 4570 mg/kg
EDQI = 6.62 mg/kg
Bkg = 140 mg/kg

PRGs:		
	shrew	457 mg/kg
	vole	573 mg/kg
	robin	502 mg/kg

No Locations

APPENDIX E

THREATENED AND ENDANGERED SPECIES INFORMATION

RECEIVED
MAY 30 2000

Bob Taft • *Governor*

Samuel W. Speck • *Director*

Division of Natural Areas and Preserves

Stuart Lewis • *Acting Chief*

May 23, 2000

Roy F. Weston, Inc.
Terry Bosko
3 Hawthorn Parkway
Suite 400
Vernon Hills, IL 60061

Dear Ms. Bosko:

I have reviewed our Natural Heritage maps and files for the Mound Plant project area, including a one mile radius, on the Miamisburg and Franklin Quads in Montgomery County, Ohio. We have one record within the project area. The location for Inland Rush (*Juncus interior*), a state threatened plant, is marked by a red dot on the accompanying map.

There are no existing or proposed state nature preserves or scenic rivers at the project site. We are also unaware of any unique ecological sites, geologic features, breeding or non-breeding animal concentrations, champion trees, or state parks, forests or wildlife areas within a one mile radius of the project area.

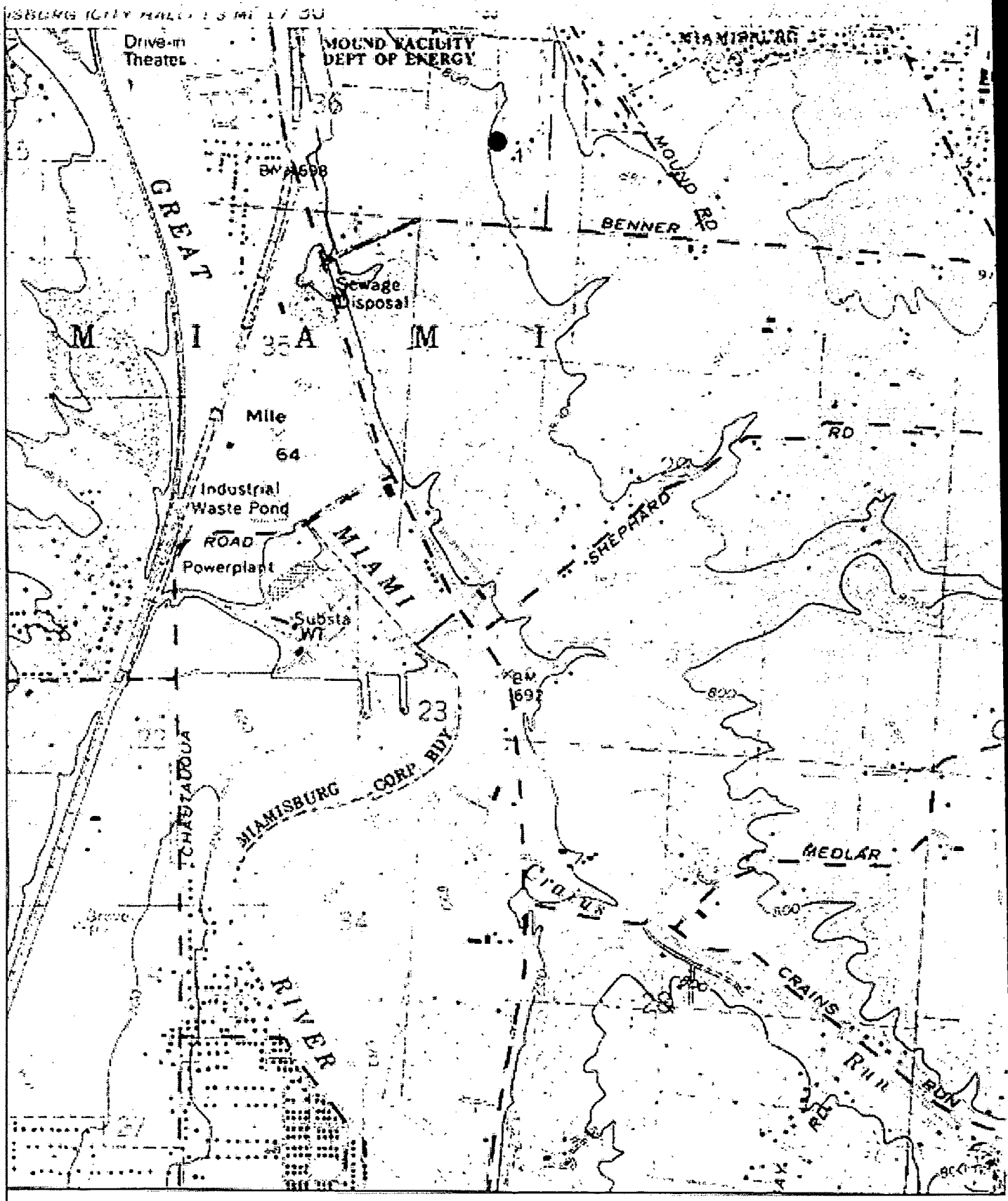
Our inventory program has not completely surveyed Ohio and relies on information supplied by many individuals and organizations. Therefore, a lack of records for any particular area is not a statement that rare species or unique features are absent from that area. Please note that although we inventory all types of plant communities, we only maintain records on the highest quality areas. Also, we do not have data for all Ohio wetlands. For additional information on wetlands and National Wetlands Inventory maps, please contact Jim Given in the Division of Real Estate and Land Management at 614-265-6770.

Please contact me at 614-265-6818 if I can be of further assistance.

Sincerely,

Debbie Woischke

Debbie Woischke, Data Specialist
Division of Natural Areas & Preserves



Name: FRANKLIN
Date: 5/22/100
Scale: 1 inch equals 1333 feet

Location: 039° 36' 30.8" N 084° 17' 03.5" W
Caption: Roy F. Weston, Inc.;
Mound Plant Project Area

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United States Department of the Interior

FISH AND WILDLIFE SERVICE

Ecological Services
6950 Americana Parkway, Suite H
Reynoldsburg, Ohio 43068-4127
(614) 469-6923
Fax: (614) 469-6919

May 31, 2000

JUN – 5 2000

Mr. Terry Bosko
Roy F. Weston, Inc.
Suite 400
3 Hawthorn Pkwy
Vernonn Hills, IL 60061-1450

Dear Mr. Bosko:

This is in response to your May 22, 2000 letter requesting information we may have regarding the occurrence or possible occurrence of Federally-listed threatened or endangered species within the vicinity of the proposed site. This information is being requested to prepare a Screening Level Ecological Risk Assessment for the Miami-Erie Canal and the South Property of the Mound Plant for the U.S. Department of Energy as part of CERCLA activities at the plant. The plant is located in Miamisburg, Montgomery County, Ohio.

In general, we recommend that proposed developments minimize water quality impacts and impacts to high quality fish and wildlife habitat, such as forests, streams, and wetlands. If streams and wetlands would be impacted, the Louisville District of the Corps of Engineers should be contacted for possible need of a Section 404 permit.

ENDANGERED SPECIES COMMENTS: The proposed project lies within the range of the Indiana bat, a Federally listed endangered species. Summer habitat requirements for the species are not well defined but the following are thought to be of importance:

1. Dead trees and snags (especially those with exfoliating bark) which may be used as maternity roost areas along riparian corridors.

2. Live trees (such as shagbark hickory) which have exfoliating bark.

3. Stream corridors, riparian areas, and nearby woodlots which provide forage sites.

Considering the above items, we recommend that if trees with exfoliating bark (which could be potential roost trees) are encountered along the proposed right-of-way, they should be saved wherever possible. If they must be cut, they should not be cut between April 15 and September 15.

If desirable trees are present and if the above time restriction is unacceptable, mist net or other surveys should be conducted to determine if bats are present. The survey should be designed and conducted in coordination with the endangered species coordinator for this office, Mr. Buddy Fazio. The survey should be conducted in June or July since the bats would only be expected in the project area from approximately April 15 to September 15.

The project area also lies within the range of the eastern massasauga, a docile rattlesnake that is declining throughout its national range and may soon receive status as a Federal candidate species. The snake is currently listed as endangered by the State of Ohio, and ultimately may become a Federally listed species. We encourage early project coordination to avoid potential impacts to massasaugas or their habitat.

The massasauga is often found in or near wet areas, including wetlands, wet prairie, or nearby woodland or shrub edge habitat. Wet habitat and nearby edges are utilized by the snakes especially during spring and fall. Upland areas up to 1.5 miles away are utilized during summer, if available. If crayfish holes exist in a wet area, the massasauga may live there, too. Some project management ideas include the

following:

1. At a minimum, project evaluations should contain delineations of whether or not massasauga habitat occurs within project boundaries. Descriptions should indicate the quality and amount of massasauga habitat that may be affected by the project.

2. In cases where massasaugas are known to occur or potential habitat is rated moderate to high, massasauga surveys may be necessary. If surveys are conducted, they should be performed during the period of Spring emergence from dens (usually a narrow window in April or May).

3. In portions of projects where massasaugas will be affected, clearing and construction activities should occur during Summer when air and ground temperatures are above 65° F. Massasaugas are mobile during this period and are more likely to move to upland sites.

4. Maintenance activities (mowing, cutting, burning, etc.) should be conducted within the specified seasonal temperature periods described.

This technical assistance letter is submitted in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C.661 et seq.), the Endangered Species Act of 1973, as amended, and is consistent with the intent of the National Environmental Policy Act of 1969, and the U.S. Fish and Wildlife Service's Mitigation Policy.

If you have questions, or if we may be of further assistance in this matter, please contact Megan Sullivan at extension 21 in this office.

Sincerely,

Ken Multon

for Kent E. Kroonemeyer
Supervisor

cc: DOW, Wildlife Environmental Section, Columbus, OH